

Teaching the Topic of Money in Mathematics Classes in Primary School

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*Received for publication on 12 Jun. 2019. Accepted, after revision, on 31 July. 2019.
 Assigned editor: Claudia Lisete Oliveira Groenwald.*

ABSTRACT

This study analyzes the teaching of the topic of money in mathematics by a fifth-grade teacher. The research is naturalistic-descriptive and is based on a case study with non-participant observation. Indicators of didactical suitability of the onto-semiotic approach were used (ecological, mediational and cognitive suitability) were used in this analysis. With respect to ecological suitability, the context used by the teacher was related to the daily experiences of her students and she was aware of many aspects of the curriculum. Regarding mediational suitability, the teacher used a variety of technological and manipulative resources. Finally, in the case of cognitive suitability in the development of the various activities, students' previous knowledge and their individual differences were taken into account.

Keywords: Elementary education; Onto-semiotic approach; Didactical suitability; Elementary school teacher; Measurements.

La Enseñanza del Tema del Dinero en las Clases de Matemática en la Educación Primaria

RESUMEN

En este artículo se realiza una descripción de las características exhibidas por una docente de quinto año de educación primaria cuanto desarrolla el tema del dinero en Matemáticas. El tipo de investigación es naturalista de corte descriptivo, basado en un estudio de caso con observación no participante. Para organizar la caracterización se utilizaron los indicadores ecológico, mediacional y cognitivo de idoneidad didáctica de procesos de enseñanza y aprendizaje de las matemáticas del enfoque ontosemiótico de la cognición e instrucción matemática. Respecto a la idoneidad ecológica, se evidenció que el contexto usado por la docente en sus actividades de aula estuvo relacionado con las vivencias cotidianas de sus estudiantes y que conoce diversos aspectos del currículo. Sobre la idoneidad mediacional, la docente utilizó, en el desarrollo de sus clases, diversos recursos tanto tecnológicos como manipulables; por último, de acuerdo con la idoneidad cognitiva, en el desarrollo

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de las diversas actividades se tomaron en cuenta los conocimientos previos de estudiantes y sus diferencias individuales.

Palabras clave: Educación primaria; Enfoque ontosemiótico; Idoneidad didáctica; Profesor de educación primaria; Medidas.

INTRODUCTION

There have been important changes in the way in which mathematics is taught in many parts of the world, making it necessary to confront new scenarios and challenges. As a result, some investigations have begun to focus on analyzing classroom practices, and the relationship of these practices with the established curriculum.

Studies such as those of Climent (2002) associate the analysis of what is being done in the classroom with the professional development of teachers, and even as a source of learning. Consideration of what happens in the classroom is currently a relevant research topic in mathematics education (Godino, Giacomone, Font, & Pino-Fan, 2018). When such situations are studied, it is necessary to have some way of describing them and understanding their link with other elements of the practice of teaching.

One possible hypothesis is that part of what happens in the classroom, such as the way in which the class is organized and the contents addressed, may be explained by a teacher's interpretation and management of the requirements of the current curriculum, but this is not necessarily true. For example, it could also be linked to a large extent to the knowledge that teachers have of the content they teach or to the resources they use when teaching a particular topic.

An adequate organization and structuring of criteria are therefore required to categorize and characterize classroom phenomena. The concept of didactic suitability of the Onto-semiotic Approach (OSA) (Godino, Batanero & Font, 2007) is a useful theoretical tool for understanding the processes that occur in the classroom (Breda & Lima, 2016; Breda, Font & Lima, 2015; Breda, Font & Pino-Fan, 2018; Godino, Bencomo, Font, & Wilhelmi, 2006; Morales & Font, 2017a, 2017b; Morales-López & Font, 2019; Morales-López, 2019; Pino-Fan, Godino, & Font, 2013; Seckel & Font, 2020). In the specific case of teaching measurement in primary education, Nogueira, Blanco, Rodríguez-Vivero, and Diego-Mantecón (2016) state that the use of Onto-semiotic Approach tools makes it possible "to make more explicit what and how students learn, and what and how mathematics teachers teach in Primary Education" (p.395).

Magnitudes and their measurement are concepts that are easy to understand for primary education students. However, a sense of measurement is not acquired through mechanical procedures that are presented in the classroom without reference to everyday life, or through rote conversions; instead, what is being learned in the classroom should be useful in students' daily activities (Alpízar, 2014).

It is therefore interesting to investigate the ways in which teachers present math topics in the classroom in primary education, and specifically the area of measurements,

in order to better know and analyze their work and its contribution to the mathematical education of individuals. Specifically, this investigation seeks to describe the way in which a fifth-grade teacher of primary education teaches students about the topic of money, a type of knowledge that is included in the area of Measurements of the official curriculum of the II Cycle of Basic General Education in Costa Rica.

THEORETICAL BACKGROUND

To develop, describe and analyze teaching, it is necessary to have specific instructional theories that help to guide decisions about the best ways to articulate the stages of design, implementation and evaluation (Godino, 2011). In addition, it is necessary to understand and interpret the elements that are involved, such as the role of teachers, their initial training (Alpizar-Vargas & Alfaro-Arce, 2019) and professional development, students and their social environment, resources and, of course, mathematical knowledge (Morales & Font, 2017a). Several theories are useful in this context; in this investigation, the didactic-mathematical knowledge and competences model (DMKC) was used (Godino, Batanero, Font & Giacomone, 2016), which is supported by the onto-semiotic approach to cognition and mathematical teaching. The notion of didactic suitability was primarily used to organize this analysis.

Didactic Suitability

The didactic suitability of a formal instruction process is defined as the extent to which that process or part of it meets certain criteria, previously defined, that allow it to be regarded as adequate to achieve adaptation between student learning and intended institutional meanings (what is intended to be taught) considering the environment in which this process takes place (Godino, Batanero, Font & Giacomone, 2016). Likewise, didactic suitability is a “support tool for the global analysis of the practice of teaching, its evaluation and progressive improvement” (Godino, Giacomone, Batanero & Font, 2017, p.102).

According to Godino, Batanero, and Font (2007), six criteria or aspects of teaching suitability can be defined: epistemic suitability, cognitive suitability, interactional suitability, mediational suitability, emotional suitability and ecological suitability. Table 1 presents interpretations of these criteria.

Table 1

Interpretation of criteria or aspects of suitability. (Godino, Bencomo, Font & Wilhelmi, 2006).

Epistemic suitability. This means that the mathematics taught is “good mathematics.” It takes the prescribed curriculum as a reference, and is based on the institutional mathematics that have been embedded in the curriculum.

Cognitive suitability. To assess, before starting the teaching process, if what is to be taught is achievable given what students already know, and after the process, if the lessons learned are close to what was intended to be taught.

Interactional suitability. The degree to which interactions allow identifying and solving conflicts of meaning and uncertainties, to favor autonomy in the learning process.

Mediational suitability. The degree of availability and adequacy of the material and the time available for the implementation of the teaching-learning process.

Emotional suitability. The degree of involvement (interest, motivation) of students in the instructional process.

Ecological suitability. The degree of adaptation of the study process to the educational goals of the institution, curricular guidelines, social environment, etc.

Godino (2011) states that it is essential to not think of criteria as autonomous entities, and points out that it is also necessary to consider what he called the “interaction between aspects” (p.14) in the sense used in this investigation, in which it is possible to interact with all of them or consider the most relevant of them when trying to achieve a specific objective. It was therefore decided to carry out an analysis of ecological, mediational and cognitive suitability, which we consider to be most directly related to what is established in the Mathematics Study Programs in Costa Rican public education. It should be noted that these study programs have been in effect since 2012, and involve a change in methodology from previous programs. It is therefore relevant to evaluate *ecological* suitability with its direct relationship to the proposed curriculum, *mediational* suitability which seeks to meditate the materials or media used in the class, and *cognitive* suitability when considering the previous concepts and the adaptation of the curriculum to the students, which are closely related to the change in the Costa Rican curriculum, where materials to be used in the classes must have an explicit didactic purpose, while maintaining a vertical consistency in which the previous concepts are respected and provide an opportunity to create new ones.

The components or categories of analysis proposed by Font (2015) were used to organize the description of teaching activities, and are described in Table 2 for each type of suitability analyzed in this article.

Table 2

Components of each type of suitability criteria. (Font, 2015).

Suitability	Components
Ecological suitability	Curricular adaptation Intra- and interdisciplinary linkages Social and work-related utility Teaching innovation
Mediation suitability	Material resources (manipulative, calculators, computers) Number of students, class schedule and conditions Time (for collective teaching / tutoring, learning)
Cognitive suitability	Previous knowledge Curricular adaptation to individual differences Learning High cognitive demand

Money in the Area of Measurements as an Object for Teaching and Learning

According to Moreno, Gil and Montoro (2015) the area of measurements is important within the field of Mathematics Education, and is becoming increasingly relevant in school curricula in different countries because of its usefulness in everyday contexts such as carrying out construction and manual activities, administering doses of medicines, and using recipes. On the other hand, measurements are closely related to the numerical sense, and this should be used to establish linkages with other mathematical areas, as well as with other disciplines such as science, history and geography (MEP, 2012; Hurrell, 2015); i.e., planning class activities with contexts in different fields, not only in the field of mathematics, to apply mathematical knowledge to solve situations that occur in everyday life.

According to the NCTM (2000), basic knowledge about measurements, the use of measuring instruments and measurement techniques should be established from the earliest levels of education based on tasks where objects are compared, units are counted together and separately, and connections are made between concepts and numbers. This allows students to understand that a characteristic that is common to several objects allows the comparison of measurements, and that similarities and differences between those objects can be determined or observed to classify them.

Using money as a magnitude is a common practice in the area of primary measurement, and is often used in both study programs and textbooks. However, Buys and De Moor (2008) point out that in some cases it is also studied as part of the number domain, using it as a basis to understand the concept of numbers and basic operations.

Either way, the concept and use of money provide an excellent opportunity for discussions with students about the reality and role of mathematics as a practical tool in everyday activities. For Barrett, Clements, and Sarama (2017), the ability to measure is strongly linked to children's mathematical and scientific thinking, permitting them to compare and observe patterns.

In general, the concept of measurement can appear in different ways in different contexts. It can be presented as an *empirical issue or problem*, in everyday life as a property of objects, or as a value assigned to an object; also as a mathematical definition or entity. In addition, it can appear as a *didactic problem*, calling for consideration of how a teacher should teach the subject and how measurements are made, the mathematical tasks that must be carried out, and the role of the teacher and the student (Godino, Batanero & Roa, 2002).

Money involves discrete magnitudes, and has an important relationship to the concept of measuring value or of evaluation. The underlying concept is that some objects are more valuable than others, and that there is a hierarchical order based on the capacity of exchange or acquisition.

Several concepts therefore arise when studying money, such as ordering, counting, the equivalence between a certain number of objects with others of the same nature (comparison) or with others, such as when a purchase or sale is made (a transaction, in the sense of Chamorro, 2005). According to Brenner (1998), these activities are not necessarily learned equally easily, since, for example, children may understand the relationship of money with other objects without fully understanding the significance of different denominations.

A significant issue is that the concept of the value of money is not intuitive. Although a child may be able to conclude that coins are less valuable than bills, this makes no sense outside the monetary system or the context of money itself.

This same problem occurs with other assumptions that are generalized from different contexts, such as the size of coins, their color, and their weight. This is quite clear in practice since based on everyday life it is possible that students have developed beliefs, for example, about the relationship between volume, weight, and value, which may lead them to think that the greater the weight or volume in a transaction, the higher the purchase or sale value involved. That is, they could conclude that an amount of currency that weighs more or is larger has greater value, which is certainly not generalizable when comparisons are made between bills and coins, or even between different types of bills, or different types of coins: for example, the size and weight of a Nickel (5 cents) are greater than those of a Dime (10 cents), but a Nickel is worth less than a Dime.

This is not a trivial issue, and other complications arise when it is mentioned that each country has a different currency, and that there are other payment instruments such as credit or debit cards and online payments that do not involve cash (Buys & De Moor, 2008).

In the case of this investigation, when using money for transactions, a number of new issues emerged, since there may be a need to compare the value of an object with respect to another, whether in terms of money or not. However, the issue of money's value and usefulness is often ignored in favor of routine arithmetic exercises in primary education. In the case of measurements, Nogueira, Blanco, Rodríguez-Vivero and Diego-Mantecón (2016) note that algorithmic practices prevail, both those associated with instruments or operations (such as obtaining quantities), without entering into conceptual exploration.

According to Chamorro (2001), the didactic intentions are clear in many texts, “not in relation to the main concept of ‘measurement’, but with a hidden object, ‘arithmetic’” (p.106), and with regard to teaching “There is a strong contradiction between what the teacher would like to do (an experimental process), and what he or she really does (an algorithmized and arithmetized process)” (Chamorro, 2001, p.109).

Thus, although many books and programs emphasize the concept of measurement based on the context and experience of students, in the case of the concept of money, the reality is that the phenomenon of purely arithmetic measurement persists, focusing mathematical activities and tasks related to this topic on practicing basic arithmetic operations. This phenomenon has been studied in detail by Chamorro (1995; 2001; 2003; 2005).

Hernández and Soriano (1997) suggest addressing this issue through practical and realistic exercises; and even when teachers' practices and proposed activities tend to favor the topic of arithmetic, creating or simulating markets, making purchases or selling or playing with money encourages children to learn and feel more secure with concepts, improving decision making, creativity, problem solving, and communication (Lee & Goh, 2012; Fuson & Lo Cicero, 2000). However, this type of activity requires more work and planning than a traditional class (Edo & Masoliver, 2008).

In the case of the study programs of Mathematics for Primary Education in Costa Rica, the topic of money is called “**Currency**”, and is part of the area of Measurements. The purpose of studying measurements is to “*understand the concept of measurements and how to calculate, estimate, compare and apply them*” (MEP, 2012, p.123), and to “*expand the knowledge that students bring to this area and prepare them to understand and apply the metric system*” (MEP, 2012, p.223).

During the first academic cycle (from first to third grades) emphasis is placed on knowledge of the official monetary unit of Costa Rican currency, the Colon, and the different denominations of coins and bills in Costa Rica, and stimulating estimation, comparing and applying these concepts in real or imaginary contexts. In the second academic cycle (from fourth to sixth grade), emphasis is given to the relationships between coins and bills, application of the monetary system of Costa Rica to real or imaginary situations (such as buying and selling), and finally, currencies of other countries and conversions between colones and Euros, colones and dollars, and vice versa.

As part of the programs of study, reference is also made to using money as a context for counting activities, representing quantities and the arithmetic operations of addition, subtraction, multiplication and division, but given how this topic is organized, it is quite clear that the study of money is a complete topic by itself.

In particular, it is specified that *“cognitive tools that allow (students) to acquire an appropriate notion of the sense of measurement should be provided; they must understand that measurement is not only numerical data associated with some characteristic, but that it has a useful meaning from various perspectives”*(MEP, 2012, p.123). These uses are even suggested in the specific details of teaching the theme of Currency, where it is stated that priority should be placed on posing problems *“in such a way that the focus is on the solution strategy and not on the work of calculation”* (MEP, 2012, p.226).

METHODOLOGY¹

This is a naturalistic investigation with a descriptive emphasis, based on a case study. According to McMillan and Schumacher (2005), a case study examines a particular situation in detail for a certain period of time. The purpose of this research was to characterize the work in the classroom of a primary school teacher on the theme of Currency, for which several criteria of the notion of didactic suitability, discussed and justified above, were considered.

In total, three work sessions were observed in a non-participative manner in a fifth-grade group of a public institution in the country’s Metropolitan area. The population attending this institution is highly diverse in socioeconomic terms, since it is an institution with an emphasis on art, unique at the national level, and children from different social strata attend it. This institution provides primary and secondary education. Approximately 600 students are enrolled in elementary school, 100 students per grade from first to sixth grades, divided into four groups per grade.

In the sessions observed, concepts related to the theme of Currency included in the area of Measurements of the MEP study programs were covered. This topic was chosen because this research is linked to a project that is investigating about the process of teaching and learning in the area of Measurements of the II Cycle of primary education. In addition, observing classes where the theme of Currency was developed was not a direct choice of the researchers, but at the time that the institution granted permission for the observations, this was the topic being covered in the class. It is therefore important to note that the characterization of the teacher’s role is valid only for this theme, and it should not be generalized to other topics.

¹ Permission was not requested from the CEP / CONEP System, since the investigation was carried out in Costa Rica, whose regulations do not require such permission. Informed consent was obtained. The investigation is exempt from any of its consequences, including full assistance and possible compensation for any damage to any of the participants in the investigation as a result of participation, in accordance with Resolution No. 510 of April 7, 2016, of the National Health Council.

The institution allowed work sessions to be recorded and the necessary permission was requested from the students' parents because the students are minors (informed consent). Each session lasted 80 minutes. There were 29 students (22 of whom were women), between 10 and 11 years old. The teacher had more than twenty years of experience in primary education and has a university degree in a career related to primary education.

To carry out observations, a guide was designed based on indicators of suitability for teaching and learning processes of mathematics of the onto-semiotic approach (OSA) (analytical categories). These indicators were based on those proposed by Godino (2011), Font (2015) and Breda and Lima, (2016), and allowed the description of the classroom work that was to be analyzed.

Among other aspects, this guide contains 15 pages detailing the indicators and components of each type of suitability. This guide was divided into 5 sections: *General aspects*: topic addressed, specific skills developed in the classroom, classroom environment (lighting, student distribution, classroom conditions, etc.). *Previous concepts*: formative evaluation, relevance in the curriculum. *Aspects referring to students*: participation, attitudes, skills development. *Activities carried out by the teacher*: relevance to the curriculum, methods, techniques and resources used. *Interaction between students and teacher-student interaction*. The tables of indicators for each type of suitability were constructed based on the observation guide, containing a summary of indicators and the frequency of occurrence of each of these indicators.

Each session was recorded in audio and video to assist in summarizing information about each type of suitability; the results are presented in tables in the following section of this document. Each aspect of teaching and learning processes to be observed was rated according to its degree of occurrence in the classroom, from *Low* (almost never occurs or was not observed, **L**) to *High* (frequently occurs in the classroom, **H**), with an intermediate category of *Moderate* (**M**). It should be emphasized that the results of the classification of activities observed in the teaching of the theme of Currency is not intended to indicate that the activities observed in these sessions are present in all mathematics classes, but are those that were observed during teaching of this topic in this particular group.

The classification of Low, Moderate or High occurrence was made based on the criteria of the researcher who observed the classes; in some cases, the frequency of the behavior could be interpreted. For example, if the indicator to be observed was *She uses a teaching methodology where the means and elements of the student's environment are used*, the classification criteria was based on whether this occurred in most of the activities carried out in the class. On the other hand, for the indicator *The contents of "Measurements" covered are part of the MEP study program of that level*, what was measured was whether or not the contents which were discussed were in the study programs; if only half of the contents were in those Programs a classification of *Moderate* was assigned, and if there were very few such contents discussed, it was categorized as *Low*.

The work sessions observed are described below.

First Session

A “Farmers Market” (a common activity in Costa Rica where groups of farmers sell their fresh produce such as greens, fruits and vegetables) was held at the school. Each student brought products such as fruits, vegetables, etc., with one part of the class representing the sellers and the other part the buyers; they used replicas of Costa Rican bills and coins to make purchases and sales.

Second Session

The theme of “Currency” was introduced, based on previous concepts that had been covered in previous years, and slides related to the topic were projected, such as the different bills circulating in the country (and conversions between different bills were reviewed). There were also discussions of everyday contexts for the use of money such as savings, credit cards and payment for a job.

The activity “Let’s go to the bank” was carried out in this session, which is detailed below.

“Let’s go to the bank”

The teacher chose 4 students to play the role of “cashier or bank teller,” with the rest of the students grouped into pairs or trios.

The teacher handed out replicas of money (coins and bills) to each subgroup so that they could count the money given and then they had to make a cash deposit to the “bank;” when they arrived at the “bank” they were received by the cashiers who counted the money to deposit and gave them receipts.

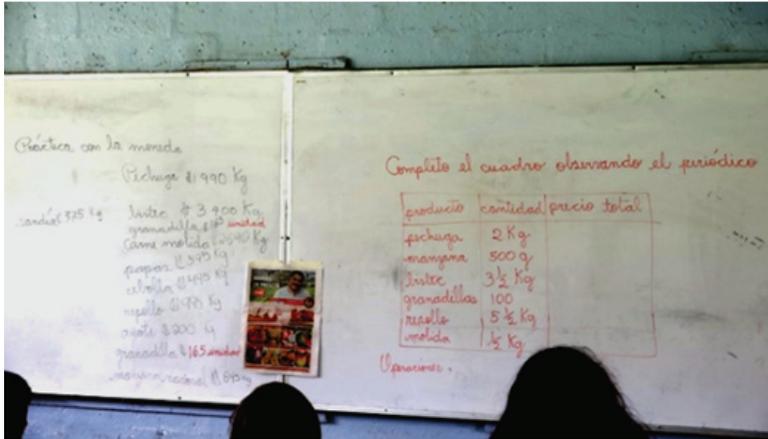
After the deposits were made, the teacher directed a discussion with the participation of all students in which some students (playing the roles of cashiers and public users) described the experience they had in the activity.

Figure 1. “Let’s go to the bank” activity.

Third Session

The teacher returned to the topic of mental calculation (an ability included in the MEP study programs starting in the first grade of Basic General Education) which is taught to a greater extent during the I Cycle, but is also taught during in the rest of the cycles. The teacher asked each student questions such as “How much money is 15 bills each worth 10,000 colones?” In addition, students worked in a contextualized problem situation assigned by the teacher, in which they had to calculate the amount that would be spent if they made weekly purchases for a family. For this exercise, the teacher gave them a page of a newspaper with the prices of different products of a supermarket chain in the country. There was no group discussion at the end of this activity, but the teacher reviewed the procedures carried out by each student in their notebooks.

Photograph of the Activity



Content Transcript

Practicing with currency
 Chicken breast @1990 Kg
 Beefsteak @3 400 Kg
 Watermelon @375 Kg
 Passion fruit @165 apiece
 Ground beef @2690 Kg

 Potatoes @595 Kg
 Onions @495 Kg
 Cabbage @995 Kg
 Squash @200 Kg
 Passion fruit @165 apiece
 Apples @895 Kg

Complete the table after reading the newspaper

Product	Amount	Total Price
Chicken breast	2 Kg	
Apple	500 g	
Beefsteak	3½ Kg	
Passion fruit	100	
Cabbage	5½ Kg	
Ground beef	½ Kg	

Newspaper with price

Operaciones

Figure 2. Purchase of food activity.

The presentation of results in the following section includes a description of the work carried out by the teacher according to the guide's criteria of ecological, mediational and cognitive suitability, and the classification of activities in the classroom. Some excerpts from dialogues or images that provide more clarity about the events that were presented in the classes observed are also included.

RESULTS

This section describes the behavior observed during the classes where the topic of Currency was taught in fifth grade, according to ecological, mediational and cognitive suitability criteria. As indicated in the discussion of methodology, each aspect observed

was rated according to its frequency of occurrence in the classroom: Low (L), Moderate (M) and High (H).

Ecological Suitability

This section describes what was observed in the classroom in terms of the following ecological suitability components: adaptation to the curriculum, intra- and interdisciplinary linkages, social and work-related utility, and didactic innovation. Table 3 presents the indicators observed and their frequencies.

Table 3
Indicators for each component of ecological suitability.

Component	Indicator	L	M	H
Curriculum adaptation	The contents of "Measurements" covered are part of the MEP program of studies for that level.			x
	The skills to be developed are those established in the Mathematics Study Programs (PEM) for the students' level.			x
	The methodology implemented is the one suggested in the PEM of the MEP (the teacher introduces the topic to be taught, holds a discussion in which everyone participates at the end of the topic, and conducts a closing activity in which the knowledge of the area of study is applied).		x	
	The educational evaluation made is that which is suggested by the MEP.			x
Linkage	There are content linkages with other areas of mathematics.			x
	There are content linkages with other topics or disciplines.			x
Teaching innovation	Use of a teaching methodology that uses means and elements present in the student environment.		x	
	Innovative use of technological tools in the teaching of lessons.		x	
	The teaching staff carries out research referring to the topic being taught, for example, use of historical illustrations.			x
	The teaching staff is open to teaching innovation (doing research, reflecting on their activities).			x
Social and work-related utility	Teaching of the contents contributes to students' social and professional training, allowing the development of critical, analytical and alternative thinking.			x
	Teaching staff directs discussions in the classroom, but allows students to express opinions on related issues – that is, discussions are not just about mathematics issues, but about the everyday lives or social contexts of students.			x

Regarding adaptation to the curriculum, it was found that the teacher addressed a topic that is in the list of knowledge areas of the PEM for fifth grade. In addition, the approach of the activities carried out showed that she was attempting to develop in the students the ability to “*Apply the national monetary system in fictitious situations or the environment*” which the PEM specifies for their academic level (MEP, 2012, p.225). The teacher also carried out introductory activities with daily topics of interest for the students, to reinforce the concepts they had learned in previous school years; some of these activities were carried out individually and others in groups. In addition, when teaching the topic, she used problem situations that were relevant to the lives of her students, as can be seen in Figure 1 and Figure 2.

The problems used by the teacher could be classified as those suggested in the PEM, where problem solving is the main axis and active contextualization is of great importance (MEP, 2012). This is because the problems presented were related to everyday contexts of Costa Rican society. This also coincides with Hernández and Soriano (1997), who suggest that the type of activities to carry out in the class when the topic being taught is money must reflect the reality of students in situations in which they are buying or selling something.

The teacher complied with the specifications of the PEM when she introduced the topic in a contextualized situation which requires that students use the concepts they previously learned: students work in groups of two or three in which they can discuss their findings, after which the entire class participates in a discussion in which part of the group of students comments on the procedures they followed to complete the assigned tasks, both in the role of people who save money, and as those who played the role of bank tellers. At the end of this activity, the concepts discussed and their links to daily life were not summarized. If the guidelines established in the PEM were taken into account, the class could have ended by considering that the way to count money was grouping by denominations or decomposing the amount originally received, as recommended by the NCTM (2000) when working on the topic of measurements (most students did not do so), in addition to emphasizing the order of actions that should be followed when using money in daily activities.

During session 3, individual students carried out the activity “Buying food” at the end of this activity there was no closure, but the teacher reviewed each student’s notebook to check their answers. Another way to corroborate the answers could have been with a classroom discussion in which some students commented on their answers and how they arrived at them, and the teacher took the opportunity to emphasize the usefulness of mathematics in daily activities.

Regarding linkages that exist between the knowledge covered and other topics both in the area of mathematics and in other disciplines, it was observed that the activities proposed by the teacher related measurements to the areas of numbers (basic operations and fractions) and statistics (tabular representation). In addition, interdisciplinary activities were related to social and civic studies, considering Costa

Rican cultural activities such as Farmers Markets and the promotion of positive values when talking about family savings and expenses.

In the case of didactic innovation, technology was specifically used to project images of bills of different denominations. In the “Let’s go to the bank” activity, the use of calculators or a computer to perform calculations more quickly could be included as a tool for students, since some of them took a long time to provide receipts to their “Customers,” which was not the main objective of the activity. During the class, some of the students who played the role of “users” used their calculators or mobile phones to do their counting; although they did so on their own initiative, calculators could be included as part of the materials to be used during the activity. This suggestion is justified by PEM recommendations that when covering the topic of measurements, attention should be focused on solution strategies and not on calculations. In addition, Chamorro’s work (described in the reference framework) also refers to emphasizing strategies rather than calculations in activities that focus on the area of Measurements.

The teacher’s methodology used different means and elements of the students’ environments, such as buying food for the family and visits to the bank. This provides students with a feeling for the relationships between the concepts learned at school and their daily experiences, in agreement with Alpizar (2014), who says that the knowledge related to Primary Measurements must be taught in the context of everyday activities. Further examples might include student activities in the school itself, such as shopping in the school’s snack shop.

Some of the activities carried out had a realistic context, so they were useful for students not only for learning mathematical content but also in civic education, which shows that the teacher reflected on her teaching and provided contextualized and updated activities for her class, as shown by her use of newspapers from the previous day to provide lists of prices for foods. When discussing bills of different denominations, she also talked about the individuals whose images appeared on these bills and their importance in the country’s history.

Teaching the area of Measurements also contributed to the social and work-related education of students; for example, one of the discussions in session 2 focused on the usefulness of money and the various ways that citizens have to obtain it (“good” and “bad”), and how to manage it. In this discussion the teacher allowed her students to offer opinions that, although in some cases were not directly related to the subject studied, contributed to social education. The third session was organized around the weekly purchases of a family, teaching students to be better citizens by being aware of the money spent at home. Figure 3 presents an excerpt from the class meeting in the second working session, in which they discussed the origin of money.

Teacher (T): What is money for?
 Student 1 (S1): To buy things, feed yourself, things are paid with money worldwide. If you don't have money, you don't have food, a house, or clothes.
 T: Where does the money that you get come from?
 S2: The bank
 S3: From the cashier
 S1: From work
 T: Do you work?
 S4: Our parents give it to us as a gift, until we grow up and work.
 T: Where does the money your parents give you come from?
 S4: From their work
 T: In other words, to receive money, people provide a service, for example, if I want someone to mow the lawn of my house, I must pay someone to do it, because they don't do it for free. Is it easy to get money?
 S4: No. You have to work.
 S1: And study hard to be professionals.

Figure 3. Excerpt from a dialogue during the introduction of the topic (session 2).

In this excerpt it is clear that the teacher wants to guide the discussion towards the origin of the money that her students use, and the effort that their parents or guardians must make to obtain it; although this is not directly mentioned in the PEM, it contributes to the formation of good citizens, by encouraging decision-making. This is in agreement with Lee & Goh (2012) and Fuson & Lo Cicero (2000), who state that activities with Money linked to student experiences make them more aware of the decisions they must make in their daily lives.

Mediational Suitability

For this type of suitability, the following components were observed: material resources used in the classes, number of students, time and conditions in the classroom, time allocated to the class and extra class activities.

Table 4
Indicators for each component of mediational suitability.

Component	Indicator	L	M	H
Material Resource	There is presence of different material resources (manipulatives, calculators, computers, etc.) in the development/teaching/delivery of the lesson.			x
	The contents are supported using concrete materials and visual aids that promote learning.			x

Component	Indicator	L	M	H
Number of students and classroom conditions	The number of students is ideal for promoting learning.			x
	Classroom conditions are adequate for the teaching and learning process.		x	
	The schedule is appropriate.			x
	The distribution of children in the classroom is adequate to promote learning.		x	
Time	The planned time for the teaching of the topic (in class) is ideal for understanding it.			x
	More time is given to the core content of the topic.			x
	The lesson is completed according to plan.		x	

Different material resources were used in the classes that enhanced the teaching and learning processes of the topic addressed. The use of different manipulable and technological resources when teaching the area of Measurements is essential for student learning (NCTM (2000), and some of these resources and their uses in the classes observed are discussed below.

Computer and projector: these were used to review the denominations of Costa Rican bills and coins, and contributed to the students having a real image of each of the elements mentioned. In addition, comments were made referring to the person that appears on each of the bills, as well as their history and contributions to the country.

Replicas of money: Replicas of bills and coins were used in the activities “Farmers Market” and “Let’s go to the bank.” In the first of these activities money was used to buy and sell products, while in the second money was counted to make bank deposits, and deposit slips were used to record the money that was deposited in the bank.

Other resources: the teacher based the activity “Buying food” on a printed copy of a popular national newspaper, using it to find the actual prices of various products that a family might consume. In addition, the use of simple calculators was allowed, although not required, in the activity “Let’s go to the bank.” More use could have been made of calculators, for example, by the students who played the role of bank tellers, since they had to add quickly large amounts of money so as not to delay their supposed customers.

Number of students and classroom conditions: With 29 students, it is a bit difficult to define their distribution in the classroom. The teacher was not strict regarding student distribution, with some of them sitting in pairs and others by themselves; therefore, student interaction was present at all times. In addition, it seemed that the teacher and students were comfortable with the organization of the classroom; the only difficulty observed was that the teacher had to project slides on the right side of the board and, therefore, those who were in the first row on the left had to stand to be able to see. Figure 4 shows some students sitting behind the teacher to see the projected images.



Figure 4. Teacher showing the bills of Costa Rica.

Note: The image was blurred to hide persons' faces and safeguard their anonymity.

Time: The classes observed were held during the morning, before 10:00 am, so students were energetic and concentrated well, and the temperature in the classroom was comfortable.

Activities were planned with an adequate amount of time for most students. It should be noted that some of them did not complete the tasks assigned by the teacher, primarily due to becoming involved in other activities or being distracted by talking with their peers; this occurred more often during the activity of “Buying food”, when they had to work individually. Enough time was dedicated to the recognition of different denominations of bills and coins and in related conversions. However, little time was dedicated to explain the task “Buying food” in general terms, which left some students with doubts at the beginning of the task. In the last session observed some textbook exercises were assigned to be solved and reviewed in the next class (this kind of exercise was not part of the sessions that were observed).

In summary, most of the indicators of mediation suitability that depend directly on the teacher were rated as “High”, since a problem with classroom conditions, being able to project only on one side of the board, is an issue related to infrastructure of the institution and not her responsibility.

Cognitive Suitability

The following components of cognitive suitability were observed: previous knowledge, curricular adaptation to individual differences, student learning and cognitive demand for the tasks proposed in the class.

Table 5
Indicators for each component of cognitive suitability.

Component	Indicator	L	M	H
Previous knowledge	Students have adequate previous knowledge to learn the new topic.			X
	The situations presented can be understood by students given their previous knowledge.			X
	The difficulty of the activities is appropriate for the students' level.			X
Curricular adaptation	Activities to elaborate on the topic being explained are included.			X
	Activities to strengthen the topic explained are included.		x	
	Individual differences between boys and girls in learning are taken into account.			X
Learning	The teacher's questions help students to learn		x	
	Different means of evaluation show that students acquired the knowledge expected		x	
Cognitive demand	Cognitive processes are activated (communication, argumentation, representation, etc.).			X

Part of the previous knowledge that students should have on the subject of “Currency” were the relationships between coins and bills of different denominations. In addition, the skills they should have acquired during the previous school year were to be able to “*Establish the financial relationships between coins and bills of all denominations*” and to “*Apply the use of amounts of money in different real or imaginary situations*” (MEP, 2012, p.224). When the teacher asked questions in class, it was observed that most students correctly identified bills of different denominations; during the second and third sessions, the teacher reviewed denominations, conversions between them and the use of money in different everyday situations.

Activities were proposed by the teacher taking into account the level of knowledge that students should have had when they reach this school year. The same teacher had taught them the previous year and during the classes she reminded them that this topic had been covered previously, providing them with examples they already knew. The teacher therefore considered that the coverage of concepts in previous years would allow students to develop the skills expected for this level.

With regard to curricular adaptation, the teacher assigned exercises that students could solve at home or in the next class. Since the school has an extended schedule in primary education (from 7:30 am to 4:00 pm), tasks are not often assigned to do at home, to not overwork the students; therefore, most extra or review activities are carried out in the classroom, and it is important to note that in the week before exams, topics are reviewed and practices are carried out with routine exercises, mainly.

The teacher tried to take into account individual differences in classroom interaction by varying the questions she asked in class, or allowing students who had a difficult time doing mental calculations to use their notebook to do the requested operations. Figure 5 presents an excerpt from a dialogue between the teacher and a group of students that illustrates this approach.

T: [Addressing S5] How much is 10 bills of 20,000 colones?
 S4: I want to say ...
 T: [with her hand she indicates that S4 should not answer] I am giving everyone a chance, some need more time.
 T: [Addressing S5] I'm giving you more time.
 S5: [The student nods affirmatively, while continuing to do the calculations in a notebook] [the student whispers a very low amount].
 T: How much? Don't be afraid, if you're wrong that isn't a problem.
 S5: 200,000

Figure 5. Excerpt from a dialogue held at the beginning of Session 3.

Questions asked by the teacher in the classroom allowed her to carry out a tentative and informal evaluation of the knowledge the group of students had about different denominations of bills and coins, as well as the usefulness of money in daily life and associated conversions; it should be noted that most of the students answered the question asked by the teacher satisfactorily. On the other hand, in the “Buying Food” activity, students made many mistakes related to numbers; for example, they did not understand the question when asked about the price of a fraction of a product (for example, half of a product), and their calculations were incorrect when performing basic operations. It should be noted that at this level they should already be able to manage the four basic operations with natural and decimal numbers; however, Figure 6 shows two errors made by different students – in multiplication, shown in the image on the left, and in division, in the case of the image on the right.

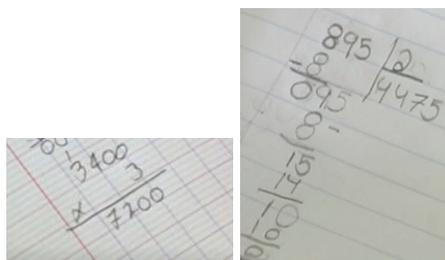


Figure 6. Procedures performed by students in the class.

As stated by Buys and De Moor (2008), Hurrell (2015) and Moreno, Gil and Montoro (2015), the topic of Measurement, and in this particular case money, is closely linked to the topic of Numbers; therefore the fact that basic operations should be carried

out in activities of this type is not inappropriate; there would be a problem if the main focus of a problem is calculation, rather than how to solve it, but it is important to draw attention to the fact that failure in handling the topic of Numbers, especially in basic operations, hinders the development of other curriculum topics.

The five mathematical processes recommended in the PEM of the MEP were used in the activities carried out; namely: reasoning and arguing, proposing and solving problems, communicating, linking and representation, although the last three of these processes were observed with a lower frequency. In all of the activities, the group of students had to reason to be able to answer the questions and justify their procedures. In addition, they were presented with problems that they could solve using previously presented concepts and making linkages with other areas of mathematics such as numbers and statistics. Finally, they had to communicate some of the results they reached. For example, in the “Let’s go to the bank” and the “Buying food” activities, the process of representation took place when students had to analyze fractions of the different products and when had to complete the respective tables.

CONCLUSIONS

An essential aspect for improving mathematical education is learning from experiences, whether they generate positive results to reinforce what the student knows of, if they showed a need for improvement. Reflecting on the practice itself is essential for a teacher and if this reflection is undertaken with the support of other professionals close to their work, it becomes more beneficial.

The contexts used by the teacher in the problems that she presented in different sessions were highly consistent with the daily family life of students in Costa Rica, such as Farmers Markets, bank deposits and purchasing food. The closeness of the mathematical tasks to aspects of daily life could develop positive attitudes in students towards the mathematical content that she addressed –and possibly influence student performance (Zamora-Araya, 2020)–, since it relates the content covered in the classroom with what happens outside the classroom, which would be in accordance with the recommendations of the PEM. This is also in direct agreement with findings in the international literature.

Elementary school students often believe that what they learn in school is not useful in their daily lives. This happens because many teachers use extremely fictitious contexts in class activities or non-real data and, therefore, create the belief that what is taught in the classroom is not related to what happens in reality. It is important that the teaching staff changes that image, which can be achieved if the activities carried out in class are useful for students’ lives, or if they can associate what they learn with their own experiences, as was done in the classes observed.

With reference to ecological suitability, the teacher showed that she knows about the proposal of the MEP regarding the topic to be taught, and the knowledge and

skills required; in the closing segments of the activities, she devoted little time to the institutionalization of the concepts of mathematics. The activities carried out in the class are related to other areas of mathematics such as numbers, probabilities and statistics, and to fields beyond the field of mathematics; she worked with social values and citizenship, contributing to the education of students with a view to their professional futures and social contexts.

Regarding the teacher's mediational suitability, it was observed that she tried to use different technological and manipulative resources to retain the attention of the students and improve the learning of the topic covered; these resources could have been exploited a little more, for example, using the calculator for complex calculations that were not the principal purpose of the activities.

Finally, characteristics of cognitive suitability could be observed when the teacher considered the students' previous concepts in planning her lessons, trying to take into account their individual differences, showing that she reflects on her work as a teacher. During the work sessions (problems presented, verbal questions, proposed exercises), some of the students failed to show the abilities desired, mainly because they have difficulties with other areas of mathematics such as numbers. For example, when they have to perform basic operations with rational numbers, they make mistakes that affect the final results of the activities.

In general, the teacher observed showed several of the characteristics described in each of the types of suitability studied. In addition, she achieved an appropriate balance of the elements that were described for teaching the theme of "Currency" in the area of Measurements, in accordance with the recommendations of the MEP study programs for the subject of Mathematics.

Finally, the theoretical tools of the OSA, mainly the notion of didactic suitability and its criteria, have proved to be of great practical utility in studying, describing, characterizing, and reflecting on classroom phenomena, especially in the case of the teaching role.

ACKNOWLEDGEMENTS

This paper is part of Research Projects: **SIA: 0082-16** and **PGC2018-098603-B-100 (MCIU/AEI/FEDER, UE)**, and International Cooperation Agreement **UNA-UB: Cod 018133**.

STATEMENTS ABOUT AUTHORS 'CONTRIBUTIONS

Both authors (M.A.V. and Y.M.L.) participated equally in all stages of the research process, as well as in the creation, writing and correction of the article.

STATEMENTS ABOUT DATA AVAILABILITY

Data supporting the results of this study will be made available by correspondence author, M.A.V., upon reasonable request.

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