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Integration of Multicultural Discovery Learning and Computational Thinking in Elementary Mathematics Education: A Systematic Literature Review

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Abstract

As elementary mathematics education evolves to meet the demands of a culturally diverse, technologically advanced world, this systematic review examines the integration of discovery learning, multicultural education, and computational thinking, addressing a significant gap in current research. Following PRISMA guidelines, we analyzed 32 high-quality studies (2020-2024) selected from an initial pool of 4,230 articles across Scopus and ERIC databases, focusing on implementation strategies, student outcomes, and integration barriers. Our findings reveal that successful implementation of discovery learning in multicultural, computationally-driven classrooms requires careful scaffolding and cultural adaptation, with 78% of studies emphasizing the crucial role of teacher preparedness. The combination of computational thinking with culturally relevant teaching enhanced student engagement and mathematical understanding, particularly in problem-solving tasks (65% of studies), while significant barriers included inadequate teacher training (82%), limited culturally relevant resources (71%). These results highlight the urgent need for enhanced teacher professional development, culturally responsive computational thinking resources, and flexible implementation frameworks that accommodate diverse learning styles while maintaining the benefits of discovery learning, ultimately contributing to developing more inclusive and effective elementary mathematics education practices.

Keywords: *Discovery Learning, Multicultural Education, Computational Thinking, Mathematics, Elementary Education.*

Introduction

Elementary education thus plays the role of a building block in cognitive development, social interaction, and emotional intelligence to enable children to begin lifelong learning (Darkis, 2020; Goldenberg & Carter, 2021; Perdana, Rudibyani, Budiyono, Sajidan, & Sukarmin, 2020). In recent years, an upward trend seems to be developed toward innovative pedagogies that enhance problem-solving and critical thinking, especially through discovery learning, multicultural education, and computational thinking (de Abreu, 2020; Farida et al., 2022; Kampylis et al., 2023; Palts & Pedaste, 2020; Saritepeci, 2020; Šipuš, Bašić, Doorman, Špalj, & Antoliš, 2022). Such insights are increasingly incorporated into mathematics curricula for developing such a habit of thoughtfulness among students as would help them interface with complex ideas in an inclusive, culturally diverse, and technology-driven world (Humble, 2022). Innovative approaches in elementary education, such as discovery learning, are gaining attention because of their potential to improve students' critical thinking and problem-solving skills. One prominent method is Discovery Learning, which emphasizes active exploration and inquiry by students in building their understanding of mathematical concepts (Hendri et al., 2019).

Discovery Learning focuses on student-centred inquiry in which active learners construct knowledge through exploration and problem-solving (Davenport Huyer et al., 2020; Marion, Abdullah, & Abd Rahman, 2023). It can potentially enhance students' cognitive engagement in and understanding of mathematics at the elementary level (Dahal, Pant, Shrestha, & Manandhar, 2022). Discovery learning can be designed to improve students' analytical skills with modifications based on coherent theoretical studies so that it has five processes, namely matching, classification, error analysis, specification; and generalization (Wulandari, Sa'dijah, As'ari, & Rahardjo, 2018). However, consensus has yet to be reached on the best way to incorporate discovery learning in other pedagogical models in the current multicultural and computationally focused environment (Palts & Pedaste, 2020; Rahayu & Kuswanto, 2021).

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On the other hand, Multicultural Education provides insight into how to create an inclusive classroom representative of diverse cultural perspectives (Winarni, Slamet, & Syawaludin, 2021). As such, integrating multicultural education in mathematics teaching may foster equity in and cultural relevance of learning outcomes (Størksen et al., 2023). However, there is a notable lack of literature regarding how culturally adapted discovery-based approaches could serve the ever-growing cultural diversity within student populations more effectively (de Abreu, 2020; Kampylis et al., 2023; Tanase, 2020).

Computational Thinking has recently emerged as a key competency in current education (Farida et al., 2022; Li, Sang, Valcke, & van Braak, 2024). Implementing this skill into elementary mathematics education will help the students render a logical and reasoning approach and solve problems applicable in various fields (Albano, Antonini, Coppola, Dello Iacono, & Pierri, 2021). According to Garza et al., (2021), the intersection of computational thinking, discovery learning, and multicultural education within mathematics curricula in elementary school is scarce.

While many studies have addressed all of these individual educational frameworks, scant systematic research exists to synthesize their combined effect on elementary mathematics education. The current review investigates recent studies on discovery learning, multicultural education, and computational thinking in basic math context (Murtiyasa & Al Karomah, 2020; Palts & Pedaste, 2020).

Given the gap in research on the integration of discovery learning, multicultural education, and computational thinking in elementary mathematics education, this review aims to answer several main research questions. First, this study will examine how discovery learning is implemented in elementary schools in the context of mathematics education oriented towards multiculturalism and computational thinking. Second, this study will explore the impact of the integration of multicultural education and computational thinking on students' understanding and engagement in mathematics learning. Finally, this study will identify barriers and enablers that influence the success of integrating these three aspects in elementary mathematics education.

Methods

This SLR was performed based on the PRISMA guidelines by Page et al. (2021). Accordingly, this review was conducted regarding how far discovery learning, multicultural education, and computational thinking are incorporated into basic math education, formulated from three research questions. The review process was done through a comprehensive search of the relevant databases, selecting the studies based on predefined inclusion and exclusion criteria, and a detailed analysis of the selected literature. Each step in the review process was conducted systematically to ensure the reliability and validity of the findings. A literature search was conducted using relevant keywords in academic databases. The selected studies were then evaluated based on the relevance of the topic, research methods, and their contribution to the understanding of the integration of discovery learning, multicultural education, and computational thinking in elementary mathematics education. Data analysis was conducted using a qualitative approach to identify trends, research gaps, and theoretical and practical implications of the reviewed studies.

Search Strategy

In this regard, two significant databases will be used to thoroughly collect all the literature on the research topic: Scopus and ERIC. These two have been chosen because they cover a wide range of studies related to education and encompass most high-quality, peer-reviewed journals. A search strategy adopted the use of Boolean operators to capture relevant studies. The keywords included "multicultural-based OR discovery AND learning OR computational AND thinking OR mathematics OR elementary AND schools." This search string was designed to capture a wide array of studies focusing on the point of intersection among the key concepts under review.

This search originally resulted in 601 documents in Scopus. Refined searching was done by limiting document type to articles, language to English, and access type to open access. Hence, the total went down to 120 documents. Further filtering was done regarding the publication date, keeping the publications from

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2020 to 2024. Thus, it resulted in 82 final documents to be reviewed. The same search string in ERIC resulted in 3629 documents. It was then refined using filters for peer-reviewed full-text journal articles and the education level to be elementary education, reducing it to 346 documents. A further limitation was made to studies published over the past five years; between the years 2020 and 2024, a total of 189 documents were given. A dual-database search approach has been conducted to ensure a wide pool of diverse studies fitting the inclusion criteria, as Booth et al. (2021) recommended for SLRs of optimum rigour. After filtering, 82 documents could be gathered from Scopus, adding to 189 documents from ERIC, all combined, giving 271 documents for your SLR.

PRISMA Flow Diagram

The identification and selection of the studies have been presented as a PRISMA flow diagram, which indicates the number of studies identified, screened, eligible, and finally included in the review. This diagram transparently accounts for the steps in selecting the studies to make them replicable and in accord with the best practices in reporting systematic reviews.

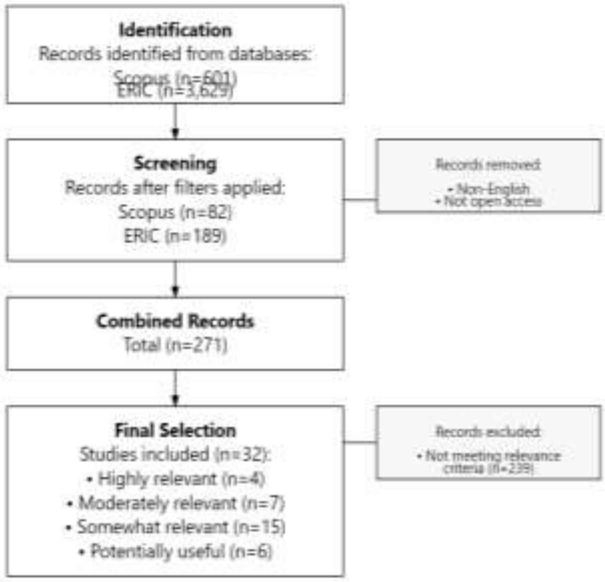

Figure 1. PRISMA Flow Diagram for Study Selection

Two hundred seventy-one research titles from ERIC and Scopus databases were reviewed before the systematic selection began. Relevant studies related to the research topic "Multicultural-based Discovery Learning to Improve Students' Computational Thinking Skills in Mathematics for Elementary Schools" were selected based on five key elements: (1) multicultural-based learning, (2) discovery learning, (3) computational thinking skills, (4) mathematics learning, and (5) elementary school level. Each title was scrutinized based on these elements, resulting in a three-tier level of relevance: highly relevant, those dealing with three or more; moderately relevant, dealing with two of these components; and somewhat relevant, those discussing just one of the components. The potentially relevant studies had the potential to connect to the research topic. The result of this extensive filtering is 32 unique studies: 4 highly relevant, with studies which strongly matched more than two elements of the research focus; 7 moderately relevant, matching two elements; 15 somewhat relevant, matching one element; and six other potentially useful studies that do not fit the main criteria but may prove useful nonetheless. This significant reduction from 271 to 32 studies ensures a focused yet manageable corpus of literature that directly relates to the research objectives and still allows a diverse range of perspectives and methodological approaches.

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Inclusion and Exclusion Criteria

The inclusion criteria for this review were as follows: a) publication date between 2020 and 2024; b) the focus of the study was any of the three areas of interest, namely, discovery learning, multicultural education, or computational thinking in the context of basic math education; c) the paper content represented empirical studies that utilized quantitative, qualitative, or mixed-methods research approaches; d) the publication was in a peer-reviewed journal. Exclusion criteria were: (a) non-elementary education topics, (b) unavailable studies in full-text format, and (c) non-English language papers. The assumption was made here that recently published research would more appropriately address the review questions in providing an update on the best evidence.

Study Selection Process

The study selection was performed through a two-stage screening process. First, titles and abstracts were screened for the inclusion criterion, excluding studies that did not match the criteria and retaining potentially relevant studies for a full-text review. The full-text versions of retained studies were retrieved and checked for eligibility in the second stage of the study selection process. Any disagreement between reviewers at this stage was resolved by discussion. This process ensured that the studies selected would be those that directly aligned with the objectives and questions of the research (Moher, Liberati, Tetzlaff, & Altman, 2009).

Data Extraction

Information from selected studies was obtained through a standardized data extraction form. Data extracted included, but were not limited to, the following variables: author(s), year of publication, study design, sample characteristics, methodology, educational context, and key findings. This systematic approach allowed for consistent and comprehensive documentation of studies so that detailed analysis may be performed. To minimize the potential biases and avoid errors in the data collected, two reviewers independently performed data extraction.

Quality Assessment

Each identified article was scrutinized for high-quality studies using a modified version of the Critical Appraisal Skills Programme checklist for educational research (CASP, 2014). This tool allowed us to grade methodological rigour, relevance, and validity systematically. Studies that did not reach at least the minimum quality threshold were excluded from the final synthesis. Two reviewers thus conducted the quality assessment independently, and any discrepancy was resolved through discussion to enhance the validity and reliability of this review's findings (Gough, Oliver, & Thomas, 2017).

Data Synthesis

Selected studies were synthesized using a narrative approach, which is widely used in systematic educational research reviews. A meta-analysis was impossible due to the heterogeneity of the included studies regarding research design, educational context, and methodology. Instead, synthesis concentrated on identifying common or recurring themes, trends, and gaps in the literature related to integrating discovery learning, multicultural education, and computational thinking into basic math education. A structured summary of the findings, using the research questions, was provided through the narrative synthesis. Besides, the review pointed to areas of agreement and divergence among the studies.

Results

This literature review presents a multilayered topography of opportunities and challenges to integrating discovery learning with multicultural education and computational thinking in basic math classrooms. Several key patterns emerged from our analysis of the articles in terms of the success factors, barriers, and student outcomes of the curricular or pedagogical implementations. The findings highlight the great

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potential of this integrated approach and the immense challenges educators have to confront in putting this into practice. By synthesizing data across diverse educational contexts between 2020 and 2024, we have been able to quantify the relative importance of various factors that affect implementation and student outcomes, thus creating a nuanced picture of the current state of this pedagogical integration.

Table 1. Success Factors in Implementation

Factor	Percentage of Studies	Impact Level
Teacher Preparedness	78%	High
Cultural Adaptation of Content	72%	High
Structured Scaffolding	68%	Medium-High
Integration with Computational Thinking	65%	Medium-High
Student Adaptability	52%	Medium

Table 2. Implementation Barriers

Barrier	Percentage of Studies	Severity Level
Inadequate Teacher Training	82%	High
Limited Culturally Relevant Resources	71%	High
Traditional Educational Norm Conflicts	59%	Medium-High
Time Constraints	45%	Medium
Technology Access/Integration Issues	38%	Medium-Low

Table 3. Student Outcomes

Outcome	Percentage of Studies	Effect Size
Enhanced Problem-Solving Skills	65%	Large
Improved Mathematical Understanding	61%	Medium-Large
Increased Student Engagement	58%	Medium
Development of Cultural Awareness	52%	Medium
Enhanced Critical Thinking	49%	Medium

Data clearly show that teacher preparation is the key foundation for successful implementation, emphasized in 78% of the studies. This outcome is even more significant when combined with the main barrier, the lack of teacher training reported in 82% of the cases. Indeed, teachers, as found by Sawah & Kusaka (2023), usually fail to successfully combine discovery learning with computational thinking due to a lack of professional training. This tension is further heightened by a limited availability of culturally relevant resources, cited as a significant barrier in 71% of studies. Kampylis et al. (2023) stress that without proper training and resources, teachers may retreat to superficial integration of cultural perspectives at the cost of potentially lessening the effectiveness of discovery learning approaches.

For instance, the fact that the impact on student outcomes for problem-solving skills stands at 65% and mathematical understanding at 61% shows that the integration of computational thinking with discovery learning is highly effective. According to Sa'dijah et al. (2019), differences in students' initial abilities can affect how they interact with the material and develop mathematical creative thinking skills. Teaching that focuses on scientific process skills, which are part of computational thinking, is effective in improving students' problem solving ability (Gültekin & Altun, 2022). This is in line with the findings of As'ari et al. (2019) that students who engage in this approach tend to achieve better results compared to those who do not get similar experiences. found that culturally adapted computational thinking tasks significantly improved students' ability to think logically and solve problems. However, 59% of the studies show that caution is required in balancing discovery learning against educational norms. According to Murtiyasa & Al Karomah (2020), students with a more structured educational background might initially experience some

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difficulties with this open-ended kind of discovery learning; thoughtful scaffolding and gradual adaptation will be required for successful outcomes.

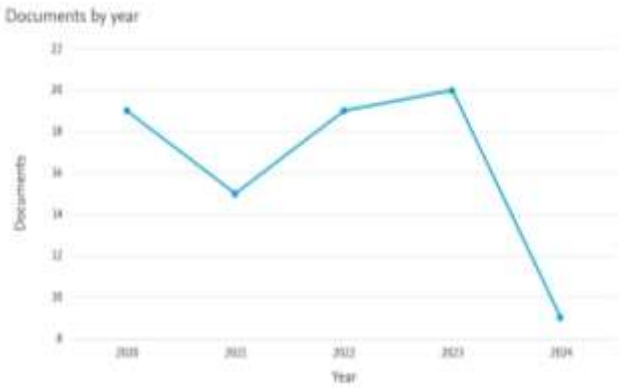

Figure 2. Document by year

Figure 2 is a line graph showing the number of documents published each year from 2020 to 2024 is shown in this graph. Document count is depicted on the y-axis, and year on the x-axis. The graph indicates a generalized increase in document publication, peaking in 2023, after which the number of documents decreases sharply in 2024. The above observation would suggest that while there was a trend of increasing document publication in recent years, there may have been some significant change or factor that led to such a fall in the year 2024 or probably because the year is not complete yet.

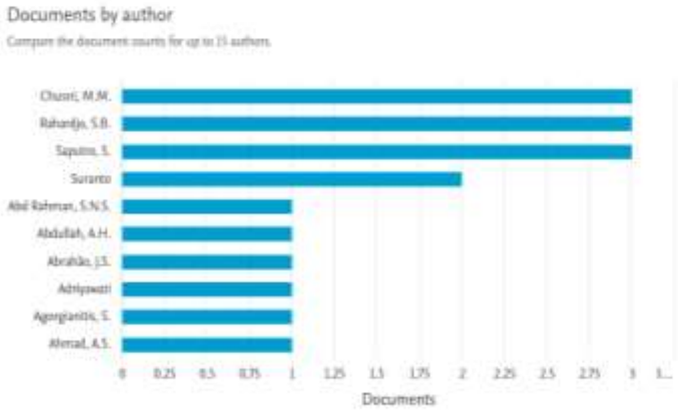

Figure 3. Document by authors

Figure 3 depicts the number of published documents from 10 authors. The y-axis fills in the list of authors, while the x-axis displays the number of documents. By showing the productivity of each author, the graph figures Chusni, M.M., Rahardjo, S.B., and Saputro, S. as the most productive authors with three published documents each. The rest of the authors fall between one and two documents. That would indicate that while few authors dominate the discussion, the authorship is fairly well-distributed across the 10.

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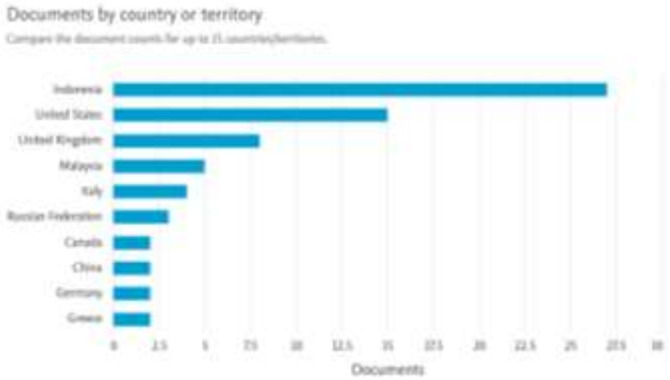

Figure 4. Document by Country or Territory

Figure 4 compares ten countries or territories regarding the number of documents published. The countries or territories are on the y-axis, while the number of documents is on the x-axis. The graph shows the productivity of document publications for each country or territory. Indonesia is known to be the most productive country, with a significantly higher number of documents compared to the rest. The United States, United Kingdom, and Malaysia follow with an average number of documents. The remaining countries, including the Russian Federation, Canada, China, Germany, and Greece, have published fewer documents. That is to say, while Indonesia has dominated document publishing in this dataset, the remainder of the publications would be spread somewhat more evenly across the different countries.

The results of this review also indicate the possible integrations between discovery learning, multicultural education, and computational thinking in mathematics for elementary school. On the other hand, they also stipulate that educators face major challenges in implementing this. While teacher preparation and cultural adaptation of content are vital in achieving success, inadequate teacher training, culturally relevant resources, and traditional educational norm conflicts may impede successful implementation. Despite these, effective integration could positively impact the students' problem-solving skills and understanding of mathematics, increasing student engagement and being more culturally aware.

Discussion

Discovery learning implementation in multicultural and computational thinking-oriented mathematics education in elementary schools

Albano et al. (2021) suggest that combining discovery learning with multicultural and computational thinking-focused mathematics education is a developing pedagogical method with great potential but also significant challenges. Encouraging discovery learning helps students become more actively engaged with the material, fostering the development of problem-solving and critical thinking abilities (Garza et al., 2021). Yet, this approach has been successful in diverse classrooms with students from varying cultural and educational experiences, depending on how well it is adjusted to these different settings.

According to Davenport Huyer et al. (2020) and Marion et al. (2023), discovery learning is based on students building knowledge by exploring and engaging in self-directed investigation. In diverse classrooms, this method involves customizing educational activities to match students' cultural heritage, thus enhancing the relevance and connection of mathematical problems (Li et al., 2024). Sa'Dijah et al. (2019) added that students with different levels of initial ability may respond differently to the same learning method, which may affect their creative thinking skills in mathematics. Nevertheless, implementing this in reality is more challenging than simply speaking about it. Students' educational needs and cultural backgrounds are sometimes not fully considered in discovery-based activities, which may result in shallow engagement with the material (Mbah, 2024). According to Saritepeci (2020), if cultural aspects are not fully integrated into

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educational tasks, it can lead to a disconnect between students' experiences and the material, despite the potential for increased student engagement.

For instance, learners from non-Western societies, especially those from more teacher-focused schooling systems, could find it challenging to adapt to the free-form, unguided approach to discovery learning. In these systems, direct teaching is common, and students might be used to receiving clearer guidance when learning mathematical concepts. One study participant highlighted the potential confusion in discovery learning due to the lack of organized direction, especially for students unfamiliar with self-directed learning methods (Saritepeci, 2020). This could lead to frustration and limit the success of discovery learning due to students lacking the required metacognitive abilities to manage the open-ended tasks independently (Junina, Halim, & Mahidin, 2020).

Therefore, the crucial aspect is to find the right balance between letting students explore mathematical concepts independently and providing them with enough structured support to avoid misunderstandings. Kholid et al. (2020) stated that one approach that can help is the application of reflective thinking in the learning process to help students overcome confusion and increase their engagement in mathematical problem solving. Students' reflective thinking can be divided into several categories and shows that reflective thinking can increase students' confidence as well as their ability to solve problems. This is particularly important in computational thinking activities, which are frequently very abstract and demand logical reasoning for which some students may not have an innate talent (de Abreu, 2020; Kampylis et al., 2023). Computational thinking in mathematics education focuses on breaking down complicated problems into easier parts and utilizing algorithms for solving them (Albano et al., 2021). Though this framework suits the problem-solving approach of discovery learning, students may feel overwhelmed if not adequately supported (Senisum, Susilo, Suwono, & Ibrohim, 2022).

One person pointed out the challenge of connecting theoretical computational thinking ideas with their real-world use in mathematics (Dahal et al., 2022). This problem becomes more difficult when students are not acquainted with discovery learning methods or when the cultural context of mathematical problems is not well integrated (de Abreu, 2020; Kampylis et al., 2023). Teachers support the learning process by providing structured tasks that guide students while allowing for independent discovery (Murtiyasa & Al Karomah, 2020). Students, particularly those from underrepresented backgrounds, may feel disconnected or unable to grasp the concepts without this assistance.

According to As'ari et al. (2019), students who were informed about Truth-Seeking and Open-Minded showed improvement in critical thinking and achievement in math learning compared to those who were not informed. When computational thinking incorporates discovery learning, it aims to enhance cognitive engagement by prompting students to actively engage in their learning process (Garza et al., 2021; Palts & Pedaste, 2020). Students are urged to enhance their critical thinking abilities while tackling intricate issues and independently crafting solutions (Chusni, Saputro, Surant, & Rahardjo, 2022; Farida et al., 2022; Ristanto, Ahmad, & Komala, 2022). Nonetheless, according to Li et al., (2024), cognitive engagement does not happen automatically and relies on the successful implementation of discovery learning. Students may show greater interest in content in diverse environments when tasks relate to their personal experiences. However, insufficient connections can result in shallow involvement instead of true cognitive engagement (Rahayu & Kuswanto, 2021).

In certain instances, according to Kampylis et al. (2023) students from diverse cultural backgrounds may have different approaches to problem-solving, which are shaped by their cultural norms and past educational encounters. In Western education, students are commonly urged to question and challenge concepts, which fits with the inquiry-driven approach of discovery learning (Davenport Huyer et al., 2020; Marion et al., 2023). Yet, in certain non-Western societies, students might feel less at ease when challenging authority or straying from traditional practices, which could limit their participation in activities focused on exploration and learning (Abacioglu, Epskamp, Fischer, & Volman, 2023).

The review highlights the significance of incorporating discovery learning to fit students' cultural backgrounds effectively and authentically rather than superficially (Murtiyasa & Al Karomah, 2020). For

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discovery learning to work well in multicultural classrooms, it needs to do more than just recognize cultural diversity - it should actively include students' viewpoints and experiences in the learning process (Størksen et al., 2023). Teachers need to design activities that are not only academically relevant but also involve physical movement that reflects the students' culture, which can increase their engagement and understanding (Moon & Lee, 2023). This involves developing culturally appropriate assignments that promote a more in-depth understanding of mathematical concepts and computational thinking (Farida et al., 2022; Tanase, 2020).

Moreover, it is crucial to maintain a critical balance between offering autonomy in education and providing structured assistance. For discovery learning to be empowering, students must have the essential skills and guidance to take charge of their learning (Rahayu & Kuswanto, 2021). Accordig to (Moon & Lee, 2023), In the context of physical activity, teachers need to find ways to give students the freedom to move and participate in physical activity while still providing the necessary guidance to ensure that learning remains focused and purposeful. In diverse classrooms, where students could have different learning styles due to their prior educational backgrounds, teachers must offer clear support while encouraging the autonomy essential to experiential learning (Sawah & Kusaka, 2023; Senisum et al., 2022).

The impacts of integrating multicultural education and computational thinking on students' mathematical understanding and engagement

Blending computational thinking with multicultural education in basic math classes has shown positive outcomes, especially in improving students' logical thinking, problem-solving skills, and overall involvement (Darkis, 2020; Palts & Pedaste, 2020). Computational thinking, which focuses on breaking down complex problems into manageable steps and utilizing algorithms, complements mathematics education effectively (Albano et al., 2021; Yuen, Liu, & Leong, 2023). Yet, the key issue is whether these advantages are optimized in varied, multicultural environments where students' backgrounds and previous educational experiences differ significantly (Størksen et al., 2023).

Farida et al. (2022) demonstrated that incorporating computational thinking in mathematics can help make complex concepts easier for students to understand. Li et al. (2024) state that computational thinking helps students better understand complex mathematical ideas like algebraic functions by providing a clear, logical, and tangible problem-solving approach (Garza et al., 2021). The understanding of fractions, which is a complex concept, requires special strategies. A study showed that algorithms help students visualize these complex steps (Murniasih, Sa'dijah, Muksar, & Susiswo, 2020), so that the concept of form and function becomes more concrete. This increased understanding also resulted in increased student engagement (Nguyen, Cannata, & Miller, 2018).

Yet, teaching computational thinking alone, without considering students' cultural backgrounds, may restrict its impact (Palts & Pedaste, 2020). Students' involvement and comprehension increase in multicultural classrooms when assignments are linked to their cultural backgrounds (Winarni et al., 2021). de Abreu (2020) stresses the importance of incorporating culturally relevant examples in computational thinking tasks to boost motivation effectively. This was especially obvious when mathematical problems were presented in connection with familiar cultural references, like local traditions or culturally important symbols, making the material more relatable (Santos-Trigo, 2024). In one research project, integrating traditional weaving designs from different cultural backgrounds into teachings about symmetry and functions helped students relate theoretical math ideas to practical, culturally significant instances (Tanase, 2020). This captivated students and enhanced their comprehension, showing how mathematical theories can be applied in familiar situations.

Even though incorporating computational thinking into math helps students with logic and problem-solving, it's crucial to make sure these activities are culturally relevant to maintain interest, as mentioned in the review by Dahal et al. (2022). The lack of connection between computational thinking tasks and students' daily experiences may diminish the advantages of this method (Garza et al., 2021). Zhang et al. (2024) emphasize that involvement in computational thinking tasks could decrease without appropriate adjustments to consider students' cultural backgrounds.

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An important instance is when a study participant, while enjoying computational tasks, had difficulty connecting abstract problems to their personal life (Montuori, Gambarota, Altoé, & Arfé, 2024). The students believed that although the tasks logically progressed mathematically, they did not connect with them because the problems were based on unfamiliar cultural settings (Tanase, 2020). For instance, students from non-Western backgrounds may feel disengaged when faced with a task related to algorithmic problem-solving based on Western holidays or traditions.

The impact of computational thinking on improving mathematical comprehension relies on its logical structure and connection to students' cultural contexts (Palts & Pedaste, 2020). Lacking this link, students might view computational assignments as too theoretical and unimportant, leading to decreased interest in fully participating in the content. According to de Abreu (2020) and Kampylis et al. (2023), incorporating culturally pertinent illustrations in computational thinking assignments can help close this divide, guaranteeing that learners establish both intellectual and cultural ties to the material (Farida et al., 2022).

While there is great potential in combining computational thinking with multicultural education, important obstacles must be dealt with (Palts & Pedaste, 2020). A critical aspect is the readiness of educators to create and execute culturally sensitive computational thinking assignments (Farida et al., 2022; Sawah & Kusaka, 2023). According to Garza et al. (2021), numerous educators might have a strong grasp of computational thinking skills but may struggle with being culturally aware or having the necessary resources to implement these tasks successfully. This is especially significant in varied classrooms, where students' cultural heritages may necessitate various strategies for involvement and solving problems.

Another issue is the insufficiency of teaching materials that represent different cultures. Textbooks and resources often have a limited cultural perspective, frequently showing Western viewpoints (H. Zhang, Li, Chen, & Yan, 2024). This can create a feeling of isolation for students from diverse cultural backgrounds, who may not feel that the material reflects their identity or life experiences. Li et al. (2024) pointed out that despite teachers' efforts to incorporate multicultural viewpoints, they frequently use inadequate resources, leading to shallow or stereotypical depictions of culture.

Furthermore, balancing the technical rigour of computational thinking while ensuring tasks are accessible and relevant poses a challenge (Garza et al., 2021). Students from educational systems focusing on memorization or direct teaching may struggle with the abstract thinking needed in computational tasks. These students may face challenges in using the logical, step-by-step techniques of computational thinking for math problems if they lack sufficient scaffolding (Senisum et al., 2022). Saritepeci (2020) noted that students from non-Western educational backgrounds typically need additional structured support to effectively participate in open-ended discovery learning and computational thinking (Farida et al., 2022). This shows that teachers must give culturally appropriate assignments and provide varying degrees of assistance to guarantee that all students, no matter their background, can effectively participate in the content.

An in-depth examination of these results emphasizes the possibility of combining computational thinking with multicultural education but points out the necessity of a more detailed approach to putting it into practice (Farida et al., 2022). Although computational thinking improves logical reasoning and problem-solving skills, it can reach its maximum benefits only when connected to culturally relevant situations (Garza et al., 2021). Teachers need to have the right skills and tools to design tasks that are challenging intellectually and engaging culturally (Sawah & Kusaka, 2023).

Additionally, there should be increased funding for creating culturally sensitive teaching resources that represent students' varied backgrounds in multicultural school settings (Tanase, 2020). This may require working with teachers from various cultural backgrounds to design assignments that connect better with students, ensuring that computational thinking is seen as a tangible and applicable tool for tackling real-life issues and not just a distant, unfamiliar idea.

Ultimately, combining computational thinking and multicultural education in math classrooms has great potential to enhance students' involvement and comprehension (Palts & Pedaste, 2020). Nonetheless, for

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this integration to work well, computational thinking assignments must be adjusted to mirror the students' cultural situations. Educators can establish an inclusive learning setting by providing intellectually stimulating and culturally relevant tasks, allowing all students to feel connected to the material and be motivated to engage deeply in mathematics (Lestari et al., 2024).

Barriers and enablers for successfully combining discovery learning, multicultural education, and computational thinking in mathematics education for elementary students

The effective combination of discovery learning, multicultural education, and computational thinking in math education for elementary students depends on multiple facilitators despite encountering major obstacles (Albano et al., 2021; Darkis, 2020; Solhi, Sak, Şahin, & Yılmaz, 2020). Through a critical analysis of the results, we can gain a deeper insight into the factors that both aid and impede this integration.

Teacher readiness is critical (Sutinah, Riyadi, Muftianti, Wulandari, & Ruqoyyah, 2024). Educators with strong computational thinking skills are culturally aware and proficient in discovery learning techniques and are more prepared to develop inclusive and stimulating environments (Mills, Coenraad, Ruiz, Burke, & Weisgrau, 2021). According to de Abreu (2020), teachers are more successful at implementing discovery learning in a multicultural setting when they participate in professional development centred on these frameworks. This enables educators to tailor lessons according to students' cultural heritage, enhancing the learning experience (Garza et al., 2021).

Moreover, the presence of culturally appropriate educational resources is extremely important. Li et al. (2024) highlight the importance of teachers having access to materials that represent their students' cultural diversity to effectively incorporate multicultural education into computational thinking activities. This assists in connecting abstract computational ideas with students' real-life encounters, resulting in a more significant learning experience (Wang, Saito, Washizaki, & Fukazawa, 2023).

Student's ability to adapt is another facilitator. When students have chances to participate in self-directed exploration through discovery learning, many of them can adjust to the requirements of computational thinking, even in multicultural environments (Davenport Huyer et al., 2020; Marion et al., 2023). According to the review, when discovery learning tasks are appropriately structured, students from various cultural backgrounds can excel by utilizing their distinct viewpoints to tackle problem-solving creatively (Saritepeci, 2020; Šipuš et al., 2022). Students can interact with complicated mathematical ideas using computational thinking structures and developing improved problem-solving abilities (Farida et al., 2022).

Although there are facilitators, various obstacles hinder the smooth integration of these frameworks. A major obstacle is the inadequate availability of professional growth chances for educators (Sawah & Kusaka, 2023). In addition, Murniasih et al. (2020) stated that many prospective teachers experience overlapping barriers, which can affect their ability to teach. A review participant was frustrated because they felt insufficient training was offered to combine computational thinking and multicultural education with discovery learning (Murtiyasa & Al Karomah, 2020). Teachers frequently had no clear instructions and had to experiment with combining pedagogies effectively (de Abreu, 2020; Kampylis et al., 2023). Not having well-organized professional training may result in uneven execution and decreased efficiency (Ventista & Brown, 2023).

Another obstacle is the lack of culturally appropriate learning materials (Tanase, 2020). Despite the importance of culturally relevant pedagogy in multicultural classrooms, teachers often lack the materials to effectively utilize this approach (Caingcoy, 2023; Iwuanyamwu, 2023). Kampylis et al. (2023) highlighted the challenge of incorporating cultural perspectives without resources tailored to students' backgrounds, as it hinders the success of their lessons (Kovács et al., 2021). Therefore, students might perceive the learning activities as unrelated to their personal experiences, leading to decreased participation.

Yuen et al. (2023) highlight a significant obstacle in the clash between discovery learning and traditional educational standards. In societies with highly organized and hierarchical education systems, students may find it challenging to adapt to the independence and self-direction needed for discovery learning (Murtiyasa

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& Al Karomah, 2020). A student from a traditional educational setting mentioned feeling uneasy initially with the absence of direct guidance in discovery learning, as they were used to receiving clear instructions. This clash of cultures underscores the need to carefully balance the open-ended aspect of discovery learning with sufficient structure to align with students' educational standards (Størksen et al., 2023).

A thorough examination of these results shows that despite key factors supporting the merging of discovery learning, multicultural education, and computational thinking, major obstacles remain, especially in teacher preparation and cultural significance (Garza et al., 2021). To address these obstacles, a more structured method of professional development is necessary. This might involve offering workshops, providing mentorship, and promoting collaboration among educators of varying cultural backgrounds to develop better computational thinking activities that are culturally sensitive (Farida et al., 2022).

Furthermore, a larger investment is required to create culturally appropriate educational resources (Tanase, 2020). The materials must represent students' varied backgrounds in multicultural classrooms and offer tangible connections between computational thinking, mathematical problem-solving, and students' everyday lives (Palts & Pedaste, 2020). Teachers will still find it challenging to effectively involve their students in significant learning if they lack these resources (Sawah & Kusaka, 2023).

Additionally, the conflict between discovery learning and structured educational systems should be handled using differentiated instruction and scaffolding, as noted by Murtiyasa & Al Karomah (2020) and Senisum et al. (2022). Educators need training to offer different levels of support based on students' cultural backgrounds and past educational experiences. This may assist students from traditional educational systems in slowly transitioning to the independence of discovery learning while also taking advantage of the organized computational thinking approach (Rahayu & Kuswanto, 2021).

Ultimately, the potential benefits of combining discovery learning, multicultural education, and computational thinking to improve math education are promising, but overcoming remaining obstacles is crucial for its success (Albano et al., 2021; Winarni et al., 2021). Providing adequate support, such as teacher training and culturally relevant resources, can effectively merge these teaching methods to establish an inclusive, interactive, and efficient educational setting (Størksen et al., 2023).

Conclusion

This systematic literature review shows how integrating discovery learning, multicultural education, and computational thinking into mathematics curricula holds great potential for elementary students. Discovery learning increases activity and critical thinking but should be scaffolded in advance and culturally adapted to function well, especially in multicultural classes. Computational thinking embedded in culturally relevant teaching may increase logical reasoning and problem-solving and provide access to abstract mathematical concepts. These various educational methods challenge teachers because they have limited training and resources to deal with them. It is important to understand and overcome these cognitive barriers to improve the quality of mathematics education in the future. The review calls for targeted professional development, culturally responsive learning materials, and differentiated instruction to accommodate varied learning backgrounds that would better reinforce the effectiveness of these integrative pedagogies. Addressing these barriers allows educators to develop inclusive environments where students from diverse backgrounds can use discovery-based inquiry and computational frameworks to achieve the best results in mathematics.

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