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# Concrete Material as Mediation for the Learning of Mathematics: A Systematic Review in Casa del Maestro

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**Abstract**

*This systematic review examines the use of concrete material in mathematics learning. The concrete material has been used in different educational contexts to promote the understanding of mathematical concepts, improve the appropriation of concepts and motivate students. The most relevant studies published in the last five years are examined, identifying the different types of concrete material used, as well as their effectiveness in improving the learning of mathematics. The results suggest that the use of concrete material may be beneficial for the learning of mathematics, but it opens the possibility of more studies to expand these conclusions and establish what type of concrete material is more effective in different educational situations, including in this view the virtual manipulatives.*

***Keywords:*** *Concrete material, Didactic mediation, Learning mathematics.*

## Introduction

Mathematics is a fundamental area in the education of children and young people, since it contributes to the development of cognitive skills and competences necessary for their academic and professional life. However, learning this discipline can be challenging for some students, especially those who have difficulty understanding abstract concepts.

In this sense, learning management in mathematics has become a priority in the educational field, since it demands meaningful learning and the development of key life skills. Thus, despite the efforts made to improve the teaching of mathematics, there are still students who have difficulties in understanding the concepts, which can demotivate them and affect their academic performance.

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In this context, the concrete material is presented as a mediation for the teaching and management of learning in mathematics. This type of material provides a tactile and visual experience that facilitates the learning and understanding of abstract concepts, which is beneficial for those students who have difficulty understanding the subject.

This article explores the use of concrete material as mediation for learning management in mathematics. To this end, an analysis of the impact of this type of material on student learning will be carried out and some recommendations for its implementation in the classroom will be presented. The methodology used will be the documentary review of previous studies.

It is hoped that the results obtained in this study will contribute to a better understanding of the role that concrete material plays in the management of mathematics learning and that they may be useful for educators in the implementation of effective and motivating teaching strategies.

## Methodology

Below are the phases that make up a methodology to carry out a documentary review study: Identification of the theme, Search for sources, Selection of documents, Analysis of documents and Synthesis and writing of the report

Identification of the theme: in this phase the object of study must be clearly defined, that is, the subject to be reviewed. It is important to establish the search criteria that will be used for the selection of documents.

Search for sources: once the theme has been defined, we proceed to search for relevant and reliable sources of information, which allow us to obtain a broad and updated vision on the subject. It is possible to use various sources of information, such as databases, scientific journals, books, theses, among others.

Selection of documents: in this phase the selection of the documents that will be studied is carried out. It is important to establish inclusion and exclusion criteria to ensure that the selected papers are relevant and pertinent to the research topic.

Analysis of the documents: once the documents have been selected, they are read and analyzed. It is important to make a critical and reflective reading of the texts to identify the main ideas and conclusions, as well as the methods and techniques used in the studies.

Synthesis and drafting of the report: in this phase we proceed to the preparation of the final report of the documentary review. This report should synthesize the most relevant ideas and conclusions of the documents analyzed, and present the conclusions and recommendations of the study.

Review and validation of the report: finally, it is important to review and validate the report by experts in the field to ensure its scientific rigor and the coherence of the results obtained. This validation can be done through peer review or presentation of the report in a scientific forum.

## Discussion

The use of manipulatives in mathematics teaching has been the focus of several studies in recent years. Jones and Tiller (2017) emphasized the effectiveness of concrete manipulatives in improving children's understanding of mathematical concepts. They suggested that incorporating manipulatives, such as blocks and tabs, can lead to more engaged learning experiences and greater information retention. Kontas (2016) also found that the use of manipulatives had a positive impact on the attitude towards mathematics. On the other hand, the study by Silveira (2021) indicates that he has been able to establish

from his research, that mathematics teachers, in their day to day constantly remember the manipulatives because they are present in mathematics textbooks.

In addition, the benefits of using manipulatives in mathematics teaching go beyond improving comprehension and performance. According to Jones and Tiller (2017), manipulatives can also help develop problem-solving skills and foster creativity in children. Kontas (2016) noted that the use of manipulatives can also promote collaboration and communication among students, as they work together to solve problems using manipulatives. Silveira's (2021) study further supports this idea by highlighting how manipulatives can facilitate active learning, where students are encouraged to explore mathematical concepts for themselves.

Overall, research suggests that incorporating manipulatives into math teaching can have numerous benefits for students of all ages. While the teaching of mathematics has evolved over time, and with it, new tools and technologies have emerged that have improved the way mathematical concepts are presented and taught. One of these advances is the creation of virtual manipulatives, tools that can be used instead of physical manipulatives in the classroom.

Virtual manipulatives are defined as digital objects that allow students to explore mathematical concepts interactively, as a result of technological innovations, the dominance of the Internet and the increasing availability of computers in classrooms and homes, an improved approach to teaching and

Learning mathematics using manipulatives and computers is emerging. This new approach essentially creates a new class of manipulatives, called virtual manipulatives, as well as new capabilities, or toolkits, for computer programs that use visual representations. these new virtual manipulators have all the useful properties of existing computer manipulators pointed out (Moyer, Bolyard, & Spikell, 2002). These resources have many advantages compared to physical manipulatives, such as the ability to be easily accessible, be less expensive, and have no physical or availability limits. In addition, according to Moyer, Bolyard, and Spikell (2002), virtual manipulatives can be especially useful for students who learn better visually.

In a study conducted by Saleem and Aziz (2017), it was found that students' spatial skills can be improved through geometric teaching and the learning process can be made interesting by using puzzle games. In that direction, the effect of using the tangram puzzle was explored. The results of the study indicated that students who used tangram puzzles in teaching geometry performed better on achievement tests than those who did not. These results suggest that tangram puzzles may be a valuable tool in teaching geometry at the primary level.

Another manipulative that has been used in the teaching of mathematics is the geoboard. Geoboards are mathematical tools composed of a grid of pegs on which elastic bands can be placed to create different geometric shapes. In a study conducted by Scandrett (2008), the effectiveness of geoboards in teaching mathematics at the primary level was explored, from this it can be seen that geoboards can particularly support learning in measurements, space and geometry of the primary mathematics curriculum. The results of the study indicated that the use of geoboards in the classroom allowed students to explore and build geometric shapes, which improved their understanding of mathematical concepts related to plane geometry.

Considering again, the advances in technology that have allowed the use of digital tools in the teaching of mathematics, such as the virtual manipulatives already mentioned, and that in the words of Bouck, Mathews and Peltier (2020) consider that manipulatives offer students with disabilities access and support in the classroom and it is important that educators are aware that concrete manipulators are not the only option, Teachers serving students identified with a disability in the middle grades may consider selecting virtual

manipulatives as a supplement, supplement, or instead of specific manipulators. For its part, Alsina (2020) proposes five productive practices for the teaching of mathematics through processes, which seek to actively involve students in the construction of their own knowledge. Among these practices is the use of specific resources and materials, such as manipulatives, to make mathematical concepts more understandable and the student can communicate them.

Likewise, Gamboa, Badillo, Couso and Márquez (2021) show how the use of modeling cycles for the analysis of the phenomenon of the growth of a rabbit population allowed a progressively more complex construction of models that integrated mathematical and scientific ideas. The progressive construction of the model was based on a design of separate cycles that First it allowed to identify the relevant mathematical ideas for the analysis of the phenomenon, and later to build new versions of the model, more adapted to reality, incorporating some relevant scientific ideas for the study of the phenomenon. This progressive modification of the initial model is considered epistemically appropriate as it reflects how scientific models are constructed and, moreover, proposes the connection between mathematics and science in STEM education (science, technology, engineering and mathematics) in primary education, using mathematical models to analyze species population growth. In this way, a more integrated and meaningful teaching of mathematics is sought, encouraging a more positive attitude towards the subject.

On the other hand, Rivas and Guizado (2022) point out that the mastery of mathematics represents a great challenge at different educational levels, so it is necessary for students to learn to solve problems from their daily lives. The objective of this study is to analyze and highlight the relevance of the development of mathematical skills from experiential games that develop the ability to solve problems of quantity and shape, movement and location.

In this systematic review, we find the work of Veloz Hidalgo (2022) focused on the following question: how is the specific material used in the teaching of Mathematics in the sixth year of Basic General Education in the San Francisco de Quito Municipal Educational Unit? and the purpose was to determine the use of such material in the study of this science; because its management as a didactic resource contributes to student learning of Secondary Basic Education. On the other hand, the study by Leonardini and Tovar (2021) that corresponds to a review article has the purpose of determining how preschool teachers teach the curricular area of mathematics and reflect on their pedagogical practice aware of the need to strengthen their teaching performance in an efficient way in search of improving the learning of their students.concluding that the use of concrete material is a useful tool in this process. Likewise, the article by Reyes and Antón (2020) analyzes the Singapore method as an effective strategy to improve the learning of mathematics, highlighting the importance of the use of concrete material in the implementation of this method. On the other hand, Ordoñez, Salinas and Quizhpe (2022) study the use of concrete material at the elementary sublevel and conclude that it is a useful tool to improve the learning of mathematics in students of this educational stage.

Along the same lines, Reyes and Antón (2020) explore the scope of the Singapore method in learning mathematics. The article highlights that this methodology focuses on the development of mathematical skills through the resolution of contextualized problems and the use of concrete materials, which allows a deeper and more meaningful understanding of mathematical concepts. The authors emphasize that the Singapore method has proven to be effective in improving academic performance in mathematics, as well as in the development of cognitive and metacognitive skills in students and the use of concrete material is key in its successful implementation.

The study by Ordoñez, Salinas and Quizhpe (2022) delves into the use of concrete material in the teaching-learning of mathematics at the elementary sublevel. The authors highlight the importance of concrete material in the construction of mathematical meanings, as it allows students to make connections between symbolic representations and real-world objects. Through the review of different research, the study shows that the use of concrete material in the teaching of mathematics improves the understanding of mathematical concepts, the development of cognitive and metacognitive skills, and promotes an active and collaborative learning environment.

In the same direction, in the work of Mechato and Rosario (2022), the use of concrete material at the secondary education level is specifically addressed, and the importance of this type of materials in the understanding of abstract concepts, as well as in the development of mathematical skills and abilities, is highlighted. For its part, in the documentary review of Manosalvas and Ronquillo (2023), emphasis is placed on the importance of concrete material in strengthening mathematics, and various studies that demonstrate its effectiveness in the teaching-learning process are analyzed. The article by Quiroz and Ramos (2022) also highlights the importance of concrete material in learning, and focuses on its application in the Bolivian educational context. In the work of Novo (2021), the importance of play and manipulative materials in the teaching of mathematics in the degree of early childhood education is highlighted, and various activities and examples of how these materials can be used to promote learning in a playful and meaningful way are presented.

Studies by Burbano-Pantoja, Munévar-Sáenz and Valdivieso-Miranda (2021) and Aguirre Álvarez (2023) show that the use of concrete material and physical manipulatives positively influences the learning of mathematics in students. Burbano-Pantoja, Munévar-Sáenz, and Valdivieso-Miranda (2021) studied the influence of the Montessori method on school math learning and found that students who participated in the Montessori program performed better in mathematics than students who did not participate. On the other hand, Aguirre Álvarez (2023) investigated the development of algebraic thinking in high school students through problem solving with physical manipulatives and concluded that the use of physical manipulatives allowed students to develop algebraic skills significantly better than those who did not use concrete material.

Piedra (2023) conducted a study on the use of concrete material to reinforce addition and subtraction operations in third-grade students and found that the use of concrete material in the classroom significantly improved students' understanding of mathematical operations. On the other hand, Tomalá Pozo (2023) studied the use of concrete didactic material in the meaningful learning of geometry in third grade students and found that students who used concrete material had higher academic performance than students who did not use it. Chávez Ortiz (2023) designed a didactic toy that stimulates the learning of concrete mathematical operations in children aged three to five years and concluded that the toy turned out to be effective for children's learning.

Revelo Ruiz (2022), who implemented in his research the use of the Singapore Didactic Method for teaching-learning of the curricular content "Operations with Polynomials" in the first year of high school. This didactic method, based on the CPA (Concrete-Pictorial-Abstract) approach, is considered one of the best for the teaching-learning of mathematics, since it involves innovative educational practices based on constructivist authors such as Brunner, Piaget and Vygotsky. This method proposes that the student builds his own learning from concrete experiences and materials, which are represented graphically to finally reach an abstract learning of mathematics.

In the same direction, Recalde and del Pilar (2022) in their work on the Singapore Method as a teaching-learning strategy of multiplication tables in school-age children, highlights the importance of the CPA (Concrete-Pictorial-Abstract) approach in the methodology. This approach is based on the idea that using concrete objects allows

children to explore different ideas when learning a concept, allowing them to think like mathematicians and understand the logical reasoning behind operations, rather than simply memorizing them mechanically. According to Ban Har (2019), Singapore's approach focuses on problem solving and not memorization to reach an outcome. These aspects are relevant to current research, since the working hypothesis assumes that the use of concrete materials is beneficial for the meaningful learning of mathematics in students.

Following in the same line is the work of Vargas Yallico, Y. A. (2022) entitled "The Singapore method to improve the resolution of mathematical problems in students of the third grade of primary school" and carried out at the Cesar Vallejo University of Lima, Peru, highlights the main characteristic of the Singapore method of covering fewer topics, but with greater depth compared to the traditional math curriculum. Each textbook builds on previous knowledge and skills, and students master them before moving on to the next grade. This underscores the importance of math class planning and the need for teachers to understand the curricular horizon, including the knowledge and skills students have upon entering the new grade, those that will be developed in the current grade, and those that will be developed in the next grade. These aspects are essential for effective classroom management and the development of competencies in mathematics.

The work of Veloz Hidalgo, C. P. (2022), who presents "The concrete material in the teaching of Mathematics", is also highlighted. In this work, the concrete material is described as a didactic resource that complements the process of teaching Mathematics by allowing to fix, understand or build knowledge in a participatory and fun way, which gives meaning to mathematical concepts. In addition, it is pointed out that the proper application of this type of resources can generate benefits such as the development of thought, the enhancement of imagination, manipulation and experimentation, as well as the motivation of learning. All these benefits are fundamental for the learning of complex knowledge in mathematics.

It is meritorious to point out, the work of Pomaquiza, J. D. C. M., & Salazar, A. Z. C. (2021) entitled "Singapore method and digital booklet applied in the subject of mathematics in Basic Education". The authors explain that the Singapore method is based on three interconnected phases: concrete, pictorial and abstract (CPA), where concrete material is used and focuses on contextualized problem solving to improve students' understanding and logical thinking. The role of the teacher is to guide in the implementation of activities that allow students to discover autonomously the processes and resources necessary for the resolution of problems. All this requires rigorous planning on the part of the teacher.

Similarly, Peña Soto (2021) and Marín Real (2021) address the application of the Singapore Method for the development of mathematical thinking in children, from two different perspectives. In the first work, it is concluded that the implementation of this method improves the skills and abilities of students in terms of their mathematical and critical thinking. Meanwhile, the second work focuses on early childhood education and states that the construction of logical-mathematical thinking is acquired through practices and actions that are related to number, space and time, and are strengthened through the development of four skills: observation, imagination, intuition and logical reasoning.

## Conclusion

In general, these studies demonstrate the importance of the use of concrete material and physical manipulatives to improve the learning of mathematics in students of all ages and educational levels.

Similarly, the cited works agree on the importance of the use of concrete material in the teaching-learning of mathematics, and highlight its effectiveness in the development of mathematical skills and abilities, as well as in the understanding of abstract concepts.

That is, the use of concrete material is an effective pedagogical strategy in the teaching of mathematics, and is supported by the studies reviewed.

Together, these studies show different ways to enrich the teaching of mathematics, using concrete and virtual tools and resources, as well as promoting the connection with other areas of knowledge and the use of playful strategies. In this way, it seeks to make mathematics a more accessible, understandable and attractive subject for students.

Currently, there is a lot of debate about the best way to teach mathematics, and several studies have investigated the use of concrete material as an effective strategy to improve student learning. The most recent literature has shown that the use of concrete material in the learning of mathematics can have a positive effect on the development of mathematical skills and competences of students. The results of the studies reviewed suggest that concrete material can be an effective tool to improve the understanding of complex mathematical concepts, as well as to encourage creativity, critical thinking and problem solving in students. In addition, various didactic resources have been identified that use the specific material in an innovative way, such as virtual tools and educational games, which expands the possibilities of teaching and learning in the classroom. However, proper implementation and effective pedagogical use of concrete material is required to obtain the expected benefits in learning mathematics. In this sense, it is suggested that teachers receive adequate training to use the concrete material effectively and that a culture of experimentation and exploration be promoted in the classroom to achieve meaningful and lasting learning in mathematics.

The push for inclusivity in recent years has led to a wide variety of students' academic skills in classrooms. While this diversity provides wonderful opportunities for students to be more aware, reflective, and respectful of each other's learning differences, unfortunately it can also leave teachers feeling lost as to which direction to take to meet each student's individual learning needs.

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