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Bibliometric Study to Find Novelty in Mathematical Communication

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Abstract: Researchers have widely studied mathematical communication, but the grouping of research results on mathematical communication still needs to be researched. This study aims to classify research related to mathematical communication in terms of product development models, learning tools, learning models, education levels, grade levels, and subjects. This research uses a literature study method by analyzing 100 scientific articles. Article collection is done using Publish Or Perish (POP) software. The article is taken from the Google Scholar database for 2018-2023 by writing the keywords for mathematical communication development and mathematical communication development. Data analysis was carried out by groups based on the above criteria. This study obtained the results of developing Tessmer and Alessi & Trollip products, learning models, PJBL learning models, university-level research, and elementary school levels, especially class V, which are rarely used. And research on mathematical communication is still about mathematics subjects. This study concludes that developing learning tools to improve mathematical communication skills is a topic with novelty to be researched.

Keywords: Bibliometric, mathematical communication, novelty

1. Introduction

21st-century skills are divided into four main parts: creative thinking skills, critical thinking, problem-solving, communication, and collaboration, *or* what is commonly referred to as 4c (Septikasari & Frasandy, 2018). Mathematical communication ability is a skill that needs to be mastered by students (Ismayanti & Sofyan, 2021). Through mathematical communication, students can organize mathematical thinking orally and in writing (Putri & Sundayana, 2021). Students with good mathematical communication skills will be smarter and have various ways of solving math problems (Purnamasari & Afriansyah, 2021). The fact is that students' mathematical communication skills still need to improve (Widyastuti, 2015).Mathematical communication skills are a student's ability to communicate ideas with symbols, figures, diagrams, graphs, or images (Nuraeni & Afriansyah, 2021). Communication is providing information in the form of messages, ideas, or ideas, both written and unwritten (Mardhiyah et al., 2021). Mathematical communication ability, namely the ability of students to explain ideas, situations, and mathematical relations orally and in writing with real objects, pictures, graphs, and algebra (Syah & Sofyan, 2021). This research uses journal objects from the Publish or Perish database from 2018-2023. This article aims to classify research based on product development models, learning tools, learning models, educational levels, class levels, and subjects. This article contributes to finding new research related to the topic of communication.

2. Methodology

The method used in this study is a literature study. By searching 100 pieces of literature using Publish or Perish (POP), using the Google Scholar database from 2018-2023 by typing communication development sentences with a maximum search of 50 articles, and typing mathematical communication development sentences with a maximum search of 50 articles. The 100 articles were grouped based on six categories: product development models, learning tools, learning models, educational levels, classes, and subjects. The product development model consists of 4D, Addie, plump, dick & Carey, Tessmer, Alessi & Trollip. Learning tools include modules, worksheets, media, instruments, and models. The learning model is divided into PBL, PJBL, reciprocal teaching, cooperative, scientific, RME, MEAs, PPL, problem solving, and contextual teaching and learning. The educational level includes elementary, middle, high school, and university. By class, it consists of grades 1-12, and subjects which consist of math subjects.

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Many researchers have studied mathematical communication skills. Reference searches for mathematical communication topics are carried out using Publish or Perish software. The search was based on the Google Scholar database, entering the keywords mathematical communication and mathematical communication from 2018-2023. On the keyword, mathematical communication obtained 640 articles, and with the keyword, mathematical communication produced 995 articles. The number of articles obtained from these two keywords is 1,635 articles. Furthermore, the 1,635 articles obtained were then inputted into the Vosviewer software to obtain a map of the relationship between the topic of mathematical communication and other topics. The results of the analysis are presented in Fig. 1.

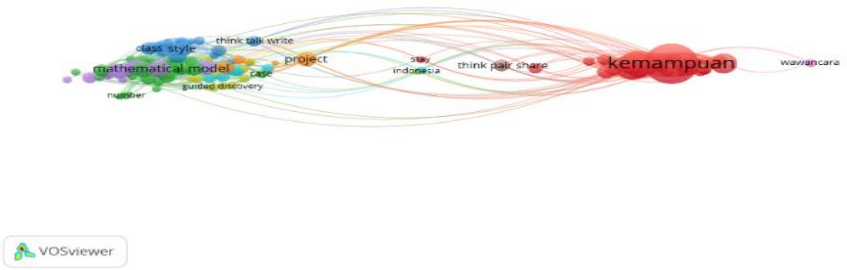

Fig. 1. Map of Linkages of communication skills with other topics. (source: *software Vosviewer*)

Based on Fig. 1, there are 100 studies on mathematical communication associated with the development model. The details are: 1) Thirty-two studies using the 4D model; 2) Twenty-four studies using the ADDIE model; 3) Sixteen studies using the PLOMP model; 4) Two studies used the Dick & Care model; 5) One study using the Tessmer model; and 6) One study using the Alessi & Trollip model.

The most used product development is 4D development, and the least used by researchers is the Tessmer method and the Alessi & Trollip method. From the development of the Tessmer model Sulitio & Destania (2020) questions are being developed so that it can be seen that the development of communication with the Tessmer model has yet to be implemented in the development of worksheets, learning media, and learning tools. Meanwhile, the Alessi & Trollip model Hotimah et al. (2021) develops multimedia in developing worksheets. Thus, research on developing modules and instruments that integrate mathematical communication has yet to be studied. So, this topic is an interesting topic for further study by researchers.

Two directly related topics are indicated by a line connecting the two. Meanwhile, topics that are not connected by lines indicate that the topic is not directly related. Mathematical communication topics are divided into 142 items and 9 clusters. Cluster 1 consists of 39 items, cluster 2 consists of 31 items, cluster 3 consists of 28 items, cluster 4 consists of 14 items, cluster 5 consists of 12 items, cluster 6 consists of 7 items, cluster 7 consists of 6 items, cluster 8 is divided into 4 items and cluster 9 consists of 1 item. However, no clustering is based on product development models, learning tools, learning models, education levels, class levels, and subjects. So, to obtain grouping based on the categories of product development models, learning tools, learning models, education level, class level, and subjects, this is done by selecting 100 articles that will be grouped into these categories.

3. Results and Discussion

Based on Fig. 2, we can see that there are 17 studies developing module learning tools, 26 studies developing LKPD learning tools, 25 studies developing learning media tools, 23 studies developing learning tools in the form of instruments, and developing learning tools in the form of models there are 4 studies. The most widely developed learning device development is LKPD. In comparison, the development of tools for learning models is still slightly developed. Models that are rarely used are problem-based learning models (Nst & Rangkuti, 2020; Syafi'i & Syofra, 2020), and interactive learning models (Dalimunthe et al., 2022; Hidayat & Wijayanto, 2021). This learning model is still rarely developed so that it can become an object that other researchers can study.

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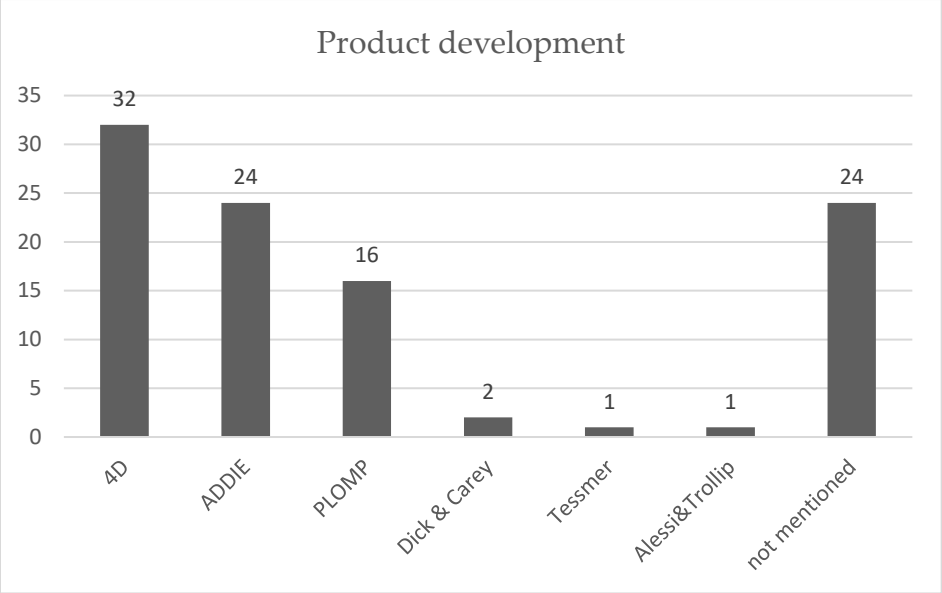

Fig. 2. Communication reviewed from the product development model

Based on Fig. 3, we can see that 19 studies use the Problem-Based Learning model, 1 research uses the Project Based Learning model, 13 studies use a learning model that is not mentioned, 2 studies use the Reciprocal Teaching model, in the cooperative learning model there are 3 studies, 3 studies on the scientific model, 14 studies on the Realistic Mathematical Education model, 2 studies on the MEAs learning model, in the PPL learning model there are 2 studies, with the Problem-Solving learning model there are 3 studies. 3 studies use the Contextual Teaching and Learning model (CTL). The learning model widely used in improving communication is the Problem-Based Learning model. The model that is rarely used is the Project Based Learning model (Saleh & Suparman, 2020).

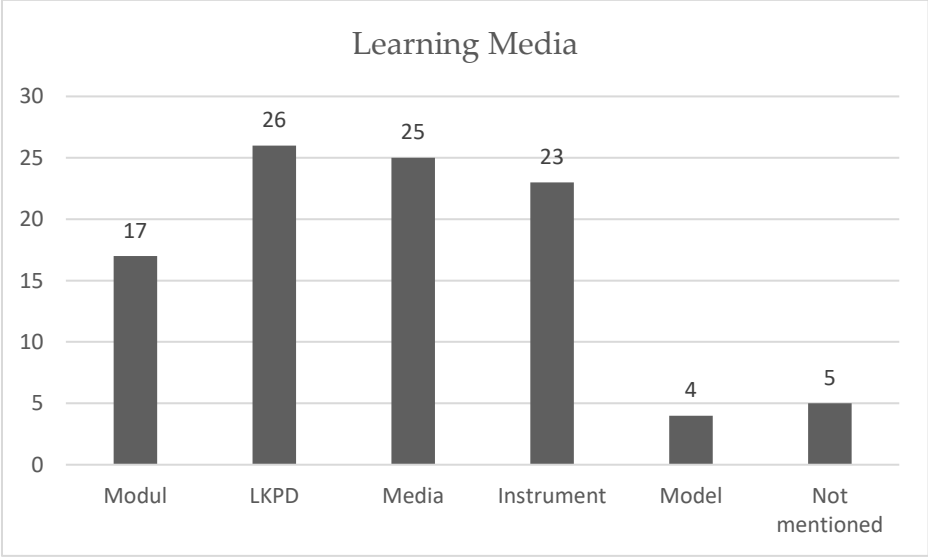

Fig. 3. Communication in terms of learning devices

Based on Fig. 4, we can see that 5 studies took place at the elementary level, 62 at junior high schools (SMP), 24 at senior high schools (SMA), and 4 at the tertiary level. At the research level, researchers are most interested in doing research at the junior high school (SMP) level, while at the higher education level (PT), it still needs to be studied. For this reason, further researchers can conduct development research to improve students' mathematical communication skills.

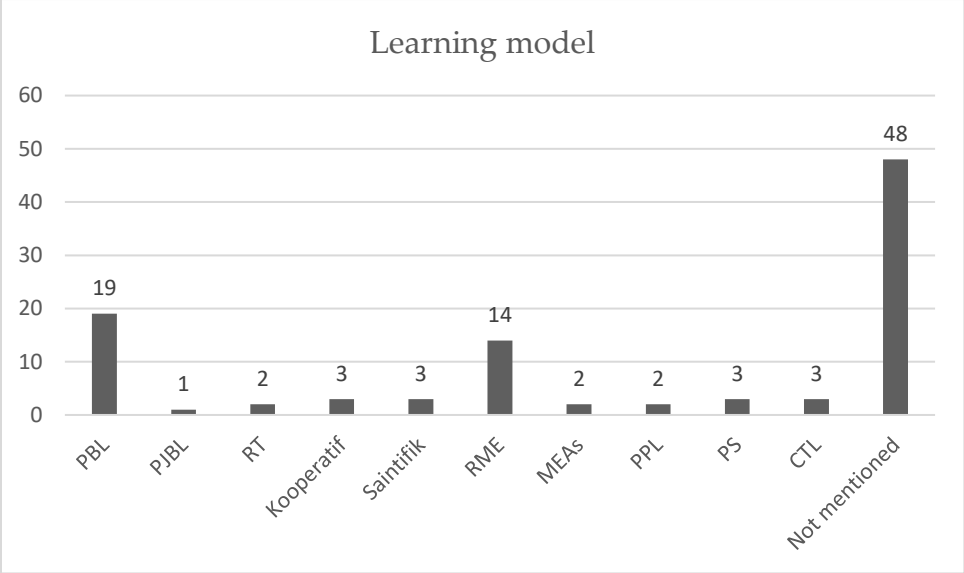

Fig. 4. Communication in terms of the learning model

Fig. 5 show that more research was conducted in class VII with 31 studies; in class VIII, 19 studies; class X, there were 12 studies; in class XI, 8 studies; class XII 3 studies; in classes IV and IX, there were 2 studies, and at least it was carried out in class V SD. Namely there was only 1 study. Most of the research was conducted in class VII, and the least researched was in class V SD. The results show that efforts to improve students' mathematical communication skills through the development of learning tools and learning models still need to be carried out in elementary schools (SD).

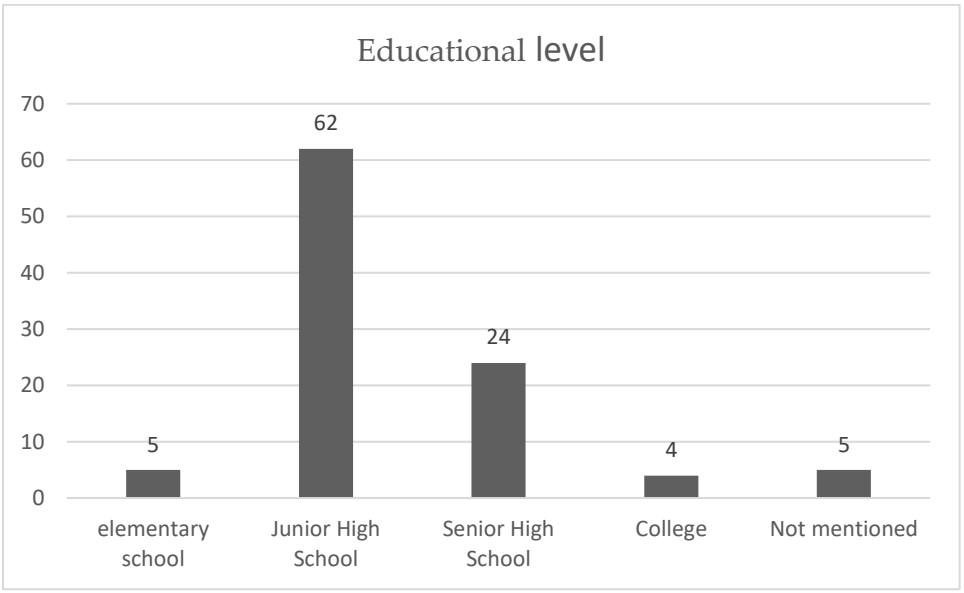

Fig. 5. Communication in terms of education level

From Fig. 6, we can see that 100 journals discuss mathematical communication in mathematics. From the literature that has been reviewed, the results obtained from 100 journals overall research on mathematics.

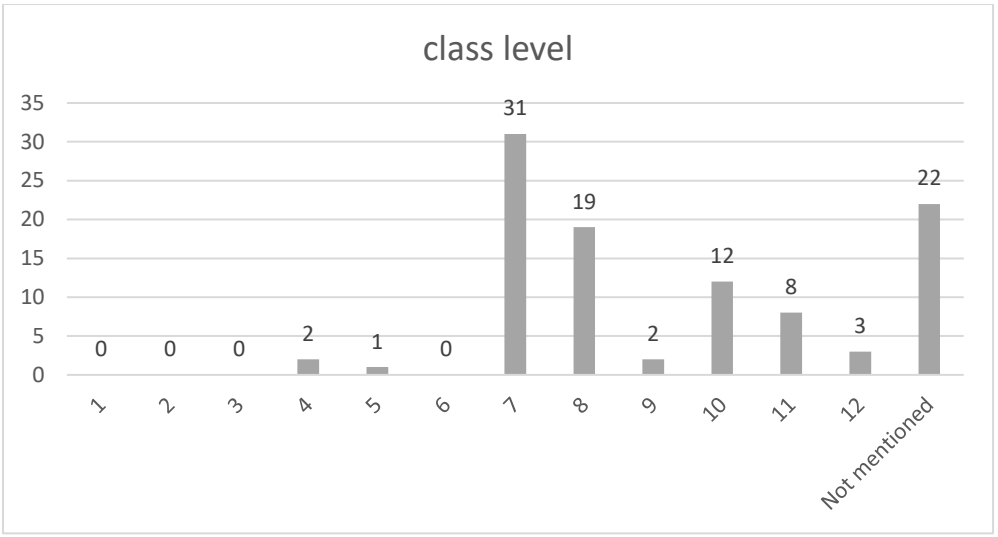

Fig. 6. Communication in terms of class level

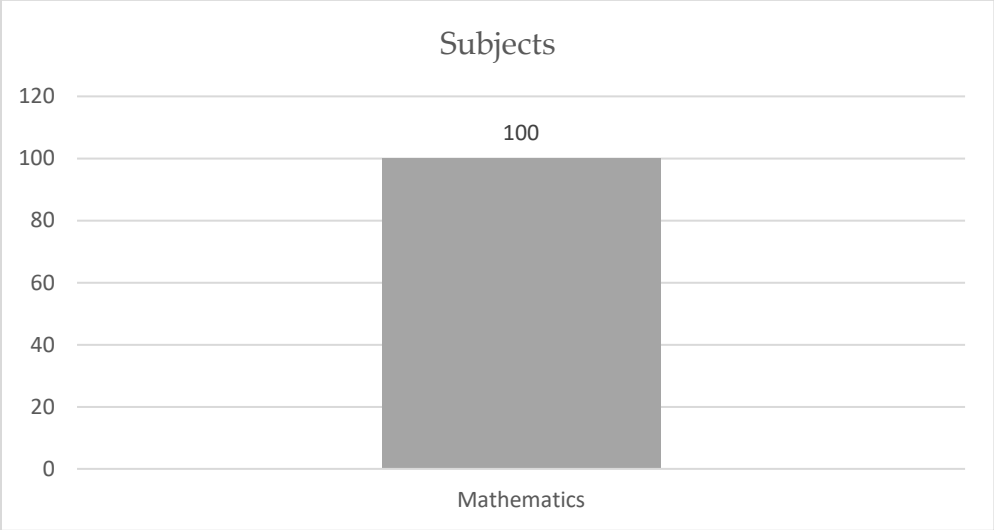

Fig. 7. Communication in terms of subjects

Mathematics is a subject taught at every level of education; mathematics has many benefits for everyday life. Through learning mathematics, students are prepared to be able to develop creative and innovative thinking by using language that is mathematical and easy to understand (Wardhana & Lutfianto, 2018). Students are required to master several mathematical abilities, one of which is mathematical communication skills (Kadarisma, 2016).

Based on the results of research from several studies that have been conducted by researchers who have examined it, it was found that the mathematical communication skills of both students at the elementary, junior high, high school, and even tertiary levels have not been perfectly fulfilled, there are still many problems found regarding the lack of mathematical communication skills. As a result of these problems, many researchers have developed various products, learning tools, and learning models to improve mathematical communication skills.

Mathematical communication can provide rational reasons for solving problems, change the form of descriptions in mathematical models, and illustrate mathematical ideas or ideas in the form of relevant descriptions (Hodiyanto, 2017). Mathematical communication skills are crucial because learning mathematics requires active interaction or communication between students and educators. In addition, with mathematical communication skills, students can organize and strengthen their mathematical ideas, which will be poured orally or in writing during the learning process (Fahrullisa et al., 2018). Trends related to mathematical communication in 2018-2023 are shown in Fig. 8.

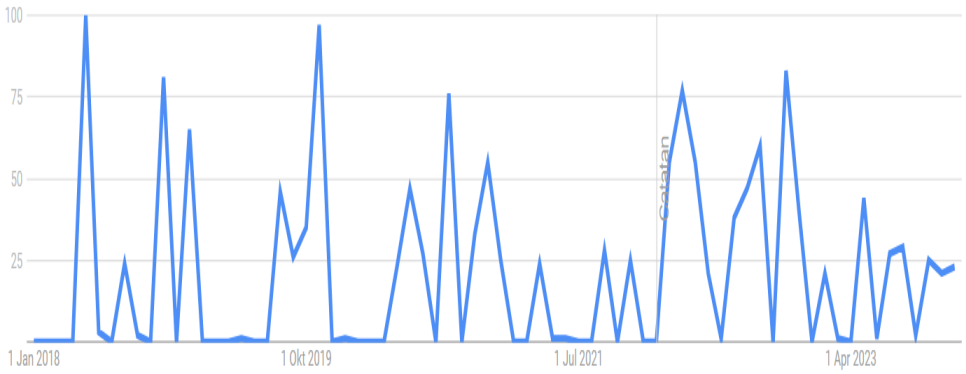

Fig. 8. Mathematical communication trends. (Source: *Google trends*)

4. Conclusion

This research concludes that the development of Tessmer and Alessi & Trollip products is rarely used. Learning tools that are rarely developed are learning models. The PJBL learning model is rarely used to develop learning tools to improve mathematical communication. Communication skills at the tertiary level are also rarely studied. While at the grade level for grade 5, it is rarely used as an object of research. As well as research on mathematical communication is still about mathematics subjects. So that researchers in developing learning tools to improve mathematical communication skills can use the Tessmer and Alessi & Trollip development tools, with the tools being developed are learning models, especially the PJBL learning model, by taking research objects at the tertiary level or the elementary school level, especially in class V.

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Conflict of Interest

The authors declare no conflicts of interest.

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