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Research Article

Systematic Literature Review: The Utilization of Learning Media in the Implementation of the STE(A)M Approach in Mathematics Learning

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Abstract.
STEAM (Science, Technology, Engineering, Art, and Mathematics) is an approach that can help provide stimulation to students to increase their creativity. Teachers can design mathematics learning in class by considering the needs of each student. Appropriate and interesting learning media can stimulate students to be able to arouse their imagination, creativity, and artistic expression. The purpose of this study is to classify the implementation of STE(A)M learning based on the level of education, type of learning media, topics, and mathematical abilities to be developed. It uses the method of systematic literature review (SLR), and concludes that STE(A)M learning has been widely applied at the secondary school level, especially in algebra and geometry, and has been proven effective in improving students' problem-solving abilities.

Keywords: Mathematics learning, STEAM, Teaching, Learning media

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1. INTRODUCTION

The world of education today is faced with the demands of society to be able to produce human resources with high competence and be able to compete in this era of revolution 4.0 both in terms of knowledge, skills, morals and ethics. Mastery of science and technology, high skills will greatly affect the quality of education in the future. 21st century learning includes aspects of forming learning skills and being able to apply innovations from thinking patterns and working methods, in addition to being able to provide information to other students in their groups, using media and technology, and having abilities/skills/life.

Mathematics is a universal science that plays an important role in everyday life and also in various disciplines of science, as well as improving human thought patterns. The

rapid development of technology is also inseparable from the role of science, especially mathematics. The role of mathematics in life is so great that it requires everyone to study it. By studying mathematics, the ability to think mathematically, logically, critically, and creatively can be developed. (Meliyani: 2021) said that one of the main problems in learning mathematics is the mastery of concepts where abstract mathematical concepts are arranged sequentially and hierarchically and require special proof, so that in the learning process the previous mathematical concepts must be mastered because they are a prerequisite for continuing the next concept. In this case, academics continue to research learning approaches that are suitable for today's students so that students can truly master mathematical concepts. The learning approach that is currently in great demand in various countries because it is considered suitable for the development of education in this era and has been widely applied is the STEAM approach.

The quality of education cannot be separated from the most basic process, namely the learning process in the classroom. The quality of learning in the classroom cannot be separated from several aspects, one of which is the learning approach. One of the learning approaches that can explore students' skills in creative thinking is STEAM. STEAM is a learning approach that integrates five disciplines including Science, Technology, Engineering, Art and Mathematics. STEAM products not only contain cognitive aspects, but will also contain several other aspects, namely affective and psychomotor aspects that can be developed by students in facing the current digital era. Cognitive abilities and creativity must continue to be developed in various forms, one of which is learning using the STEAM approach that integrates design, creativity, and innovation in the disciplines of science, technology, engineering and mathematics so that students can develop the abilities needed in facing globalization and the development of science and technology. Learning with STEAM connects problems that are often encountered in everyday life, so that it is expected to have high thinking power, creativity and curiosity(1). The implementation of STEAM in school learning has been widely carried out in various subjects. One of the subjects that can use STEAM is mathematics. The implementation of STEAM in mathematics learning can be done well when teachers as learning companions can understand the meaning of an implementation. The implementation or application of STEAM is the process of applying the ideas and concepts of the STEAM approach in learning that has an impact and improves the quality of education towards a better direction.

In the context of the STEAM approach, learning media plays a very important role because the use of appropriate media can help students understand complex concepts

better and can increase students' learning motivation.(2). Without the help of learning media, of course the STE(A)M approach will be difficult to implement. However, currently there have been many digital-based media developed. In his book(3)classifies digital-based learning media into six parts, including E-Books, Learning Videos, Learning Applications, Simulations or Games, Webinars and Videos, as well as Augmented Reality and Virtual Reality.

Students' mathematical abilities according to NCTM in(4)divided into several types including problem solving skills, reasoning skills, communication skills, connection making skills, and representation skills. NCTM explains these skills in the following definition. Problem solving skills are students' ability to see a problem from various perspectives and use various reasoning techniques to confirm or refute their guesses. Reasoning skills involve the ability to make arguments, draw conclusions, and prove statements with various reasoning techniques and evidence to confirm or refute their guesses. Mathematical communication skills are aspects of the ability to convey and describe information mathematically so that one person has the same understanding. The ability to make connections helps students build a deeper understanding and see mathematics as a coherent whole. While mathematical representation skills involve the use of various ways to describe mathematical ideas such as pictures, tables, graphs, and symbols to capture mathematical concepts or relationships(5).

This study will examine in more depth the use of media in STE(A)M learning, levels of education that have widely implemented STE(A)M learning, mathematical content that has widely implemented STE(A)M learning and mathematical abilities that are to be improved through the implementation of STE(A)M learning.

2. METHOD

To answer the research questions above, a systematic review of qualitative studies on the Utilization of Learning Media in the Implementation of the STE(A)M Approach in Mathematics Learning was conducted. This study uses the Systematic Literature Review (SLR) method. The purpose of a Systematic Literature Review is to identify, examine, evaluate, and interpret all available research with a topic area of interesting phenomena, with specific research questions that are relevant(6). The data collection of this study is a review of electronic journals, namely Google Scholar, Eric, Scopus between 2020-2024 with the help of the publish or perish application. There are 2 keywords used, namely "Mathematics Knowledge OR Skill AND STEAM AND Teaching

OR Learning Media" and "Mathematics Knowledge OR Skill AND STEM AND Teaching OR Learning Media". 561 articles were found in the Eric database, and 22,700 articles in the Google Scholar database, and 124 articles in the Scopus database. Because of the large number of articles found, in order to be more focused, the author only took one database, the least of which was Scopus.

2.1. Search Process

The search process is carried out to obtain relevant sources to answer the Research Question and other related references. The search process begins by writing keywords in the keyword column, writing the search year, namely 2020-2024 in the publish or perish application with the database used being Scopus. In the search process for the first keyword "Mathematics Knowledge OR Skill AND STEAM AND Teaching OR Learning Media" produced 18 articles, and for the second keyword "Mathematics Knowledge OR Skill AND STEAM AND Teaching OR Learning Media" produced 106 articles. The search focused on the objects of study of STEM and STEAM, and the media that will be used in STEM and STEAM learning. Next, the data search process will be explained so that articles are obtained that are ready to be analyzed through the chart below.

2.2. Limitation Criteria

This stage is carried out in an effort to decide whether the data obtained is suitable for use in SLR research or not. The criteria for eligibility selected in this study are, first, data obtained from Journals and Proceedings. Second, data was taken from the Scopus database. Third, Articles published in 2020-2024. Fourth, the language used is English or Indonesian. Fifth, the variables discussed are STEAM or STEM. Sixth, the field of research is mathematics.

2.3. Research Quality

In SLR research, the data found is evaluated based on quality assessment criteria questions, namely:

1. QA1: Research at which level has studied the use of media in implementing learning? STE(A)M in mathematics learning?

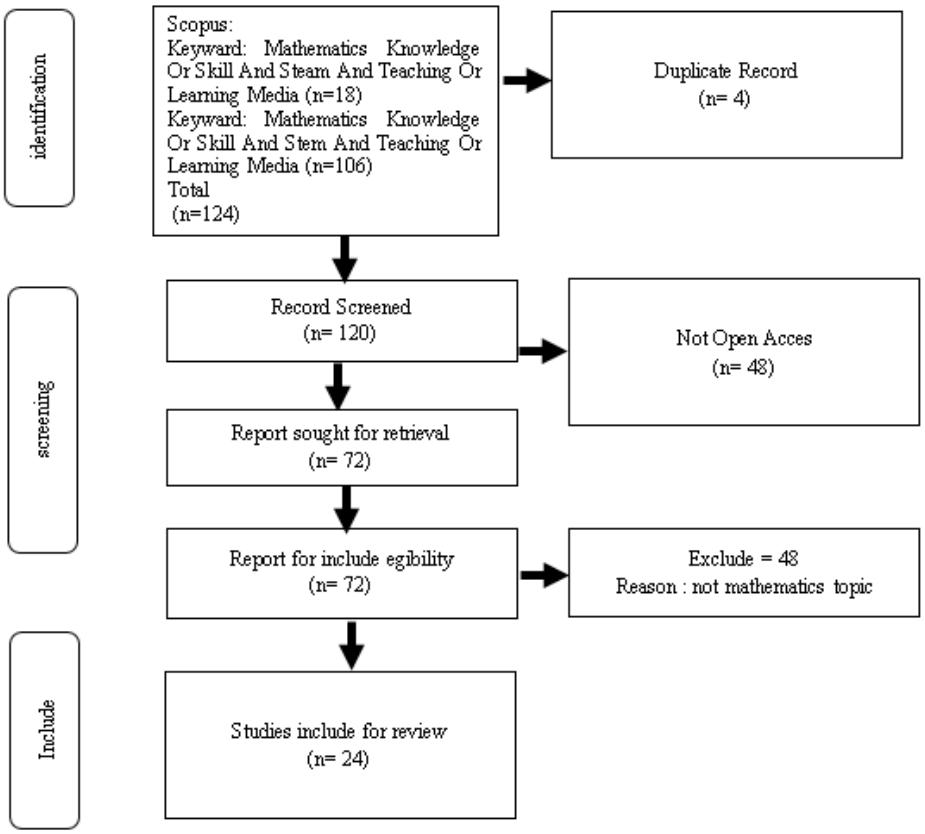

Figure 1: Data Search Process Chart.

TABLE 1: Inclusion and Exclusion Criteria.

No	Category	Inclusion Criteria	Feature Description
1	Publication Type	Articles published in journals and proceedings	Articles published in books, websites, blogs, etc.
2	Database	Scopus	Besides Scopus
3	Year of publication	2020-2024	Under 2020
4	Language used	English or Indonesian	Besides English or Indonesian
5	Independent Variable	STEM or STEAM	Not STEM or STEAM
6	Field	Mathematics	Not Mathematics
7	Research Subject	Formal education of students and teachers includes early childhood school, elementary school, middle school, high school, vocational high school, and university	Students and teachers in non-formal schools or special needs school

2. QA2: What are the types of learning media are used to implement problem-based learning? STE(A)M in mathematics learning?

3. QA3: Implementation of learning What mathematics topics has STE(A)M media been used on?

4. QA4: What mathematical abilities develop through the use of media in the implementation of STEAM learning in mathematics learning?

2.4. Data Collection

The data analyzed consisted of 24 articles as follows:

2.5. Data Analysis

The analysis conducted on the articles that have been collected is by listing each article collected, then classifying the articles to show, first, the level of education that studies a lot about the use of media in the implementation of STE(A)M learning in mathematics learning; Second, the types of media that are widely studied in research on the use of media in the implementation of STE(A)M learning; third, the topics of mathematics that are often discussed in research on the use of media in the implementation of STE(A)M learning; fourth, what mathematical abilities can be developed through the use of media in the implementation of STE(A)M learning in mathematics learning.

3. RESULTS AND DISCUSSIONS

The results of the search process obtained 24 mathematics and mathematics education journals indexed by Scopus.

(RQ1) Research at which level has studied the use of media in the implementation of STE(A)M learning in mathematics learning?

According to Law of the Republic of Indonesia Number 20 of 2003, education levels are stages of education determined based on the level of development of students, the goals to be achieved, and the abilities developed. In formal education, education levels are in the form of basic education, secondary education, and higher education. The form of basic education is elementary school. The form of secondary education is in the form of junior high school and high school. While the form of higher education is in the form of college.

Table 2: Article data to be analyzed.

No	Author Name	Journal Name
1	(7)(Nindiasari et al.,2024)	Infinity Journal
2	(8)(Chang, 2023)	IEEE Transactions on Education
3	(9)(Cisneros, 2023)	Frontiers in Education
4	(10)(Apriandi et al.,2023)	Journal of Learning for Development
5	(11)(Duo-Terron, 2023)	Education Sciences
6	(12)(Manera.,2020)	Springer Proceedings in Advanced Robotics
7	(13)(Jesionkowska et al.,2020)	Education Sciences
8	(14)(Xu et al,2024)	Education and Information Technologies
9	(15)(Lee,2024)	Mathematics Enthusiast
10	(16)(Gal,2022)	Statistics for Empowerment and Social Engagement
11	(17)(Siang See et al.,2023)	Journal of Information Technology Education: Innovations in Practice
12	(18)(Rohendi et al.,2023)	International Journal of Instruction
13	(19)(Jemali, 2022)	IOP Conference Series: Earth and Environmental Science
14	(20)(Zhao, 2022)	IEEE Access
15	(21)(Hadiyanti, 2021)	Journal of Physics: Conference Series
16	(22)(Rahman, 2021)	Journal of Physics: Conference Series
17	(23)(McHugh, 2021)	Research in Science Education
18	(24)(Hamdu, 2021)	Journal of Physics: Conference Series
19	(25)(Putri & Asikin, 2021)	Journal of Physics: Conference Series
20	(26)(Susanti, 2021)	Journal of Physics: Conference Series
21	(27)(Tannirat, 2020)	International Journal of Advanced Science and Technology
22	(28)(Inganah et al., 2023)	ASEE Annual Conference and Exposition, Conference Proceedings
23	(29)(Ibrahim, 2020)	Journal of Physics: Conference Series
24	(30)(Priyanto, 2020)	Journal for the Education of Gifted Young Scientists

In the research on the use of media in the implementation of STE(A)M learning in mathematics learning, the forms of education levels used are elementary schools, junior high schools, and high schools. The percentage of each level of education in the research is presented in Figure 2.

The figure shows that junior high schools dominate with a percentage of 63% with 15 articles. Meanwhile, elementary schools have a percentage of 17% with 4 articles.

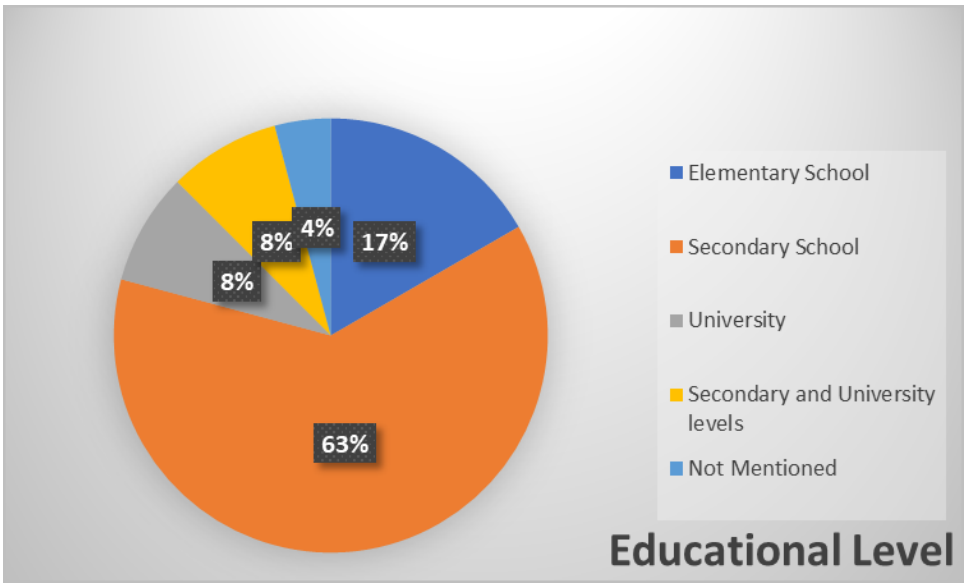

Figure 2: Percentage of Education Levels.

Colleges have a percentage of 8% with 2 articles. Colleges and secondary schools have a percentage of 8% with 2 articles. And 1 article does not mention the level of education.

(RQ2): What types of learning media are used in the implementation of STE(A)M-based learning in mathematics learning?

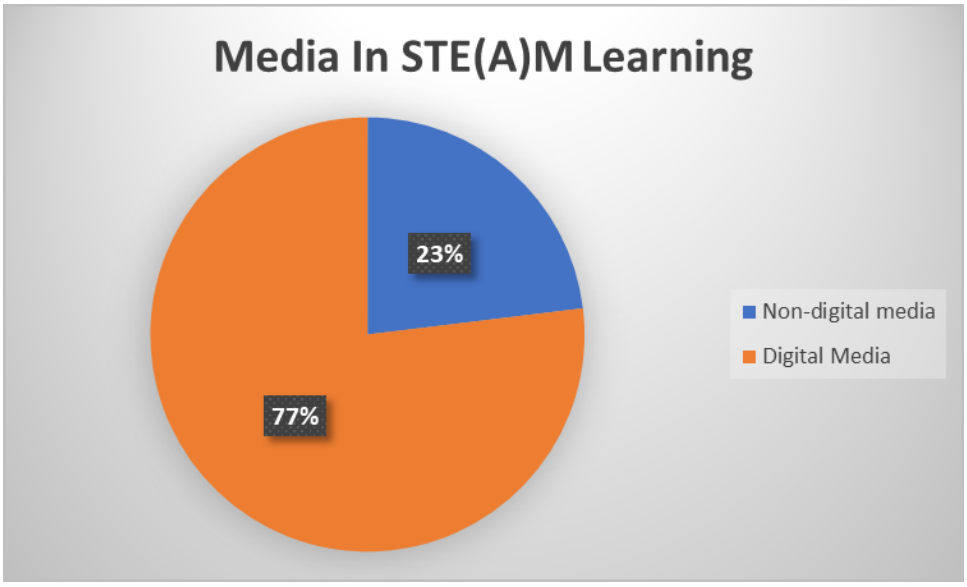

Figure 3: Percentage of Learning Media.

The pie chart above shows that digital media is used more in the implementation of STE(A)M learning with a percentage of 77% with 20 articles compared to non-digital media which has a percentage of 23% with 6 articles. This study classifies learning media into two parts, namely digital media and non-digital media. (3) divide the types

of digital-based learning media that exist today, into several types, first E-Book which is a digital form of a book that can be accessed via electronic devices that allow students to read and access learning materials in digital format. Second, Learning videos which are content in the form of videos that present visual explanations of the material. This video can combine elements such as animation, narration, and images, to help convey information. Third, Learning applications which are software specifically designed for educational purposes. Fourth, Simulations and learning games have an important role in providing a more interactive and interesting learning experience. Fifth, Webinars and Video Conferences which are effective solutions in providing distance online learning. Sixth, Augmented Reality (AR) and Virtual Reality (VR) which are technologies used to provide interactive and in-depth learning experiences through digital media. VR and AR allow students to experience a more realistic learning experience and explore concepts intuitively. STEAM-based media are currently being widely developed by researchers. Starting from E-books, Learning Videos, Learning Applications, and Simulations or learning games. The percentage of digital media use in the implementation of STE(A)M learning is explained in the bar chart below

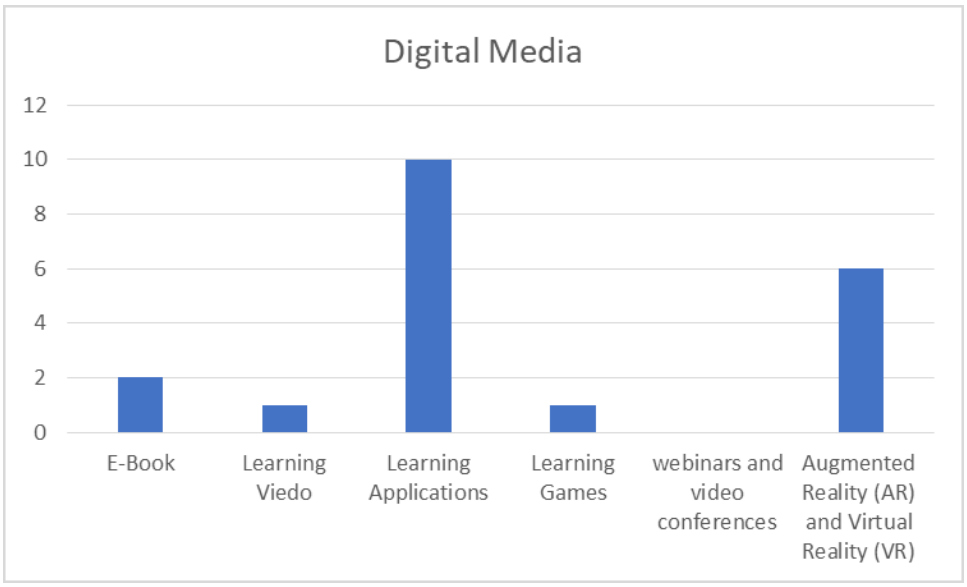

Figure 4: Types of digital media.

Based on the analysis conducted, it is known that the digital media that is most widely developed and used in the implementation of STE(A)M learning is the Learning Application. Furthermore, Augmented Reality (AR) and Virtual Reality (VR) are also starting to be widely developed. Learning Games and Learning Videos have not been widely developed. This can be a reference for further researchers to be able to develop learning videos and learning games.

In his research (7) said that the use of Augmented Reality Mathematics (ARM) media with STEAM learning can improve problem-solving skills in geometry concepts.

(RQ3): What mathematics topics has the implementation of STE(A)M learning been used on?

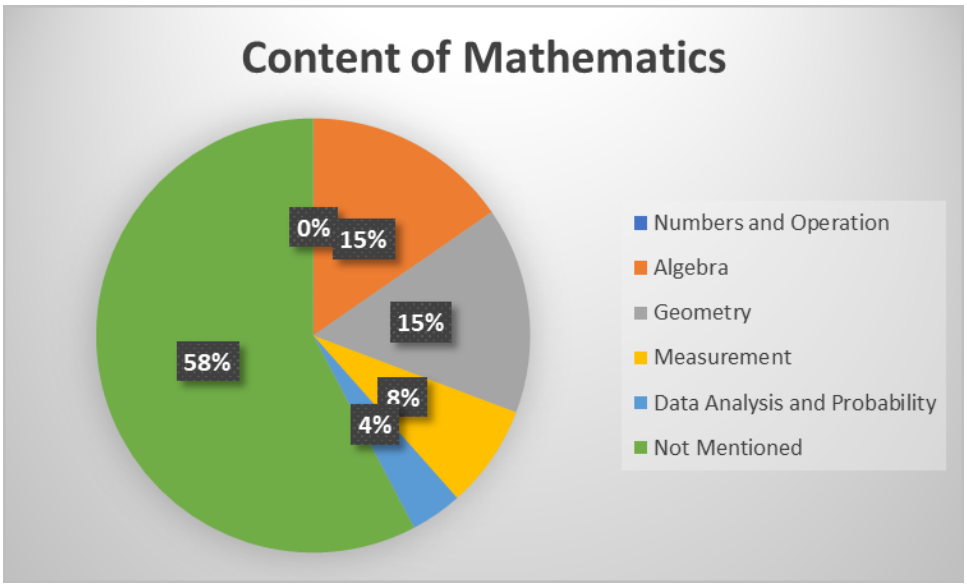

Figure 5: Mathematics Topic Diagram.

NCTM divides mathematical content into numbers and their operations, algebra, geometry, measurement, data analysis and probability. In the study on the use of media in the implementation of STE(A)M learning in mathematics learning, there are 9 topics discussed. The dominant topics are geometry and algebra with each percentage being 15%, amounting to 4 articles. Measurement content with a percentage of 8%, amounting to 2 articles, data analysis and measurement content with a percentage of 4%, amounting to 1 article, while 58% of articles do not mention the content discussed in detail.

(RQ4): What mathematical abilities develop through the use of media in the implementation of STEAM learning in mathematics learning?

NCTM (National Council of Teachers of Mathematics)(4)establishes five standard abilities that must be possessed in learning mathematics, namely problem solving abilities, reasoning abilities, communication abilities, connection making abilities, and representation abilities.

Mathematical problem solving skills are a complex thinking process where in the learning process it will enable students to think more critically in investigating problems, so that they can respond to and solve problems better, and can apply these

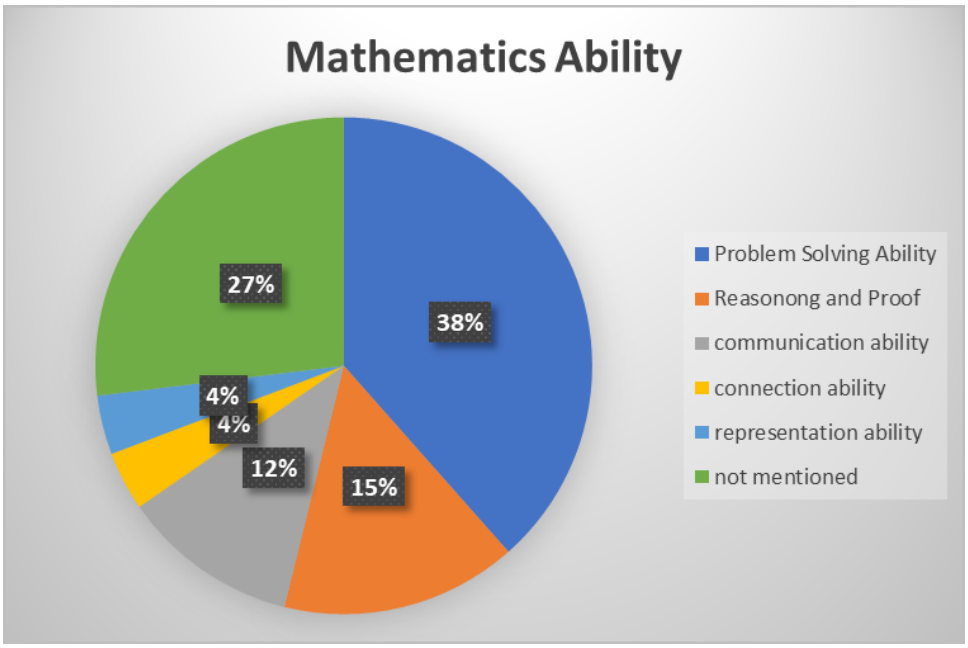

Figure 6: Mathematics Ability Diagram.

mathematical problem solving skills in mathematics learning, other learning, and in solving problems in everyday life.(31). Mathematical reasoning ability is the ability to use mathematical rules, properties, or logic to obtain a correct conclusion. Mathematical communication ability is the ability of students to express mathematical ideas either verbally, in writing, such as pictures/diagrams, representing them in algebraic form or using mathematical symbols.(32). Mathematical connection ability is the ability to make connections between mathematical study objects which include facts, concepts, principles and skills.(33). Mathematical representation ability is the ability to express mathematical ideas in the form of problems, definitions, etc. and to communicate mathematics in the form of tables, images, graphs, mathematical statements, texts, and also a combination of all of them.(34).

The mathematical abilities to be developed are dominated by problem solving abilities with a percentage of 38% of 10 articles, mathematical reasoning abilities with a percentage of 15% of 3 articles, mathematical communication abilities with a percentage of 12% of 3 articles, mathematical connection abilities, and mathematical representation with a percentage of 4% of 1 article, and 27% of 7 articles do not include the mathematical abilities to be developed. The mathematical ability that is greatly improved in STEAM learning is problem solving abilities.

The implementation of the STE(A)M approach in the last five years has been dominated by junior high school education with a percentage of 63% followed by elementary

education with 17%. However, the implementation of the STE(A)M approach is still relatively little applied at the higher education level. STEAM has a fairly important role in creating a curriculum that is more relevant to the needs of today's society. STE(A)M overcomes rigid learning, encourages students to think critically and creatively and can develop social and emotional skills that are currently needed in society. In addition, STE(A)M prepares students to face challenges in this digital era. The author hopes that STE(A)M learning can be implemented at all levels of education.

It is hoped that STE(A)M learning will better prepare students to face the world of work.

4. CONCLUSION

The conclusion of this study was obtained from the data analysis that had been carried out so that information was obtained that the Implementation of STE(A)M learning has been widely used at the secondary school level. The media that is more widely developed in the implementation of STE(A)M learning is digital media compared to non-digital media. Meanwhile, STE(A)M-based media that has been widely developed and used is the Learning Application. However, AR and VR-based applications are also currently being widely found. The implementation of STE(A)M learning has been widely used in almost all mathematical content, but the most widely applied is Geometry and Algebra content. This STE(A)M learning has helped teachers improve students' mathematical abilities such as problem solving skills, reasoning skills, communication skills, connection skills, and representation skills. However, STE(A)M learning is most effective in improving students' problem solving skills.

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