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INSIGHT INTO MATHCITYMAP-BASED OUTDOOR MATHEMATICS LEARNING FROM COGNITIVE AND AFFECTIVE PERSPECTIVES: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT
Technology integration is currently crucial in learning. One emerging technology is MathCityMap, specifically designed to support contextual mathematics learning through exploration of real environments. This study aims to observe research trends on the use of MCM based on regional distribution, cognitive and affective ability domains, and widely studied mathematics topics. This Systematic Literature Review (SLR) study used the PRISMA method to filter the articles analyzed. The study inclusion criteria consisted of raw articles in the form of journals, aligned with the research questions, published in scientific journals between 2020 and 2025. A total of 295 articles were identified from the Scopus, ERIC, Semantic Scholar, OpenAlex, Crossref, and Google Scholar databases. After a selection process, 25 articles were obtained for further analysis. The results of the analysis indicate that MCM-based outdoor mathematics activities provide a positive contribution to the development of cognitive abilities as well as affective engagement of students. However, research related to MCM is still dominated by exploration of the cognitive domain, especially problem-solving and critical thinking skills, while studies on the affective domain are still relatively limited. In terms of content, geometry is the most widely topic, while MCM implementation is still more common in schools than in authentic learning environments outside of school. These findings indicate that MCM not only has potential as a means of developing higher-order thinking skills but also holds significant potential to support students' character development, social interactions, and contextual learning experiences more comprehensively.

INTRODUCTION

The integration of digital technology into mathematics learning has opened up opportunities for more interactive and contextual learning experiences. However, most implementations are still dominated by screen-based activities, which have the potential to reduce physical engagement, social interaction, and environmental exploration. This aligns with the 2013 Minister of Education and Culture Regulation Number 65, which stipulates that the learning process in educational units must be conducted interactively, inspiringly, enjoyably, and challengingly, motivating students to actively participate, and providing sufficient space for initiative, creativity, and independence in accordance with students' talents, interests, and physical and psychological development.

One innovation that bridges digital technology with physical activity is MathCityMap (MCM), a location-based learning platform that enables students to complete math tasks through exploration of real objects in their surroundings. MCM is a digital tool used to support students in completing outdoor math tasks related to real objects in their surroundings (Jablonski et al., 2023). Various studies have shown that MCM effectively supports learning in topics such as measurement, geometry, and arithmetic and increases student engagement in contextual learning. According to Khoir (2024), several schools in Indonesia from various regions and school levels have also begun using MCM in innovative learning programs, such as in research conducted at SDN II Kaweron which stated that the presence of the MCM application is one of the innovations in mathematics learning because learning becomes more enjoyable. The SLR study conducted by Paramitha & Agoestanto (2023) stated that the integration of the use of the MCM application in learning can help improve students' problem-solving abilities. Meanwhile, other SLR studies show that MCM helps teachers design and offer interesting activities for students so that students can enjoy and gain experience in learning mathematics (Sholikhakh et al., 2022).

However, most existing research still focuses on improving problem-solving skills, learning engagement, or designing learning activities (Paramitha & Agoestanto, 2023). For example, one study found that outdoor mathematics improves engagement, contextual understanding, and spatial reasoning (Niam, 2025). Previous synthetic studies have also emphasized the integration of MCM in mathematics learning and the development of outdoor activities, but have not specifically mapped how MCM implementation simultaneously contributes to the cognitive and affective domains. Yet, both domains are important indicators of the success of contextual mathematics learning. Modern mathematics learning needs to simultaneously integrate the cognitive and affective domains, where the affective domain encompasses motivation, attitude, and interest (Hui & Mahmud, 2023).

The cognitive domain plays a crucial role because it focuses on knowledge acquisition, critical thinking, ethical reasoning, knowledge application, and creativity. Meanwhile, the affective domain encourages personal growth and social contribution through the development of curiosity, emotional intelligence, creativity, resilience, collaboration skills, and visionary thinking (AlAfnan, 2025). Cognitive ability is the ability of students to think, know, and solve problems, while the affective domain is the ability related to attitudes and values (AlAfnan, 2025). The cognitive domain aims to develop mental skills and individual knowledge acquisition where mathematical abilities include certain cognitive abilities which, if inadequate, can have a chain effect on mathematics learning, while the affective domain refers to an individual's affective reactions to a stimulus, which includes feelings, attitudes, interests, motivations, and values that emerge during the learning process (Hui & Mahmud, 2023).

In this context, MCM has unique characteristics because it can integrate physical and cognitive activities. Other research shows that emotions have a significant influence on motivation, achievement, and persistence in mathematics (Schoenherr et al., 2025). Outdoor learning environments facilitated by MCM have the potential to generate unique dynamics between these two domains, making it important to analyze them comprehensively through a Systematic Literature Review approach.

Referring to the link between the affective and cognitive domains, this study aims to analyze trends in MCM research in mathematics learning, focusing on: (1) the geographic distribution of research, (2) the contribution of MCM to students' cognitive and affective domains, (3) the most frequently studied mathematics topics, and (4) the characteristics of the learning environment or implementation area.

METHOD

The PRISMA method was used in this study. Research data was collected from scientific articles on leading journal websites, including Scopus, Semantic Scholar, ERIC, OpenAlex, Crossref, and Google Scholar. The journals collected covered the period 2020 to 2025, as MathCityMap is a relatively new technology. The journal search was conducted using the Publish or Perish application; except for the ERIC database, where researchers searched directly on the website. The keyword or title used in the search was "MathCityMap."

Researchers conducted an initial search procedure during the identification stage. This initial search procedure aimed to gather articles suitable for answering the research questions and additional relevant data for reference. In the first stage, or identification stage, the researcher obtained 50 articles from Scopus using both keywords and titles, 29

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articles from Semantic, 18 articles from ERIC, 52 articles from OpenAlex, 41 articles from Crossref, and 105 articles from Google Scholar, bringing the total number of articles obtained to 295.

To determine whether the articles were suitable for use in the study, the researcher established inclusion and exclusion criteria as described in Table 1 below:

Table 1. Inclusion and Exclusion Criteria

Type of Publication	Inclusion Criteria	Exclusion Criteria
Year of Publication	Learning Context: Articles published between 2020 and 2025	Research in mathematics learning: Articles published before 2020
Type of Publication	Journal Articles	Books, Proceedings, Anthologies, Monographs
Language	Articles in Indonesian, English, and other languages written in Latin and machine-translatable	Articles written in languages other than Latin that are difficult to translate by machine-translatable
Type of Research	Not SLR-type articles	SLR-type articles
Accessibility	Open Access	Closed Access
Research Object	Research Object: Students	Research Object: Non-students
Research Level	Research conducted in elementary and secondary education	Research conducted in higher education, training institutions, and outside of school
Learning context	Research in mathematics learning: Articles published before 2020	Research outside the field of mathematics learning

Source: (Page et al., 2021)

After the articles were obtained, the next step was the screening process. First, the researcher checked for duplication of articles. Based on the researcher's findings, 169 duplicate articles were found, and 18 articles were not publicly accessible. Therefore, 187 articles had to be removed in the first screening process, leaving 108 articles. Then, these 108 articles were included in the second screening process. In this second screening stage, 77 articles were also eliminated because 1) 71 articles were not journals, and 2) 6 articles were SLRs, leaving 31 articles to be included in the eligibility criteria stage. After the screening process, the researcher continued with the screening process based on the eligibility criteria. At this stage, of the remaining 31 articles, 5 were removed because the research object was not students, and 1 article was removed because MCM was not used in mathematics lessons. Thus, the final articles used for this study were 25 articles, which can be seen in more detail in Figure 1 below:

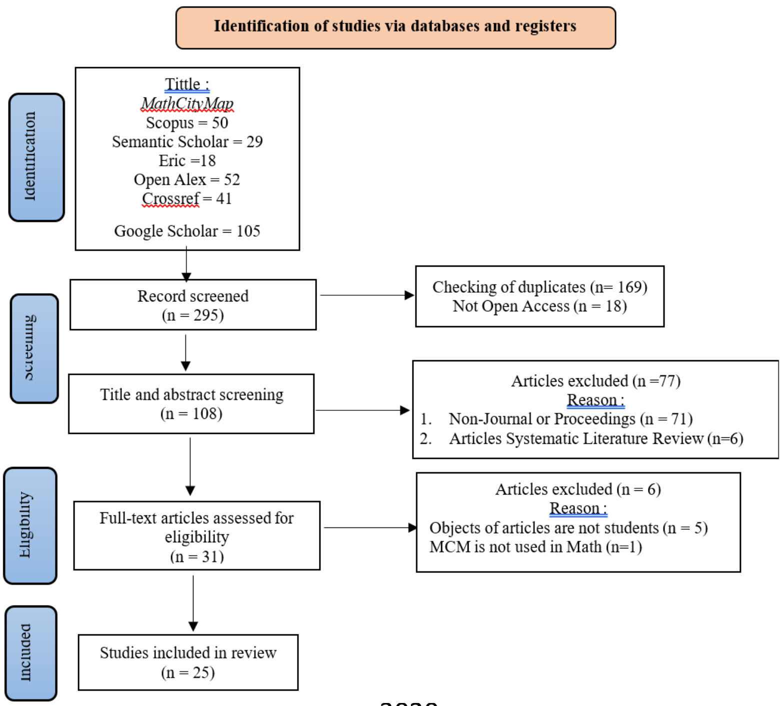

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Figure 1. Identification of Studies Via Databases and Registers

After meeting the eligibility criteria, the researchers conducted data analysis. All articles were thoroughly read, and any important information was recorded on a data extraction sheet. In the next stage, the obtained data was classified into four main categories based on the research objectives and questions. The following table presents the classification based on the research objectives.

Table 2: Article classification based on research objectives

Research Purposes	Analysis Focus	Data Classification
Identifying geographic trends	Research location	Country, region
Identifying ability contributions	Research results	Cognitive, affective
Identifying mathematics topics	Learning materials	Topics studied
Identifying implementation areas	Learning context	School environment, outside of school

All grouping results were then analyzed to identify dominant patterns, research trends, and the relationship between MCM implementation characteristics and students' cognitive and affective domain development. A list of the articles analyzed is presented in Table 3 below.

Table 3. List of Articles Analyzed

No	Article Title	Author	Year	Journal Name
1	Development of Mathematics Learning Activities Using Mathcitymap at Sindu Kusuma Edupark to Learn Contextual Problem-Solving	Tyas, A M W., et al	2024	Jurnal Pendidikan Matematika
2	How digital tools support the validation of outdoor modelling results	Jablonski, et al	2023	Frontiers Education
3	MathCityMap Application in Mathematics Learning in Primary School	Muliasari, EA., et al	2023	Dwija Cendekia: Jurnal Riset Paedagogik
4	Mathematical Literacy in Mathematical Learning Visual Auditory Kinestetic (VAK) Model Using The Mathcitymap Application	Oktaristanti, et al.	2024	Edumaspul: Jurnal Pendidikan
5	Pengaruh Penggunaan Aplikasi MathCityMap Terhadap Kemampuan Numerasi Siswa Kelas VIII SMP Yapis Merauke	Taufik, A R Suryani, D R	2024	JiPiMat: Jurnal Pendidikan Matematika
6	Pengembangan Aktivitas Pembelajaran Matematika Konteks Gardu Pandang Kaliurang Menggunakan Mathcitymap Untuk Meningkatkan	AF Pramudita, HS Pratini	2024	Asimtot: Jurnal Kependidikan Matematika
7	Pengembangan Aktivitas Pembelajaran Menggunakan Aplikasi MathCityMap Untuk Mengembangkan Kemampuan Pemecahan Masalah Kontekstual	Pramudita, A F Rudhito, M A	2024	Jurnal Ilmiah Pendidikan Matematika
8	Pengembangan Media Pembelajaran Menggunakan Mathcitymap dalam Kemampuan Pemecahan Masalah Berbasis Etnomatematika Konteks Benteng Vredeburg	Maheswari, G A Saraswati, E	2023	Jurnal Pendidikan Matematika (JPM)
9	Pengembangan Math Trail Menggunakan MathCityMap Berbasis Etnomatematika Embung Tambakboyo Untuk Meningkatkan Kemampuan Berpikir	Victory, C G Adriantoro, A A	2024	Soulmath (Jurnal Edukasi Pendidikan Matematika)

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No	Article Title	Author	Year	Journal Name
	Kritis Siswa			
10	Solving Geometric Problems Using a Non-Traditional Form of Teaching	Rumanová, L	2024	TEM Journal
11	Students' Verification and Elaboration in Outdoor Mathematics: The Role of Digital Feedback in MathCityMap	Simone Jablonski	2024	Digital Experiences in Mathematics Education
12	The Influence of the Realistic Mathematics Learning Approach Assisted by the Mathcitymap (Mcm) Application on the Mathematical Problem Solving Ability and Learning Interest of Class V Students	Nazwar, et al	2024	Jurnal Pendidikan EDUMASPUL
13	Math City Map: Provide And Share Outdoor Modelling Tasks. An Experience With Children.	Ariosto A, et al	2021	AAPP
14	Pengembangan Aktivitas Pembelajaran Menggunakan Aplikasi MathCityMap Untuk Mengembangkan Kemampuan Pemecahan Masalah Kontekstual	Pramudita AF, Rudhito MA	2024	JIPM (Jurnal Ilmiah Pendidikan Matematika)
15	Development of Mathematics Learning Media Assisted by the MathcityMap to Improve Students' Critical Thinking Skills.	Buchori, et al	2023	Journal of Higher Education Theory and Practice
16	The Influence of the Realistic Mathematics Learning Approach Assisted by the Mathcitymap (Mcm) Application on the Mathematical Problem Solving Ability and Learning Interest of Class V Students	Muslan, N. Et al	2024	Edumaspul: Jurnal Pendidikan
17	Analisis Kemampuan Berpikir Kritis Matematis Pada Pembelajaran Project Based Learning Berbasis Aplikasi MathCityMap Ditinjau Dari Gaya Belajar Siswa	Paramitha, W. et al	2024	Teorema: Teori dan Riset Matematika
18	Ensino de geometria em extramuros: etnomodelando com o MathCityMap em uma escola do campo em Panelas-PE	Silva, TTX Barbosa, EJT	2025	e-Almanaque EtnoMatemaTicas Brasis
19	Pengaruh Model PBL dengan Aktivitas Math Trail Berbantuan Mathcitymap Terhadap Kemampuan Numersi Siswa	Erria, R. Et al	2025	Jurnal Cendekia : Jurnal Pendidikan Matematika
20	Pengembangan Aktivitas Pembelajaran Matematika Berbasis Pendidikan Matematika Realistik Dengan Bantuan Mathcitymap Untuk Mendukung Kemampuan Pemecahan Masalah Matematis Pada Materi Bangun Ruang Sisi Datar Smp Kelas VIII	Ningrum, MP. Rudhito, MA.	2024	Jurnal Karya Pendidikan Matematika
21	Aktivitas Matematika Kompleks Candi Prambanan dengan MathCityMap untuk Melatih Pemecahan Masalah Kontekstual	Victri, A. et al	2024	Jurnal Penelitian Pendidikan dan Pengajaran Matematika

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No	Article Title	Author	Year	Journal Name
22	Math Trace of a Million Flowers City: Learning Two-Dimensional using Ethno-RME and MathCityMap	Ristiana, N. et al	2024	Jurnal Riset Pendidikan Matematika
23	Tecnologias na Educação Matemática- Coordenação António Domingos: MathCityMap: Trilhos matemáticos nas Caldas da Rainha	Marques, M. et al	2024	Educação e Matemática
24	Pengembangan Aktivitas Pembelajaran Matematika Konteks Gardu Pandang Kaliurang Menggunakan Mathcitymap Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa	Pramudita, FA. Pratini, HS.	2023	Asimtot: Jurnal Kependidikan Matematika
25	The Application of MathCityMap at SDN Kaweron II to Improve Students' Problem Solving Abilities	Khoir, AK. et al	2024	Prima: Jurnal Pendidikan Matematika

RESULT AND DISCUSSION

The research findings from 25 articles are presented in order of research questions, and each finding is interpreted analytically by linking it to theory and previous research to gain a more comprehensive understanding of the trend in the use of MCM in mathematics learning. The distribution of publication years of the articles, if diagrammed, is as shown in Figure 2:

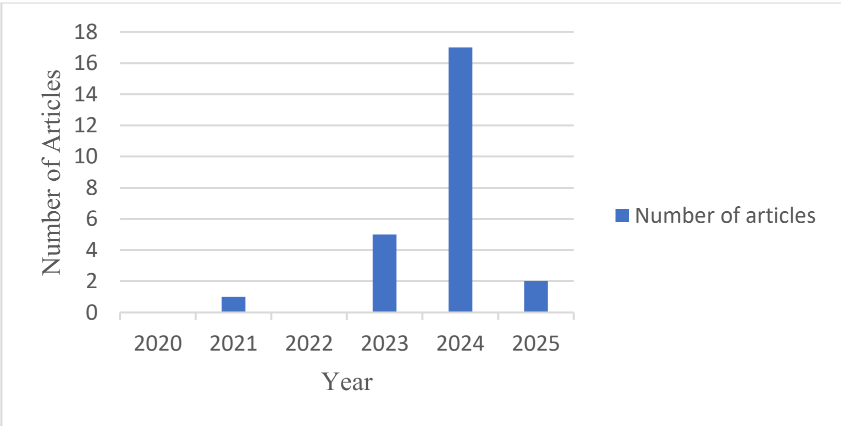

Figure 2. The Distribution of Articles Published from 2020 to 2025

Figure 2 shows the distribution of articles published from 2020 to 2025. The number of articles increased from 2022 to 2023, and a sharp increase from 2023 to 2024. Only two articles met the inclusion criteria for 2025, as it was the same year this research was conducted. Furthermore, the 25 articles provided answers to the following research questions:
RQ 1: In which regions or countries was research conducted using MathCityMap conducted?
The distribution of regions or countries where the research in the articles was conducted is depicted in Figure 2.

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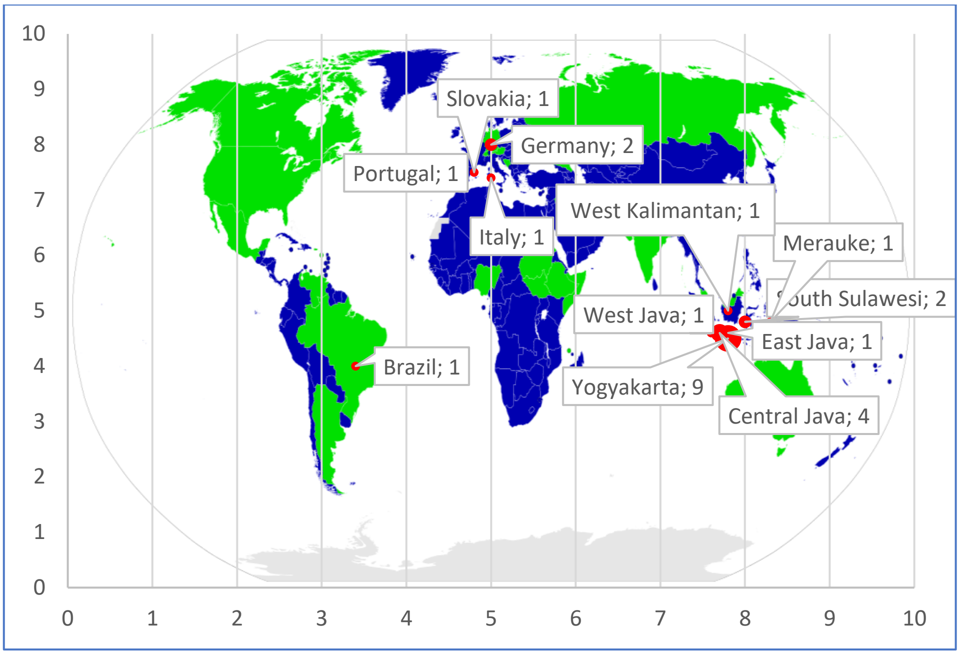

Figure 3. Distribution of Regions or Countries Where the Research in the Articles Was Conducted

The overview of article distribution in Figure 3 shows that research using MCM applications has spread to several countries, including Italy, Germany, Slovakia, Portugal, and Brazil. Meanwhile, in Indonesia, research has reached a fairly wide area, but is still dominated by Java, especially Yogyakarta, with 9 articles.

This finding indicates that MCM applications have received a positive response internationally, with Germany and Indonesia dominating. Germany's dominance is understandable because MCM was first developed at Goethe University Frankfurt, allowing for an earlier academic ecosystem, institutional support, and international collaboration networks. This finding is consistent with research indicating that the use and development of MCM has been supported by several international partners, including France, Italy, Portugal, Spain, Estonia, and Slovakia (Pramudita & Rudhito, 2024). Interestingly, Indonesia, particularly Yogyakarta, has shown a high contribution to publications. Yogyakarta's dominance in MCM research is due to a collaborative project between Indonesian researchers and German MCM experts conducted at Taman Pintar Yogyakarta and subsequently disseminated to local schools (Jablonski, 2019). Furthermore, several MCM studies have utilized contextual locations in Yogyakarta, such as Sindu Kesuma Edupark and Benteng Vredeburg, to develop environmentally-based learning media, demonstrating that Yogyakarta is a key location for the implementation and dissemination of MCM innovations in Indonesia (Tyas et al., 2024). This indicates that innovation adoption is influenced not only by the origin of the technology development but also by the presence of local academic communities and international collaborative projects. These findings suggest that MCM dissemination is more influenced by collaborative networks than by geographic distribution alone.

RQ 2: How does MCM implementation contribute to students' cognitive development and affective engagement in learning?

Based on the analysis of 25 articles, the contribution of MCM implementation to student development can be classified into 10 cognitive domain abilities and 3 affective domain abilities, as presented in Table 4.

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Table 4. Contribution of MCM to Cognitive Development and Affective Engagement

No	Types of Improved Domain	Number of Articles	Cognitive	Affective
1	Problem solving skills	9	√	
2	Mathematical results	1	√	
3	Mathematics learning outcomes	1	√	
4	Mathematical literacy	1	√	
5	Numeracy	2	√	
6	Critical thinking	5	√	
7	Spatial	1	√	
8	Mathematical reasoning	1	√	
9	Understanding mathematical concepts	3	√	
10	Motivation/interest	3		√
11	Mathematical communication	1	√	
12	Commitment	1		√
13	Autonomous	1		√

These findings indicate that research related to MCM is still dominated by exploration of the cognitive domain, while the affective domain is still relatively limited. In the cognitive domain, problem-solving ability is the most widely researched aspect with a percentage of 36%, followed by critical thinking ability at 20%, as shown in Figure 4a. The dominance of these two abilities indicates that MCM is positioned more as a means of developing Higher Order Thinking Skills (HOTS). HOTS is a person's thought process where in solving problems not only relying on memorization but also the ability to think critically in analysis, generating creative ideas, associating and drawing conclusions from new information obtained (Widhiyani et al., 2019). This is understandable because math trails-based learning activities require students to conduct direct observations of real objects, collect data through measurements, build mathematical models, and validate the obtained solutions. These findings align with research by Simone Jablonski, Simon Barlovits, and Mathias Ludwig, which demonstrated that the use of MCM helps students validate, elaborate, and repeat the modeling cycle when completing outdoor mathematics assignments (Jablonski et al., 2023). Furthermore, research by Nugraha, A.A. et al. (2023) demonstrated that mobile math trails activities can support the development of students' mathematical modeling skills through direct interaction with real-world environments. These characteristics align with the problem-solving indicators outlined by the National Council of Teachers of Mathematics, which include understanding problems, designing strategies, implementing procedures, and reflecting on solutions. Thus, the dominance of problem-solving and critical thinking skills in MCM research indicates that this approach has strong potential in developing higher-order thinking competencies in contextual mathematics learning. However, other cognitive abilities such as mathematical literacy, numeracy, mathematical reasoning, mathematical communication, spatial skills, and conceptual understanding have received relatively little research. Research on the cognitive and affective domains, if presented in percentage form, is as in Figure 4a and Figure 4b below:

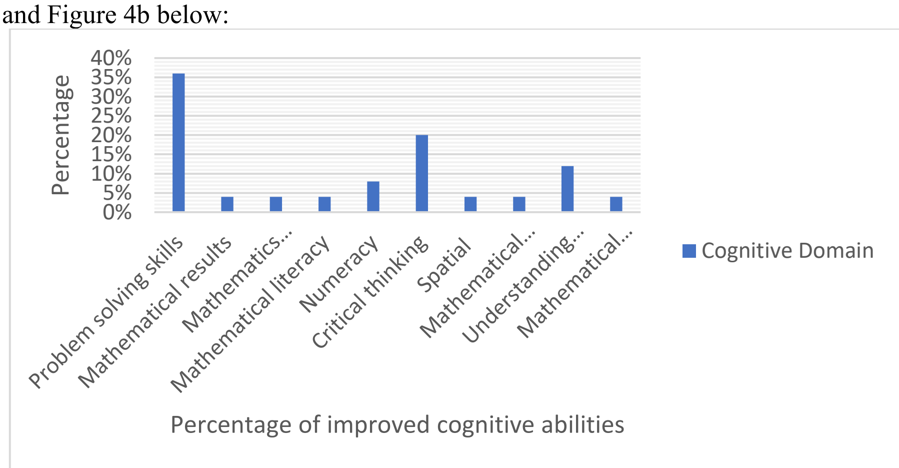

Figure 4a. Percentage of Improved Cognitive Abilities

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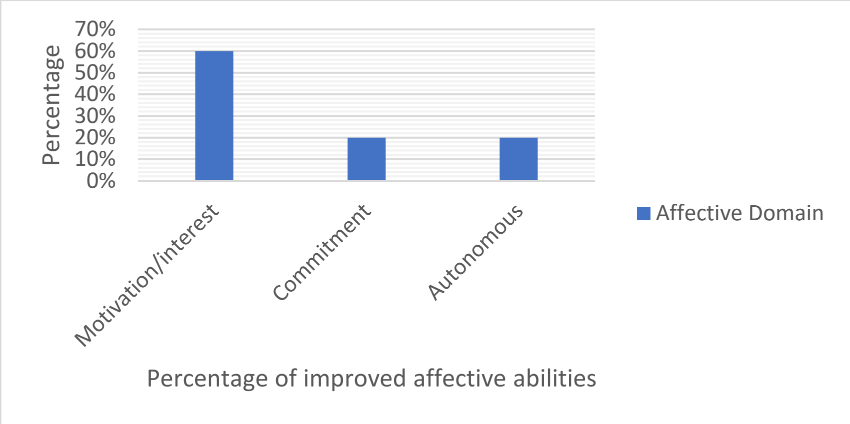

Figure 4b. Percentage of improved affective abilities

Based on the figure above, in the affective domain, motivation and interest in learning are the most frequently identified aspects, as shown in Figure 4b. Other aspects, such as mathematical communication, independence, and commitment, remain very limited. This finding demonstrates an imbalance in research focus in the affective domain, with motivation and interest in learning being studied more frequently than other aspects. This situation indicates that exploration of the contribution of MCM to students' affective development has not been conducted evenly and comprehensively. However, the affective and cognitive domains are not separate domains but interact to shape learning outcomes (Li, J., et al., 2023). Similarly, Ganley & Lubienski et al. (2021) explain that cognitive achievement influences affective, and affective achievement also influences cognitive achievement. Therefore, the limited research in the affective domain has the potential to lead to a suboptimal understanding of the contribution of MCM to students' holistic learning development.

The results of the article review indicate that of the three affective abilities identified, two, or 60%, examined personal growth (motivation and independence), and one examined social contribution ability (commitment). However, according to Al Afnan, the affective domain plays a crucial role in fostering personal growth and social contribution through the development of motivation, collaboration, resilience, and commitment. Therefore, the gap between the dominance of research in the cognitive domain and the limited studies in the affective domain suggests an opportunity for further research to explore the potential of MCM in developing students' character, resilience, and social competence more comprehensively.

RQ 3 : Topik matematika apa yang paling banyak digunakan dalam penerapan MathCityMap?

Berdasarkan analisis terhadap 25 artikel, topik matematika yang digunakan dalam implementasi MCM disajikan pada tabel 5 berikut.

Table 5. Topik matematika yang digunakan

No	Mathematics Topics Used	Number of Articles
1	Linear Function	1
2	Geometry	18
3	Not explained	2
4	Numeracy	1
5	Equation of a Stright Line	2
6	Trigonometry	1
7	Probability	1
8	System of Linear Equations in Two Variables	1
9	Time, Distance, and Speed	1

The topics used in the articles studied, as shown in table 5, were then grouped into five mathematical elements: Geometry, Algebra, Number, Measurement, and Data Analysis and Probability. The topic groupings above are presented in figure 5 below:

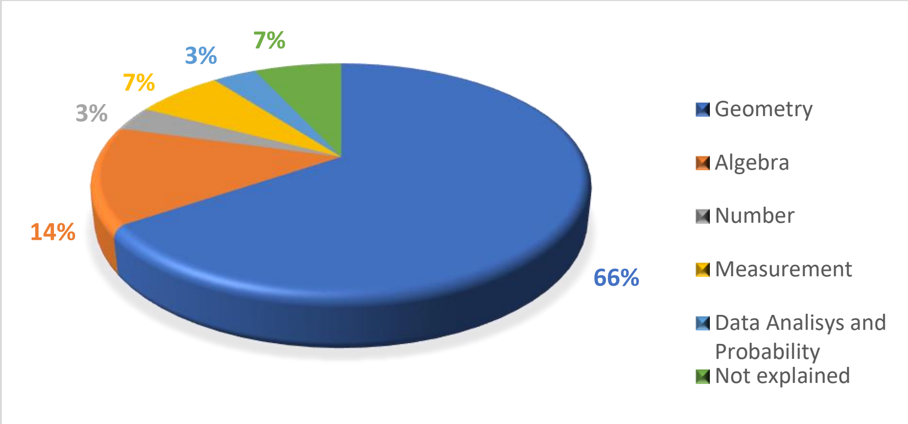

Figure 5. Mathematics topics used

Figure 5 shows that geometry is the most dominant topic used, accounting for 66% of the total, far surpassing other mathematics topics. The dominance of geometry demonstrates a strong fit between the characteristics of geometry material and the outdoor learning approach promoted by MCM. Geometric concepts such as plane figures, solid figures, angles, distances, and measurements can be easily connected to real-world objects in the students' environment, such as buildings, parks, roads, fences, and public facilities. This finding aligns with research by Rumanová (2024), who stated that the relationship between geometry and math trails is highly relevant because it allows students to connect mathematical representations with real-world spatial experiences. Similar findings were also reported by Pramudita & Rudhito (2024), who demonstrated that the geometry context in MCM helps students understand concepts and develop problem-solving skills through environmental exploration.

Compared to other topics, the use of algebra, statistics, and probability remains relatively low. This indicates that teachers and researchers tend to choose topics that are easier to visualize directly in the physical environment. This finding is interesting because, theoretically, MCM is not limited to spatial material. Research by Barbosa (2022) shows that math trails have the potential to develop mathematical modeling processes, allowing more abstract material such as early algebraic reasoning, as well as sequences and patterns, to be integrated when designed within an authentic context.

Thus, the dominance of geometry not only demonstrates a fit between the material and the real-world environment but also indicates that the use of MCM in more abstract mathematical topics is still suboptimal. This situation opens up opportunities for further research to develop more varied MCM activity designs, so that their implementation not only focuses on spatial representation but also supports contextual learning of algebra, statistics, and data analysis.

RQ 4: What are the learning implementation areas used in the research?

Based on the synthesis results, the implementation areas of MCM in the analyzed research can be grouped into two categories: the school environment and the non-school environment. Of the 25 articles analyzed, 15 implemented MCM in the school environment, while 10 articles utilized areas outside the school, such as city parks, educational tourist attractions, urban areas, and other public spaces. These results are presented in Table 6 below.

Table 6. Research Areas

No	Research Area	Number of Articles
1	School Area	15
2	Outside the School Area	10

These findings indicate that MCM implementation is still more common in school settings than in more open learning environments. The dominance of school settings can be understood from both practical and pedagogical perspectives. School environments tend to be easier to control in terms of security, time management, technology access, and monitoring student activities during learning. This finding aligns with research by Matthias Ludwig (2022), which shows that math trails are developed as part of formal mathematics instruction and designed to help teachers integrate outdoor activities with classroom learning objectives. This situation often makes the school setting the starting point for math trail implementation because it is easier to integrate with the curriculum and regular learning activities. Furthermore, research by Jablonski et al. (2023) also shows that using familiar environments helps students adapt more quickly to location-based activities before exploring more complex contexts.

However, the dominance of school settings also suggests that MCM's primary potential as an outdoor contextual learning approach has not been optimally utilized. Articles that use outdoor settings generally focus on linking mathematical concepts to real-world objects, such as measuring buildings, analyzing geometric shapes, or estimating distances. However, very little research has utilized this environment to instill values, character, or social and ecological awareness.

This finding opens up opportunities for integrating MCM with the UNESCO Education for Sustainable Development (ESD) approach. According to Amelia, ESD plays a role in developing students' competencies to make decisions that consider social, economic, and environmental impacts. Through direct interaction with real-world contexts, this application has the potential to not only develop understanding of mathematical concepts but also build sustainability awareness, social responsibility, and environmental concern (Amelia et al., 2020). Therefore, integrating MCM with a sustainability context presents a promising research opportunity to produce a more holistic and meaningful mathematics learning experience.

CONCLUSION

Based on the analysis of 25 articles, it is clear that the implementation of MCM in mathematics learning has developed in various countries. In terms of the skills developed, MCM is still dominated by the cognitive domain, particularly problem-solving and critical thinking skills. While studies on the affective domain, such as motivation, independence, collaboration, and commitment, are relatively limited. In terms of content, geometry is the most dominant topic, while more abstract mathematical topics such as algebra, statistics, and probability remain underexplored. Furthermore, MCM implementation is still more prevalent in school settings than in more authentic learning environments outside of school.

The main contribution of this research is providing a multidimensional mapping of trends in MCM use based on geographic distribution, ability domains, mathematical topics, and implementation contexts. It also identifies the gap between the dominance of studies on the cognitive domain and the limited exploration of the affective domain. These findings reinforce the fact that MCM not only has potential as a means of developing higher-order thinking skills but also holds significant potential for developing students' character, social interaction, and contextual awareness. Practically, the results of this study can serve as a reference for teachers and learning developers in designing more varied MCM activities, both in terms of mathematical topics and the use of the learning environment. Academically, further research is recommended to expand the implementation of MCM to less explored areas, integrate more abstract mathematical topics, and examine MCM's contribution to the affective domain in greater depth.

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