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Improving Students' Mathematical Disposition In Mathematics Learning: A Systematic Literature Review

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Abstract

Interest and positive attitude can support optimal mathematics learning. When students like math and have a positive attitude, it will allow students to succeed in learning mathematics. These interests and tendencies are called mathematical dispositions. Mathematical disposition plays an important role in the expected progress of mathematics learning, primary research has been conducted to improve mathematical disposition. Therefore, this study examines efforts or programs that can improve students' mathematical disposition, the methods used, reviews the effectiveness of these efforts, and reviews suitable efforts in improving mathematical disposition based on education level. This research is a Systematic Literature Review (SLR) using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) with the following steps: first, identification; second, screening; third, eligibility; and fourth, included. The relevant articles reviewed were from the last 5 years in 2019-2023. The results showed a variety of efforts and methodologies in improving mathematical disposition from the 20 included studies. Mathematical disposition is improved by various efforts such as the application of student-centered learning models and approaches, counting activities, application of technology, development and application of teaching materials. The results of this study are expected to be useful for practitioners in improving students' mathematical disposition so that it can support optimal mathematics learning and improve mathematics learning outcomes.

keywords: *Mathematical Disposition; Student-Centered Learning; Systematic Literature Review*

Introduction

Mathematics is a field of science that is powerfully useful in various fields, in life or improving the quality of a person's abilities. The field of mathematical knowledge is a very strong mental tool to help individuals when solving problems and developing high-level thinking abilities (Skemp, 1987; Yuliani et al., 2021). Mathematics equips students with a unique and powerful set of tools to make sense of and change the world (Andamon & Tan, 2018). Therefore, effective mathematics learning can support a person's various abilities.

Interest and tendency to have a positive attitude in learning mathematics supports the realization of optimal mathematics learning and supports various competencies and mathematics learning outcomes (Claudia et al., 2021; Hwang & Choi, 2020; Kamid et al., 2021). This interest and tendency to be positive is called a mathematical disposition. If a student wants to improve their mathematical abilities, students

must believe that mathematics is a science that can be understood and mastered easily, with diligent effort it can be learned and used (Kilpatrick et al., 2001). A positive disposition is a different step from flexible thinking which is an effective solution in various scientific disciplines (Claudia et al., 2021; Geiger et al., 2023).

Dispositions are habits of mind that routinely arise without external pressure, and are patterns of behavior that occur under controlled and voluntary awareness, they are carried out deliberately and are oriented towards broad goals (Katz, 1993; Wilson et al., 2020; Zhang et al., 2022). Mathematical disposition refers to the tendency to think and act positively and view mathematics as something useful, be persistent, and behave in mathematical achievement (Lin & ChunTai, 2016; Minarti et al., 2020; NCTM, 1989). This disposition is clearly visible if students enjoy learning mathematics and can make students enjoy mathematics learning activities and feel the benefits of the usefulness of mathematics (Kilpatrick et al., 2001; Panggabean et al., 2022).

In reality, students' mathematical disposition is relatively low in mathematics learning. Based on research by Saniah & Nindiasari (2023) and Yuliani et al. (2021) students lack confidence in using and communicating mathematical ideas and are less diligent when carrying out mathematical tasks. Students consider mathematics to be a science that is difficult to understand and students do not appreciate the benefits of mathematics matematika (Almerino, Jr. et al., 2019). This indicates that efforts are needed to improve students' mathematical dispositions.

Primary research regarding efforts to improve mathematical dispositions in mathematics learning has been widely carried out. The primary research that has been carried out produces individual research findings. This research needs to be studied to find out a description of research regarding mathematical dispositions. One way to study this topic can be a Systematic Literature Review (SLR). This research aims to identify, group and analyze primary research findings regarding programs and efforts implemented to improve students' mathematical dispositions in the context of mathematics learning. The research questions include: (1) What programs or efforts are implemented to improve mathematical disposition? (2) What is the methodology used to assess mathematical disposition? (3) How effective are the various programs or treatments implemented in improving mathematical disposition during mathematics learning? (4) What programs and efforts are suitable for improving mathematical disposition in terms of educational level?

Method

This research is a Systematic Literature Review (SLR). Primary research that has relevant topics is identified, analyzed and evaluated with SLR. In the literature study process, Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) were used. The steps in carrying out a literature study involve several stages, namely: (1) Identification, (2) Screening, (3) Eligibility, and (4) Inclusion (Page et al., 2021)

The literature search was carried out by accessing the Scopus database and mathematics education journals on the Science and Technology Index (SINTA), namely articles indexed by SINTA 1 and SINTA 2. To obtain relevant articles that had the potential to be studied, the search was carried out on Scopus with the keywords "Disposition AND in AND mathematics AND education". In mathematics education journals indexed SINTA 1 and SINTA 2 with the keyword "Mathematical disposition" or "Mathematical disposition". The literature that has been collected is sorted based on the inclusion and exclusion criteria in this study in table 1.

Table 1. Inclution and Exclution Criteria

Inclusion Criteria	Exclusion Criteria
IC1: Research-oriented improves mathematical dispositions	EC1: Research is not oriented towards developing or improving mathematical dispositions
IC2: publication of articles/proceedings/conferences	EC2: book/ book review
IC3: Publication in journals/proceedings/conference papers 2019-2023	EC3: Publication in journals/proceedings/conference papers before 2019
IC4: Primary research subjects are elementary school, middle school, high school/ vocational school, and college students.	EC4: Primary research subjects other than elementary school. middle school, high school/ vocational school, and college students.
IC5: Types of primary research such as quantitative, qualitative, mixed, and development.	EC5: Types of research: literature review and meta analysis.
IC6: Open access	EC6: Close access
IC7: Articles in Indonesian or English	EC7: Articles in languages other than Indonesian or English

Based on the search results and filtering process for articles shown in Figure 1. The combination of keywords produced 339 potentially relevant articles or conference papers from two different databases, namely 40 from journals indexed by SINTA 1 and 2 and 299 from Scopus. 296 articles were excluded because they did not meet one or more of the IC2-IC7 inclusion criteria.

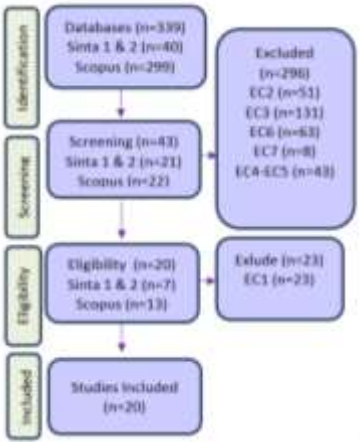

Figure 1. Literature Search

Screening is carried out by reviewing the title and abstract of the article as well as the filters of the database used. In the screening stage, 43 articles were found that met the criteria by examining the articles in full text. After that, a feasibility review was carried out, 20 articles and conference papers were obtained that met the eligibility criteria and could be analyzed.

Result and Discussion

20 articles were obtained that were suitable for analysis. The descriptions of the 20 articles were analyzed based on the research questions.

Program or Effort to Improve Mathematical Disposition

Based on a study of research results, improving mathematical disposition is carried out with various programs and efforts. Efforts are made through the application of various models, strategies and

approaches to mathematics learning, except for the research of Sudarman et al. (2022) which applies e-learning and research by Russo et al. (2021) who use rich narratives: children's literature, films and short films. additionally, research by O'Keeffe et al. (2023) who reviewed the experience of doing mathematics homework on mathematical disposition, application application by (Hamid et al., 2020) and previous student abilities such as research by Balala et al. (2021) as well as the development of teaching materials by (Nurmeidina et al., 2020).

The application of discovery learning programs has been implemented to improve mathematical dispositions, one of which is research by Agustina et al. (2023) and Dina et al. (2019) improve students' mathematical disposition by implementing the discovery learning model. Other discovery learning-based research was conducted by Sudarman et al. (2022) whose learning is e-learning using the Google Classroom platform by applying the discovery learning learning model. (Pedersen & Haavold, 2023) menerapkan applies inquiry learning to foster mathematical dispositions. The discovery learning model is effective for improving students' mathematical disposition in learning mathematics. This is because discovery learning refers more to learning and experience so that students discover concepts for themselves and give meaning to students (Hammer, 1997 ; Andelkovic & Maricic, 2023). Therefore, discovery learning is suitable for improving mathematical disposition.

Another research by (Haji et al., 2019) which applies the RME learning model through an outdoor approach. The implementation is carried out by inviting students out of the classroom, students solve contextual problems through observing real objects of everyday life. Meanwhile, research by Supianti et al. (2022) applies the CORE model learning process. Wang & Walkington (2023) research investigated problem-posing during math walks in informal learning by observing a series of different locations and asking questions about how mathematics benefits the environment. Another study conducted by Russo et al. (2021) which uses rich narratives to engage students through children's literature, films, and short films. Rich learning experiences can also support students' mathematical dispositions such as math walks, and also learning that utilizes learning resources that are interesting to students such as rich narratives such as children's literature, films and short films. According to Maxwell (2001), this disposition is clearly visible if students enjoy learning mathematics.

Increasing mathematical disposition with problem-based learning was also carried out by Maharani et al. (2019) which implements the PBL and PBL-team teaching learning models, teaching carried out by more than one teacher. There are other studies that apply PBL with MHM strategies (Miliyawati et al., 2019). PBL learning with the MHM strategy is carried out by presenting problems as a trigger for learning and thinking habits. Research by Wondo et al., (2021) which applies PBL to the STAD setting. In line with Hwang & Choi (2020), mathematical disposition can be improved through learning that encourages students to solve challenging problems, express ideas and discover for themselves and reason in learning.

Phase-based learning such as research by Nopasari et al. (2020) which applies 5E learning, namely engagement, exploration, explanation, elaboration, and evaluation. STEM learning can also improve mathematical dispositions, such as research conducted by (Mohamed Elsayed, 2022). Syahputra et al., (2021) who apply ARCS learning, (Purba & Surya, 2020) who apply the CTL Approach, (Dewi et al., 2021) who apply generative learning where this application can improve mathematical disposition.

Overall, discovery-based learning and problem-based learning as well as student-centered models and approaches are the learning used to develop mathematical dispositions in mathematics learning. Other efforts are also being made to improve mathematical disposition. Other aspects need to be paid attention to, including research (Balala et al., 2021). which examines whether numeracy activities and early numeracy skills can improve mathematical disposition. The use of rich narratives can also improve mathematical disposition (Russo et al., 2021). Implementing the maple application can also support students' mathematical disposition (Hamid et al., 2020). The development and implementation of

appropriate teaching modules by (Nurmeidina et al., 2020) is able to support students' mathematical dispositions.

Methodology for Assessing the Effectiveness of a Program to Improve Mathematical Disposition

Research related to improving mathematical disposition consists of quantitative, qualitative, mixed method, and R & D research. As shown in the following diagram.

Figure 2: Type of Research

In figure 2 it can be seen that 60% of the research is quantitative research, 25% is qualitative research and 10% is mixed method research, and 5% is research and development (R & D). In general, quantitative research with quasi-experimental design is the most common type of research used in research oriented towards improving mathematical disposition and the other is cross section studies. Quantitative research tests learning designs that are oriented towards improving mathematical dispositions. This qualitative study was conducted to describe in detail the impact of the program on mathematical disposition. Mixed research (mix method) has also been carried out. Research and development is more about developing a product to improve mathematical disposition. Research and development to improve mathematical dispositions is still relatively small, compared to other types of research.

The research subjects in the articles studied consist of four levels of educational units, namely university, high school, middle school and elementary school. The highest levels of education used as research subjects were 7 studies at the university level and 6 studies at junior high schools, 4 studies at elementary schools, and 3 studies at high schools. This shows that research oriented towards improving mathematical dispositions has been carried out at various levels and is dominated by tertiary and junior high school levels.

Effectiveness of Programs Implemented to Improve Mathematical Disposition

Table 2. Program Effectiveness

Program/treatment	Result
Discovery-based learning: Discovery Learning Model, E-learning discovery learning, Inquiry learning	Effective/increasing
RME with outdoor approach	Effective/increasing
CORE learning model	Effective/increasing
math walk in informal learning places	Quantitative analysis of changes did not change significantly, but qualitative analysis showed a better mathematical disposition.
Rich Narraties : Children's literature, Movies and Short Films	Effective/increasing
Problem-based learning: PBL Model, PBL-	Effective/increasing

MHM Strategy, PBL with STAD setting.	
5E learning cycle model	Effective/increasing
STEM approach	There is a significant increase
Homework experience	There is no increase/negative impact
Counting activities and early numeracy skills	Effective/increasing
Generative learning	Shows a positive but not optimal mathematical disposition
Implementation of Maple	Effective/increasing
CTL approach	Effective/increasing
ARCS learning model	Effective/increasing
Blended-learning learning model	Mathematical disposition is moderate
Probability theory module	Effective/increasing

Table 2 shows programs that can improve mathematical dispositions, including student-oriented learning designs, both discovery-based learning, problem-based learning, and also learning with the application of rich narratives such as children's reading, films and short films, as well as numeracy activities that can also support development. mathematical disposition, application and development of teaching materials and applications (Dina et al., 2019; Hamid et al., 2020; Maharani et al., 2019; Nurmeidina et al., 2020; Russo et al., 2021).

The research results show that the application of generative learning has not shown an optimal mathematical disposition, this is because learning is carried out online or during the pandemic. Another study found a moderate mathematical disposition with blended learning. Online learning is not something that has a bad impact on mathematical disposition, but it has not optimally improved mathematical disposition. Apart from that, the research results of O'Keeffe et al. (2023)show that homework experiences can impact negative mathematical dispositions such as lack of confidence and hopelessness as well as negative views of mathematics.

A Suitable Program for Improving Mathematical Disposition at Various Levels of Education

Programs and treatments have been carried out at various levels of education in order to develop mathematical dispositions. At the elementary school level, increasing mathematical disposition is more about learning experiences that are close and contextual to the student and in accordance with the developmental stages of elementary school students. Several studies, such as research (Haji et al., 2019) which integrate RME with an outdoor approach. Apart from that, research by (Russo et al., 2021) uses narratives rich in children's literature, films and short films which are closer to the world of elementary school children. Another program is activities and early numeracy skills that can have a good impact on students' mathematical disposition.

The development of elementary school students who are still iconic and happy to explore physically, of course this can develop the mathematical disposition of elementary school students. This implies that mathematical dispositions are developed using an approach that is appropriate to the stages of cognitive development of elementary school students, namely the concrete operational stage. According to Mcleod (2018) Piaget's theory of development, at the concrete operational stage, individuals aged 7-11, generally elementary school students, are students at the stage of learning through physical things in students' real lives. Something close to elementary school students such as RME learning with an outdoor approach and narratives and media that are close to students. Apart from that, early numeracy activities and skills can also provide self-confidence and a positive mathematical disposition for elementary school students.

At the secondary school level, in improving mathematical disposition, junior high school/equivalent and high school/equivalent have programs and treatment that are not much different.

Discovery-based learning, problem-based learning, CORE learning model, 5E learning cycle model, STEM approach are programs implemented to support students' mathematical dispositions in secondary schools. This is in line with research (Knezek & Christensen, 2020) that project-based learning with STEM pathways has a good impact on the positive tendencies of secondary students. Middle school students are at the formal operational stage of development. Students at the formal operational stage can develop the ability to think in abstract and logical concepts (Mcleod, 2018). In line with Awofala (2017) research recommendations that student investigations in various ways and mathematical discoveries in secondary school students are suitable for improving mathematical dispositions.

At the tertiary level, mathematical dispositions are developed with various learning designs such as generative learning, CTL approach, ARCS learning model, blended learning, and PBL. Apart from that, at the tertiary level mathematical dispositions are also developed with various software and media that support the mathematics learning process such as the use of the maple application in calculus learning (Hamid et al., 2020) and also modules on opportunity material (Nurmeidina et al., 2020). This is as stated by Sunandi et al. (2023) that the use of technology has a positive and significant impact on students' learning experiences in higher education.

Conclusion

Based on the results and discussion, it can be concluded that in improving mathematical disposition the efforts that can be made are applying models, approaches, student center oriented learning, such as problem-based learning, discovery-based learning, STEM approach, 5E model, CORE learning, RME with an outdoor approach, CTL , ARCS learning model, math walk, use of rich learning media such as films, children's books and also short films. early numeracy activities and skills, use of maple application technology and module development.

The methodology for assessing the effectiveness of the program in developing the mathematical disposition of quantitative, qualitative, mixed, and developmental research is dominated by quantitative research. Effective programs and efforts to improve mathematical dispositions include student center oriented learning designs, both discovery-based learning, problem-based learning, and also learning with the application of rich narratives, and numeracy activities can also support mathematical dispositions. It is necessary to review the impact of online learning and homework experiences on mathematical disposition.

Mathematical disposition is improved in various ways. At the elementary school level, it is enhanced by learning experiences that are close and contextual to the students themselves and in accordance with the developmental stages of elementary school students. At the secondary school level through discovery-based learning, problem-based learning, and student-centered learning. At the tertiary level through the application of technology and applications that can support student learning.

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