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Students' Mathematical Attitudes: A Systematic Mapping Study

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Abstract

This article is preliminary research that explores the results of studies conducted on students' mathematical attitudes using Systematic Mapping Study (SMS). The purpose of this Mapping is to discuss any mathematical attitude topic that is being reviewed and studied. This research uses qualitative methods using a study library. The search was carried out on the Scopus database with 36 articles used in 2014-2022 publications published in the form of scientific journals included in the inclusion criteria. The results of this SMS show an overview of opportunities to explore new topics in students' Mathematical Attitudes or utilise existing issues regarding the most significant focus of mathematics education: gender, student attitudes, self-concept, attitudes to mathematics, gender differences, and mathematical performance. The trends from several countries studied are China, the United States, the United Kingdom, Italy, Spain, Germany, the Russian Federation, France, and Canada

INTRODUCTION

Humans need education throughout life; it will be easier to develop and experience change. Therefore, education needs to be taught from the basic level, middle level to advanced level, one of which is mathematics education. Kaiser & Sriraman (2010) say that mathematics is an excellent means for training and developing intellectual competence, the ability to think logically and systematically to solve mathematical and everyday problems. Hidayat, Wahyudin, and Prabawanto (2018) said that mathematics must be taught to students because 1) it is always used in our lives; 2) all lessons require appropriate mathematical skills, 3) the means of communication is a vital, short, and clear, challenging problem. This shows that problem-solving plays a vital role in mathematics learning.

The success of mathematics learning is also influenced by various factors, including students' attitudes towards mathematics. Ainley, M., & Ainley, J. (2011) Attitudes towards mathematics include affective, cognition, and conation. The cognitive part is composed of the knowledge and information a person has about the object of their attitude, the affective component is evaluative and relates to feelings of pleasure and displeasure, and the conation component is a person's readiness to act about the object of

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their attitude or a part related to the tendency to work towards it. Object. Students' mathematical attitudes cannot be ignored in mathematics learning because they influence education.

Knowing students' attitudes towards learning mathematics is very important in supporting the success of teachers in teaching mathematics. If mathematical problem-solving abilities are low, it will result in students having a negative attitude toward learning mathematics, or conversely, students' negative attitudes towards mathematics can result in students' low mathematical problem-solving abilities (Eccles et al., A. (2002)). So, teachers must eliminate harmful attitudes and instil positive attitudes in students towards mathematics.

Stigma like this decreases students' mathematical performance, including low problem-solving abilities. Several previous studies (Fuadi et al., 2017), which researched analysing students' mathematical problem-solving skills, showed that students' mathematical problem-solving abilities still needed to be in a better category. Therefore, various aspects supporting students' abilities in solving mathematical problems must be considered, including students' mathematical attitudes. Students' attitudes towards mathematics will influence student achievement; this is supported by research results (Makur et al., 2019), which state that the more positive a student's mathematical attitude, the better their mathematical problem-solving abilities.

Mathematics education research has widely discussed students' attitudes towards mathematics (Mensah et al., 2013). Besides cognitive factors, student attitudes have also been accepted as a critical factor influencing student achievement (Mensah et al., 2013; Abu & Leong, 2014). According to Ayob & M. Yasin (2017), positive perceptions of mathematics learning among students will develop positive attitudes toward mathematics and lead to higher achievement. In line with this, one of the goals of mathematics education is the formation of students' attitudes. Therefore, paying attention to students' attitudes towards mathematics in the mathematics learning process is appropriate.

Attitude is a component that significantly influences the success of mathematics learning programs. Someone with a positive attitude will show actions that always lead to efforts to achieve mathematics learning goals (Hannula, MS 2006). One of the things that a teacher needs to pay attention to in making his learning a success is creating a learning condition and climate that can stimulate and increase students' positive attitudes toward learning mathematics.

According to Sax (1989), attitude is a tendency on a dimension from likes to dislikes towards a particular group, institution, concept, or object. Nitko (2007) emphasised that attitude is a person's characteristic that describes their positive and negative feelings towards a particular thing, situation, institution, person, or idea. White et al. (2006) continued that attitude shows a person's decision, which is shown in terms of good or bad towards something in the form of supporting or opposing behaviour.

Attitudes towards mathematics, according to Zan & Martino (2007) state that attitudes towards mathematics are seen as a relationship pattern of beliefs and emotions with mathematics in line with research by Yáñez-Marquina & Villardón-Gallego (2016),

which shows that mathematical attitude is directly proportional to mathematical ability, the higher the mathematical attitude, the higher the mathematical ability, including problem-solving ability.

Arcavi (2006) states, "Mathematical thinking-related attitudes are intellectual predispositions towards doing mathematics and solving problems, including perspectives on what is mathematics and mathematical activity." The statement above explains that mathematical attitudes are intellectual tendencies towards mathematics and problem-solving solutions, including perspectives on mathematics and mathematical activities.

Khalik (2006) explains the importance of mathematical attitudes in mathematics learning; mathematical attitudes are a significant affective factor in determining students' behaviour in mathematical thinking and problem-solving because students' attempts in mathematical thinking depend on how interested they are in problem-solving or the lesson. So, mathematical attitude is a significant affective factor in determining student behaviour in mathematical thinking and problem-solving because students' efforts in mathematical thinking depend on how interested they are in problem-solving or learning.

Isoda emphasises the definition of mathematical attitude. M & Katagiri. S. (2012) that mathematical thinking is like an attitude, as it can be expressed as a state of "attempting to do" or "working to do" something. It is not limited to results represented by actions, as in "the ability to do," "could do," or "could not do" something. Isoda. M & Katagiri. S. (2012) emphasised that mathematical thinking is like an attitude in that it can be expressed as a state of "trying to do" or "working to do" something. It is not limited to the outcome represented by the action, as in "the ability to do it," "can do," or "cannot do" something.

Mathematical attitudes are a driving force in mathematical thinking related to mathematical methods and ideas. So, mathematical attitude is a critical component of mathematical thinking. Isoda. M & Katagiri. S. (2012) explains the mathematical attitude as follows: a) Objectifying (Attempting to grasp one's problems or objectives or substance clearly by oneself): (1) Attempting to pose questions; (2) Attempting to be aware of problems; and (3) Attempting to realise mathematical problems from the situation. b) Reasonableness (Attempting to take logically grounded and reasonable actions): (1) Attempting to take actions that match the objectives; (2) Attempting to establish a perspective; and (3) Attempting to think based on the data that can be used previously learned items, and assumptions. c) Clarity (Attempting to represent matters clearly and simply): (1) Attempting to record and communicate problems and results clearly and (2) Attempting to sort and organise objects when representing them. d) Sophistication (Attempting to seek better ways and ideas): (1) Attempting to raise thinking from the object to the operation; (2) Attempting to evaluate thinking both objectively and subjectively, by each other, for refining; and (3) Attempting to economise thought and effort. (1) Attempting to raise thinking from the object to the operation; (2) Attempting to evaluate thinking both objectively and subjectively, by each other, for refining; and (3) Attempting to economise thought and effort. (1) Attempting to raise thinking from the object to the operation; (2) Attempting to evaluate thinking both objectively and

subjectively, by each other, for refining; and (3) Attempting to economise thought and effort.

In the context of mathematical solving and mathematical activities, mathematical attitudes can be measured in four dimensions of attitude measurement, which are synthesised based on the definitions above, namely: (1) Objectifying, understand the problem and the purpose and substance of the problem independently, (2) Reasonableness, try to take logical action, (3) Clarity, try to express things clearly and concisely, (4) Sophistication, trying to find a better solution. The method considered the most reliable for revealing a person's attitude is to use a list of statements from the description of each mathematical attitude indicator that the individual must answer, called an attitude scale.

Hart (1989) refers to mathematical attitudes as individuals' emotional responses to mathematics, beliefs in mathematics, and how they behave towards mathematics. Hannula (2002) defines attitudes based on emotions, thoughts, and behaviour. Di Martino and Zan (2007) suggest that cognitive must also be integrated into the mathematical attitude component. Therefore, the definition of mathematics attitude has been expanded based on three elements: affective (i.e., emotional and beliefs), behavioural, and cognitive (Ayob & M. Yasin, 2017). Positive attitudes toward mathematics influence students' willingness to learn mathematics compared to students who have negative attitudes towards mathematics, and once they feel mathematics is essential,

Search results using the Scopus electronic database regarding journals or scientific articles discussing Mathematical Attitudes. The approach method used is a Systematic Mapping Study (SMS). There are nine articles from search results from the Scopus electronic database (Banaeianjahromi & Smolander, 2016; Kitchenham & Charters, 2007; Muhammad et al., 2017; Petersen et al., R. and Mujtaba; S. & Mattsson, 2008). This systematic mapping analyses search results from 36 articles with Research Questions (RQ).

Based on this, this article aims to make it easier for researchers to find previous studies related to research themes on Mathematical Attitudes research objects, and this systematic mapping is to form a research background and gain insight into Mathematical Attitudes as well as implications and guidelines for other academics to create a research basis about Mathematical Attitude.

METHOD

This research uses a Systematic Mapping Study (SMS) approach. SMS has its roots in the study literature review (SLR), which was introduced in medical research (Kitchenham, 2007). The application of SLR is to identify, evaluate, and interpret all available and relevant literature related to the research question or domain of interest (Kitchenham, 2007; Petersen et al., 2008). The most common reasons for SMS are, first, to summarise existing evidence on the topic; Second, to identify gaps in current research and provide suggestions for future investigation; And third, to provide background for positioning new research activities (Kitchenham, 2007). SMS is applied to describe the

types of research activities that have been carried out in this research. SMS describes the research at a high level and maps the research rather than investigating the research question in detail (Petersen et al., 2008). In other words, SMS can be considered a method for obtaining a general overview of a particular research area because SMS research explores information in detail (Kitchenham, 2007).

Search Steps

To increase the accuracy of SMS studies, the search and analysis process must be as accurate as possible. Thus, this section characterises selecting data sources, implementing strategies for creating search strings, and determining exclusion and inclusion criteria. This research adopts the search process from research (Petersen et al., 2008). Each step has a result in this process, and a systematic map is the final result of the mapping process. The table illustrates the SMS process and performing an online search on the Scopus electronic database.

Table 1. Search Steps

Data source	Search Intervention	Detected
SCOPUS	*Search string* "mathematical attitude."	51
	Filter 2/Limit to: a. Open access: All Open Access *b. Subject Area: Mathematics* *c. Document Type: Article* *d. Source Type: journals* *e. Language: English*	9
	Final Paper	9

Source: Processed data (2022)

Search Strings use boolean words to synthesise into one search string. Researchers used a "mathematical attitude," and in the end, researchers found 51 documents. The search string above is applied to search all article parts in the Scopus database, such as title, abstract, keywords, and main section. The search process begins in October 2022 (Barbosa, 2011). The next step to do a filter is a. Open access: All Open Access subjects are Mathematics, Publication stage: Final, Document Type: Article, Source Type: journals, Songage: English. After that, there are nine articles.

The author classifies paper types and research methods, referring to the research of Banaeianjahromi Smolander (2016), where the article groups paper types into five categories and research methods into three categories (Table 2).

Table 2. Classification Categories

Paper Type		
1	*Validation Research*	The method used is new and has not yet been implemented in practice
2	*Evaluation Research*	Investigation methods are implemented in practice and presented in evaluation methods
3	*Solution Proposal*	The proposed solution to the problem could be a new approach or one already implemented.
4	*Philosophical Papers*	Introduce new perspectives using a conceptual framework or taxonomy
5	*Experience Papers*	The author's personal experience of what and how he does in practice
Research Methods		
1	Qualitative Method	Rapid Assessment Process, secondary data, ethnography, Focus Group Discussions, in-depth interviews, Diaries, and language analysis present qualitative methods.
2	Quantitative Methods	Quantitative Methods present sample designs, hypotheses, and tests, all of which are statistical formulations
3	Mix-Method	Mix methods are presented by combining quantitative and qualitative methodologies for research to obtain more comprehensive, valid, reliable, and objective data.

Source: Banaeianjahromi & Smolander (2016)

RESULTS

The results of the systematic mapping of 9 articles regarding mathematical attitude were grouped based on the following categories: research focus, research method, type of paper, and publication trends.

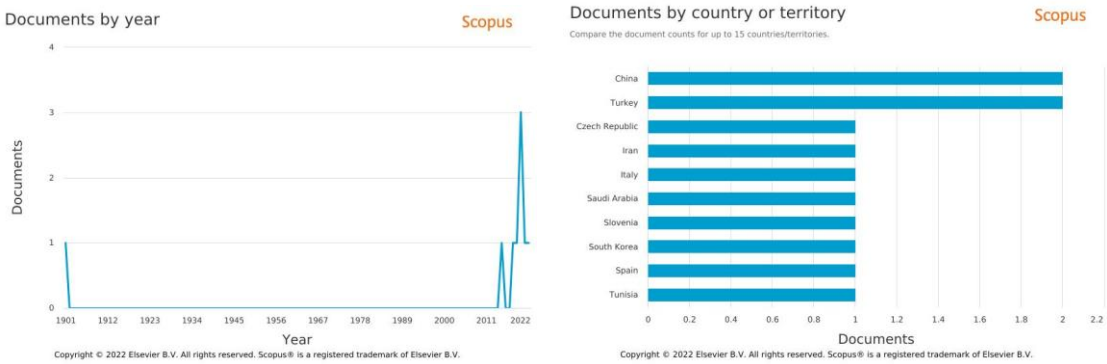

Figure 1. Country Trends & Year of Publication

The results of a systematic mapping study show that from 9 scientific articles, it was found that publications related to mathematical attitude experienced an increase starting in 2015 with a peak in 2020 (33.3%), then decreased in 2022 only (11.1%). The figure shows the trend of the country of origin of publications regarding mathematical attitude, which dominates China and Turkey (22.2%), followed by the Czech Republic, Iran, Italy, Saudi Arabia, Slovenia, South Korea, Spain, and Tunisia.

Research Methods and Paper Type Used

In this discussion, the author classifies paper types and research methods, referring to the research of Banaeianjahromi and Smolander (2016), wherein the article grouped paper types into five categories and research methods into three categories (Table 2). Based on a systematic mapping study (Petersen et al., 2008).

Table 3. Article Mapping

No	References	Year	Title	Country	Research Focus	Research Locus	Research Methods	Paper Type
1	Bakar, SA Job, AFM	2020	Relationship between attitude towards mathematics and mathematical problem-solving achievement among pre-university students in Malaysia	Malaysia	relationship between attitude towards mathematics and problem-solving	Attitude; Enjoyment; M achievement; Problem solving; Self-confidence	Quantitative	*Evaluation Research*

2	Opstad, L	2021	Factors explaining business student attitudes towards mathematics : Does gender still matter?	Nor-way	identify factors that can explain the perspectives of business students toward mathematics	Attitudes towards mathematics; Big Five; business school; Gender differences; Independent t-test; Mathematical skills; Regression analysis	Quantitative	*Evaluation Research*
3	Rourke, Iseult O Prenderg ast, Mark	2021	Mathematics as a gendered subject: a deeper insight into students' attitudes in Irish post-primary schools	Fran-cis	examines gender differences in students' attitudes to mathematics	mathematics education; gender; student attitudes; self-concept	Quantitative	*Evaluation Research*
4	Kolopajl o, L	2019	Attitudinal and mathe-matical assessments as measures of student success in a college general chemistry II course	United States	attitudes and mathematical skills equally affect final course grade	Michigan; Minnesota; United States; assessment methods; building; cosmochemistry ; gender; measurement method; public attitude; questionnaire survey; students	Quantitative	*Solution Proposal*
5	Dowker, A Sheridan, H	2022	Relationship s Between Mathematics Performance and Attitude to Mathematics : Influences of Gender, Test Anxiety, and Working Memory	United King-dom	investigating working memory, attitude to mathematics, test anxiety	adults; attitudes to mathematics; gender differences; mathematical performance; test anxiety; working memory	Quantitative	*Solution Proposal*

6	Jufrida Jufrida, Wawan Kurniawan, Astalini Astalini, Darmaji Darmaji, Dwi Agus Kurniawan, Weni Angra Maya	(2019).	Student's attitude and motivation in mathematical physics	Indo-nesia	This study aims to determine the attitudes and causes of students in mathematical physics	Attitude Motivation Physics mathematics Students	Quantitative	*Evaluation Research*
7	Suk Young Yun, Yu Jung Nam, Yong Il Kwon, and Byung Jin Choi	2020	The Effects of the Horticulture - Mathematics Integration Program on Mathematical Attitude and Money Calculating Ability of Students with Intellectual Disabilities	Korea	Effects of a horticulture-mathematics integration program on mathematical attitude and money calculating	horticulture activities, mathematics curriculum, purchase activities program, particular school	Quantitative	*Evaluation Research*
8	Doz, D., Felda, D., & Cotič, M	2022	High school students' attitudes towards geometry: An exploratory factor analysis	Slo-venia	instrument that can be used to measure students' attitudes	geometry, philosophy, PCA, EFA, high school	Quantitative	*Solution Proposal*
9	Lixin Ren • Wendy M. Smith		Teacher characteristics and contextual factors: links to early primary teachers' mathematical beliefs and attitudes	China	teacher charac-teristics and contextual factors are related to early primary teachers' beliefs about mathematical teaching and learning and teachers' attitudes toward their understanding of mathematics	Teacher beliefs Mathematical attitudes Teacher knowledge Teacher characteristics Teaching contexts	Quantitative	*Solution Proposal*

DISCUSSION

*Systematic mapping study (SMS)*provides an overview of mathematical attitude. Researchers from academics and practitioners can use this research as initial research. This systematic mapping used 51 research articles from the Scopus database. After mapping using the guidelines in Table 1, we found nine pieces. Next, the author developed a classification scheme that categorises articles based on reference, title, country, year of research, research focus, type of research, and research methods. Regarding research focus, we conclude that research on mathematical attitudes mainly researches Social Science (53.8%), while for research methods, most use quantitative methods, nine articles. There are several limitations in this systematic mapping process, including journal searches only sourced from 1 scientific database, namely Scopus, so it can only cover some existing journal and conference databases. Apart from that, we only took the categories of articles in English, international journals, and research papers and did not include books and magazines.

CONCLUSION

Research related to mathematical attitudes is currently experiencing an increase, marked by the emergence of indicators of mathematical attitudes. Mathematical attitude is an integral part of mathematics learning because it has a direct relationship and influence with mathematical ability and achievement. This research maps the existing Mathematical Attitude literature by searching for articles from the Scopus database. This was done to provide a general overview of existing literature on Mathematical Attitudes for further research so that it is easy to find the state-of-art of Mathematical Attitudes. This research applies the SMS method to determine the focus of what has been studied in this research area. From the results of 9 research articles that have been mapped systematically, classify research articles based on the research method approach with the topics discussed, namely: Mathematical Attitudes with the following research focus: mathematics education; attitude; students; self-concept, attitudes towards mathematics; gender differences; mathematical performance. The results of this research can guide in helping researchers plan future research by finding research gaps.

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