



## The Taptana Cañari as a Didactic Resource to Promote Solidarity in the Teaching of Mathematics



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### Keywords

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didactic resource;  
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solidarity;  
taptana cañari;

### Abstract

The purpose of this work was to design a strategy that uses the Taptana cañari as a didactic resource to promote solidarity in the teaching of mathematics. The research approach was qualitatively framed in the sociocritical paradigm, through a case study. As a method and investigative techniques were used: observation in the workshops, interviews with teachers and expert judgment to analyze the photographs taken during the workshops. Based on the theoretical categories of solidarity: social responsibility, respect for identity, emotional intelligence and teamwork, the instruments were elaborated: observation guide, interview guide and the observation sheet used by the experts. Among the main results, it can be indicated that the use of the Taptana cañari as a didactic resource generated interest in ancestral knowledge and facilitated the learning of mathematics, which promoted the development of solidarity as a human and social value.

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## 1 Introduction

The Ministry of Education of Ecuador (MinEduc, 2016) in the Curriculum of the Levels of Compulsory Education determines that the exit profile of the baccalaureate Ecuadorian is based on the values of justice, solidarity and innovation along with skills and responsibilities that students must develop throughout their student life. This profile highlights the interest of the Ecuadorian educational system in developing teaching processes that favour the formation of citizens' values. In addition, the curriculum attaches great importance to ancestral knowledge and the dialogue of knowledge (Ananda et al., 2022). At the same time, it declares that interculturality is a transversal factor that must be considered in all processes. However, teachers are threatened by the challenge of educating their students integrally, combining knowledge and values through an innovative educational practice, which is not specified how achieved in the curriculum.

Díaz Quezada & Letelier (2013), point out that the inclusion of the so-called Transversal Fundamental Objectives (OFT) in all areas of the curriculum favours the training of students so that they reasonably and autonomously build their value systems, to that they are trained to critically evaluate the reality that surrounds them and actively intervene to achieve its improvement. Therefore, the use of concrete material to teach Mathematics can favour the development of ethical values such as justice and solidarity. Consequently, it is proposed as a general objective of this study to design a strategy that uses the Taptana cañari as a didactic resource to promote solidarity in the teaching of Mathematics.

In this sense, it is based on previous studies that have shown that the use of tangible materials generates interest in students (González, 2010) while contributing to their empowerment when issues of identity are addressed (Vargas, 2014). Consequently, the Taptana cañari can contribute to the active construction of knowledge while creating an ideal space for teachers to work through values, especially those of multiculturalism and solidarity based on individual differences. In addition, Bernstein (1987) points out that,

The school must become a community of life and education must be conceived as a continuous reconstruction of experience. community of democratic life and reconstruction of the experience based on dialogue, contrast and real respect for individual differences, on whose acceptance mutual understanding, agreement and solidarity projects can be based. What matters is not uniformity, but the discourse (p.47).

However, to achieve this reconstruction indicated by Bernstein, schools must foster the development of human values. Mutual respect, solidarity and common interests through the content of the different fields of knowledge, can be approached interdisciplinarily as part of the knowledge that people need to make a full and democratic life possible (Herliah et al., 2022).

Now, mathematics as a discipline is essential for children to develop intellectually because it contributes to orderly and logical reasoning, as well as projecting their minds for analysis, reflection and abstraction (Morales, 2019). For this reason, mathematics should be the main area of knowledge that seeks to train children and young people in values for conscious and favourable decision-making, which allows them to undertake actions that lead them to find solutions to the problems they face. must face in daily life. In addition, mathematics allows students to build patterns to guide themselves through a lifestyle and to face reality in a rational and pertinent way (Theodorou et al., 2021; Salinas et al., 2013).

In this order of ideas, MinEduc (2016) proposes that values should be formed from the national identity framed in a safe and peaceful world that values multiculturalism and respects the identity of others. While Medina & Rodrigo (2005), state that the proposals to establish a "solidarity" from cultural pluralism suppose a transformation in the way of perceiving the world based on the certainty of the potentialities of each person. In other words, education is called to go through models based on the cultural and discursive patterns of ethnic groups to support the development of basic cognitive skills and the formation of ethical values more consistently (Elledge et al., 2018).

In the current curriculum of Ecuador, multiculturalism is associated with solidarity. This is clearly expressed since it establishes that the value of solidarity must be expressed in the recognition and respect of minorities (MinEduc, 2016). In this virtue, it becomes necessary that intercultural connections are based on

respect for plurality and mutual richness. But it must be recognized that it is not a procedure that is developed without dilemmas. However, these disagreements can be resolved by respecting differences, organizing a horizontal context to communicate effectively, strengthening dialogue and active listening in both directions, achieving equitable and relevant access to relevant information, and seeking pacts and partnerships. In this scenario, ancestral knowledge can guide teachers to generate development alternatives in the various human processes, through education, for which well-developed scientific research will be the tool that makes it possible to achieve that goal. For this reason, the need arises to study concepts such as the Taptana cañari, an element developed by the Cañaris indigenous people 3,500 years ago, to develop educational proposals that improve the educational process by forming values such as solidarity (Calderhead, 1989; Korthagen et al., 2006).

According to Gheverghese (1996), mathematics emerged in different latitudes as a cluster of concepts produced by human beings, given the needs of their context. Proof of this is that, in southern Ecuador, specifically in Narrio (a community near the city of Cañar) belonging to the area populated by the ancient Cañaris, the archaeologist Donald Collier discovered an object called Taptana cañari. This object arose in the epistemological field of Andean philosophy, where knowledge is holistic, contrary to Western concepts, which propose a scientific division that gave rise to various branches of knowledge.

At this point, it should be noted that the historian Cordero (1984), discovered the algorithms that showed that this object allowed its designers to perform arithmetic calculations. Later, his work was perfected and made known by Professor Luis Montaluiza in 2007 who came to design a taptana that makes it clear that this artefact was used as a calculator by its creators, the Cañaris. It should be noted that the taptanas found have been carved in stone or wood and have unique characteristics such as a larger cavity considered the most relevant piece of the object, in addition, it has some columns shaped like snakes formed by nine smaller cavities, easily recognizable that are concentrated in such a way that they do not allow any misrepresentation (Vásquez & Duchi, 2021).

Along the same lines, it should be noted that according to Vásquez and Duchi (2021), certain guidelines must be met to work with the Taptana. Among these, that the Taptana is based on the base ten notation, that the largest cavity is related to the conceptualization of zero, not in the sense of the absence of quantity, but as the link that enables the change of an order to its immediate higher. In other words, this cavity is the means to change from units to tens, from tens to hundreds and others in the same direction. Similarly, tokens or grains can only be in the larger cavity temporarily, and grain or fichas can only represent a numerical order. In addition, it must be fulfilled that the snakes or leoquinas facilitate the representation of the units, tens, hundreds, and units of a thousand, to constitute the order of the cards used, which must be located from the outside in, that is, towards the cavity. higher, and finally, if there are no tokens or grains in a leokine, it means that this order would have zero elements (Vásquez & Duchi, 2021). From this, with the Taptana cañari you can develop different operations such as counting, addition, subtraction, multiplication, and division.

## 2 Materials and Methods

This work is based on the socio-critical paradigm, because Popkewitz (1988), proposes as precepts of this model to perceive and understand reality from practice unified with theory, integrating values, actions and knowledge to include all research participants, including the researcher, in self-reflective processes to make joint decisions. In this way, it is possible to use the Taptana cañari as a didactic resource that allows promoting solidarity as a fundamental value in the training of students in the Ecuadorian educational system.

To develop this research, a qualitative approach was proposed, based on a case study, since this type of study allows us to observe group behaviour adapted to its context, understanding the speaker and their understanding of reality, combining their perceptions, and enabling assimilation and interpretation studies sponsored by experienced subjects (Stake, 1998). In this way, an urban educational unit in the city of Azogues was selected as a case study, because the director showed a clear interest in developing workshops in this institution, which is always open to innovative processes in education and is a benchmark in basic education in the province and the country. Thus, we worked with the two parallels of the fourth year of Basic Education of the institution, so that 44 boys and 36 girls aged between 8 and 9 years participated in the workshops. Also,

two teachers participated, one from each classroom of the fourth year of elementary school and four teachers who fulfilled the role of experts.

Considering that this work used the Taptana as a didactic tool that allowed integration values in the teaching of mathematics, it is also highlighted that the case study provides both students and teachers with the opportunity to examine the results of this experience in the compilation information on the various responses that have emerged from the execution of the proposed workshops. Therefore, the workshops were held for an hour and a half in the morning and another hour and a half in the afternoon over 4 days in February. It was applied as a research method: participant observation during the execution of the workshops, the interview with the teachers after the implementation of the workshops and the judgment of experts to analyze the photographs taken during the workshops (Tambychik & Meerah, 2010; Friso-Van den Bos et al., 2013).

Participant observation was used because it allows the researcher as an observer to be part of the research and not a subject distance from the process and the reality that is analyzed, to obtain information from within the phenomenon studied (Díaz, 2011). In this sense, the participant observation allowed the researchers to obtain information on the use of the Taptana cañari as a resource for teaching mathematics, from the context where the research participants develop, that is, in their classroom in the educational unit during the implementation of the workshops, to understand if these workshops fulfilled the objective. Similarly, interviews were applied to classroom teachers to know their perception regarding how practices or aspects related to the theoretical categories of solidarity that are proposed in this research were developed in the workshops. According to Vargas-Jiménez (2012), the interview as a technique allows knowing the informants' perception of a certain phenomenon in detail and from their perspective, which allowed the researchers of this work to have a different point of view from that of them the workshops that were applied, in which the Taptana was used as a didactic resource.

To design the information collection instruments, the concept of solidarity was started, which, according to the review of the literature carried out, can be analyzed from four theoretical categories: "social responsibility, respect for identity, emotional intelligence and teamwork". team" (Vasquez, 2021). Therefore, the instruments designed and applied in this research were the following: workshop observation guide, interview guide addressed to the teachers of the fourth year of basic parallels in which the workshops were implemented and the directed observation sheet. to external experts (Prykhodko et al., 2022). On the one hand, the observation guide was designed with 4 items based on the determined theoretical categories, to which there were spaces to record observations and a final space to record any comments that the observer may have. On the other hand, the interview guide was designed with 14 questions distributed as follows: two questions in the social responsibility category, four questions in the respect for identity category, five questions on emotional intelligence, two items on teamwork and a general question about the teachers' perception of the Taptana cañari workshops and their impact on students (Zengin et al., 2012; Yamagishi & Mifune, 2009). In the same logic, the observation sheet addressed to the external experts who analyzed the photographs was designed with two questions that sought to know the experts' perception of the students' attitudes, emotions, and values practice during the implementation of the workshops. always directed towards the promotion of solidarity (Merz et al., 2007).

### 3 Results and Discussions

It was possible to collect the results of eight filled observation guides, two interview guides with the teachers' perceptions and four guides with the opinions of the experts. Consequently, for the analysis of the information collected, the NVivo software was used, which allowed the interviews to be transcribed and then to create codes based on the theoretical categories and the emerging categories that appeared during the investigation. The same software was used to analyze the information from the observation guides. However, for the analysis of the photographs, expert judgment was first applied and then these results were compared with those obtained from the interviews and the observation guides. Subsequently, with the same tool, the following graphs were created to be analyzed and interpreted to obtain reliable results for the investigation. Table 1 shows the results of the observation guide.

Table 1  
Results of the observation guides

Sessions	Results of the observation guides
First session	Familiarization with the Taptana cañari Organization of groups Generation of a pleasant environment to work
Second session	The artistic creativity of the students Students value ancestral knowledge Generation of collaborative environments
Third session	Commitment and responsibility of students Compliance with the proposed activities Compliance with the curriculum
Fourth session	Compliance with the proposed activities Introduction of narratives of the place Compliance with the curriculum
Fifth session	Assimilation of the algorithms of the Taptana cañari Construction and problem-solving Completion of the curriculum
Sixth session	The student with different abilities allowed the cards to be placed in the taptana with the guidance of his classmates The participants enjoy the cooperative work The children f They were very creative, cordial and participative
Seventh session	Active and dynamic participation of the children The children encouraged their classmates with different abilities The children are more supportive of the active participation of the group
Eighth session	The children harmonize in the work and do it as a team The students assimilated the mathematical processes with enthusiasm In the groups, everyone participated in the different activities

According to the Ministry of Education (MinEduc, 2016), "the mathematics curriculum promotes ethical values, dignity and solidarity, and the strengthening of a sociocultural" (p.82). Hence, by using the Taptana cañari as a didactic tool for teaching mathematics during the development of the workshops, it was possible to create an environment in which the activities were carried out in a warm and supportive manner with respect, support, collaboration, joy. and other values such as solidarity. Therefore, what is indicated by the Ministry of Education reaffirms what was concluded in this study.

It is important to emphasize that the presence of a student with different abilities in the classroom aroused in his classmates an attitude of solidarity in the sense that the proposed activity was adapted by his classmates so that their participation is active. By this, what was stated by Juárez Núñez et al. (2010), is confirmed, who points out that "the school must be the privileged space, where we all learn to live with others, and where each one has the opportunity to develop maximum their learning capacities" (p.46). Consequently, it was found that the development of the workshop activities developed an environment of respect, camaraderie and cooperation, which in turn changed the attitudes of all the participants.

The technique of expert judgment was applied to analyze the photographs taken during the workshops, because, according to Escobar-Pérez & Cuervo-Martínez (2008), "an informed opinion of people with experience in the subject, who are recognized by others as qualified experts in it, and that they can provide information, evidence, judgments and assessments" (p.29) the reliability of an investigation and the products or information collected in these can be validated. Among the criteria for the selection of the experts, it was considered that they had training in Basic Education, ten years of minimum experience teaching classes at this level of education and that they had publications related to the teaching of mathematics so that when observing the photographs could provide a valid and scientific judgment based on the observation of the

attitudes and emotions shown in the photographs. Table 2 shows the judgment of the experts related to the photographs.

Table 2  
Judgment of experts regarding the photographs

Category	Expert 1	Expert 2	Expert 3	Expert 4
Social responsibility	Interaction with heterogeneous groups	Comprehension	Empathy	Tolerance
Respect for Identity	Action for a peaceful world	Acceptance of multiculturalism	Positive assessment of multiculturalism and multiethnicity	Respect for the identities of other people
Emotional intelligence	Be positive	Be flexible	Be cordial	Be supportive
Teamwork	Understand the surrounding reality	Respect the ideas of other people	Show solidarity toward colleagues	Respect the contributions of other people

Figure 1 shows the analysis carried out by interviewee 1, where you can see the impact, it had on the students and the perception of the Taptana cañari workshops.

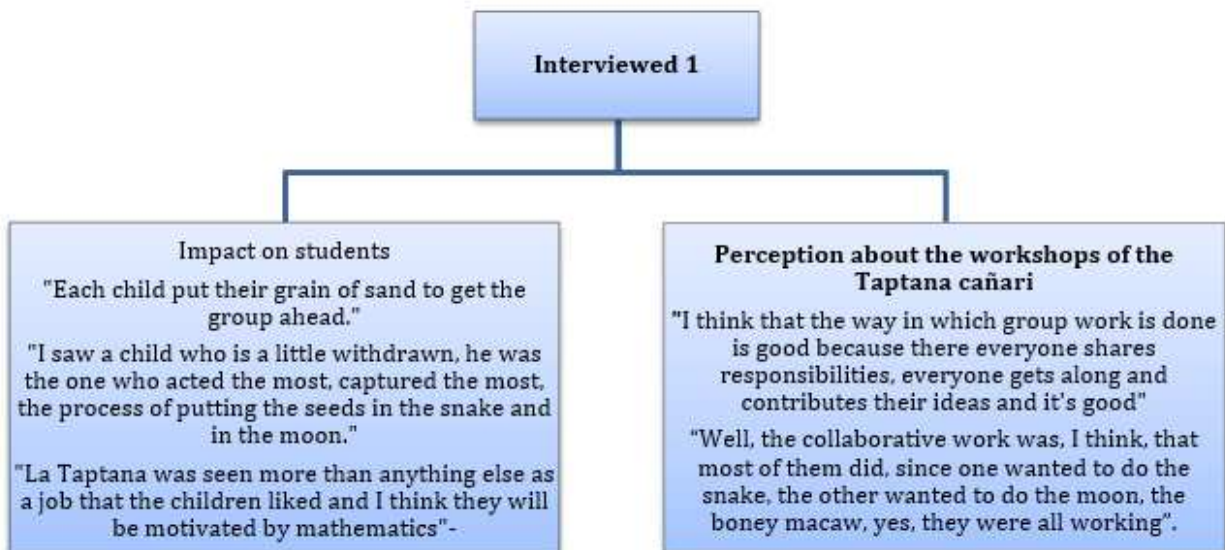


Figure 1. Answers from interviewee 1

Figure 2 shows the result of interviewee 2, where the impact on the students and the perception of the workshops are observed.

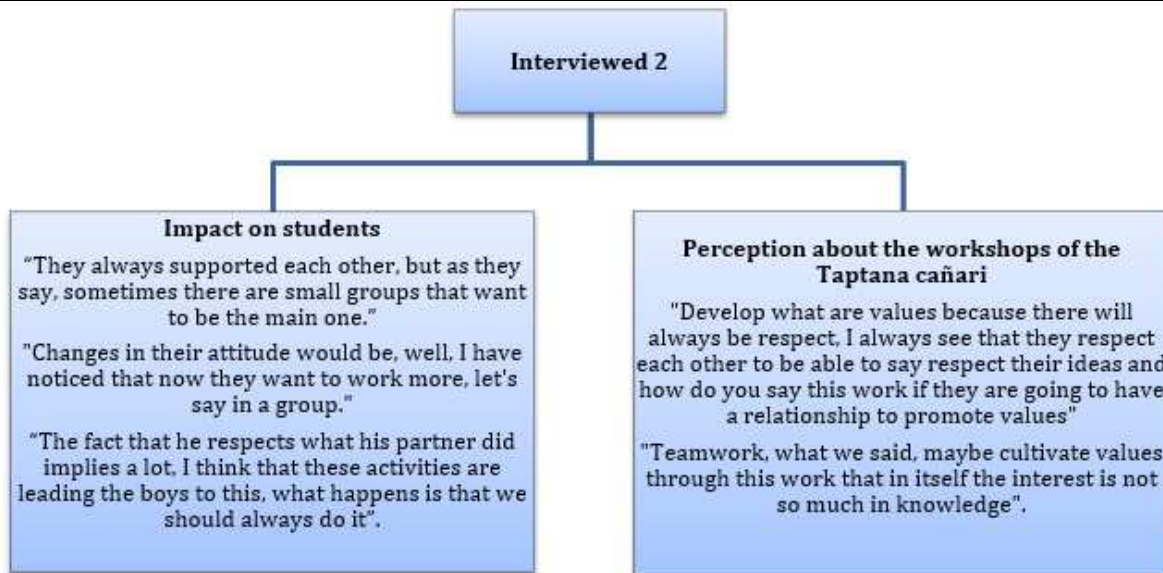


Figure 2. Answers from the interviewee 2.

Through the workshops interest is generated, the process of teaching mathematics is facilitated, and student participation is encouraged. This is a part of cohesion, an awareness of ancestral knowledge and an aspect that reinforces identity. In agreement with what is indicated by the Ministry of Education (2016), which indicates that to develop the value of solidarity, it is necessary to build the national identity peacefully, valuing multiculturalism and multiethnicity, with respect for the identities of others. In addition, an environment of greater participation and trust was developed, with features more in line with the so-called New School, which, in turn, generates an ideal space to promote the value of solidarity. Consequently, the importance of the results obtained is demonstrated because they show that the implemented workshops have made it possible to achieve the proposed research objectives.

Bishop (2000), argues, although this is not a generalization, that when teachers strive to develop mathematical content most effectively so that their students can assimilate it, solidarity is fostered, as is the case when classmates who understand Better some concept support others so that they also assimilate said concept. An idea that agrees with what was stated by the experts who determined as subcategories of social responsibility, empathy and tolerance are values that contribute to the promotion of solidarity.

It is worth noting that all the experts have observed team or group work and that the records of these experts ensure that collaborative work was carried out, favouring educational innovation. According to Vásquez (2018), educational innovation is not developed solely from objects, processes, or methodologies, but rather, innovation is developed from the attitude of teachers. Therefore, of the four categories established for the value of solidarity, these were observable in the photographic records created in the workshops that were developed. It should also be noted that the group of experts has made it clear that the behaviour of the participating students indicates the practice and development of the value of solidarity.

Educational innovations do not necessarily mean that new methods or resources are proposed or created, but that small changes are generated that help teachers and students build knowledge using existing resources, regardless of the situation. Therefore, the Taptana cañari as a teaching resource meets the dimensions that characterize educational innovation. That is, it creates perceptions of improvement among the actors in the educational process, by using it effectively and efficiently, democratizing the classroom with a social sense of knowledge and being innovative in the context.

It could be pointed out that in a future investigation it would be beneficial to implement the workshops in a school with rural jurisdiction, to obtain information on the development of solidarity as a fundamental value in that context using the Taptana cañari as a didactic resource. In the same way, in addition to intercultural elements, trans and interdisciplinary processes could be worked on that allow students to be integrated holistically.

## 4 Conclusion

The use of Taptana cañari as a didactic resource has generated interest in ancestral knowledge and has facilitated the learning of mathematics, as well as holistic learning that fosters the development of solidarity as a human value. In addition, the workshops allowed students to develop the activities in their context, with their possibilities and limitations, which leads them to their construction of knowledge and development of values, favouring the appropriation and assimilation of contents. In short, solidarity becomes a means to achieve learning outcomes, in addition, practice shows the importance of cultivating this value to achieve positive results in life.

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