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Journal Basic Education

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The works must be unpublished and refer to topics of Basic education, higher education, higher education, comprehensive education reform, national agreement for modernization, basic education and other topics related to Humanities and Behavioral Sciences.

Presentation of Content

In the first article we present *Virtual education, an engine to increase learning in the pandemic*, by MONCADA-RODRÍGUEZ, Gloria Rebeca, VILLARREAL-SOTO, Blanca Margarita, ESPERICUETA-MEDINA, Marta Nieves and GONZÁLEZ-CEPEDA, María Cristina, with adscription in the Universidad Autónoma de Coahuila, as second article we present *Foundations of the teen's second home*, by CEPEDA-GONZÁLEZ, María Cristina, VILLARREAL-SOTO, Blanca Margarita, MUÑOZ- LÓPEZ, Temístocles and CASTILLO-CANIZALEZ, Diana Cecilia, with adscription in the Universidad Autónoma de Coahuila, as third article we present *Importance of breakfast in schoolchildren*, by CAMPOS-RAMOS, Cynthia Ivett, GUTIÉRREZ-HERNÁNDEZ, Rosalinda, LAZALDE-RAMOS, Blanca Patricia and REYES-ESTRADA, Claudia Araceli, with adscription in the Universidad Autónoma de Zacatecas, as fourth article we present *The MTSK and TSD: didactic planning as a proposal for the learning of rational numbers in fifth grade primary school pupils*, by HERNÁNDEZ-GUTIÉRREZ, Francisco Javier, PACHECO-MACIAS, Melissa and LIZARDE-FLORES, Eugenio, with affiliation at the Escuela Normal Rural “Gral. Matías Ramos Santos”.

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Article **Journal Basic Education**
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A didactic sequence for the initial study of fractions

Una secuencia didáctica para el estudio inicial de las fracciones

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Abstract

The present study is focused on the mathematical object of fractions. A didactic support sequence was elaborated and implemented as the first formal approach to its study for students in the third year of elementary level school, using, as a means, accessible manipulative materials to be used in the classroom. In order to identify the theoretical elements that served as a guide for the design of the activities and the manipulative materials, analyzes were carried out from the epistemological and didactic approaches. The didactic sequence consists of three parts: the first is based on the previous notions that the student has about fractions, using their experiences with daily life; in the second part it is contextualized, trying to formalize the object, going from a middle to a half; Finally, the use of numbers to represent fractions is introduced, making use of figural representations. It was applied to 6 students. It was concluded that the process of building their knowledge about fractions, starting with ½, associating it with their experiences, and using manipulative materials, allowed students to outline the concept of fractions and arrive at its numerical representation, giving meaning to the numerator and denominator.

Didactic sequence, Mathematics, Elementary level

Resumen

El presente estudio está centrado en el objeto matemático de las fracciones. Se elaboró y se implementó una secuencia didáctica de apoyo como primer acercamiento formal a su estudio, para alumnos de tercer año de primaria, usando, como medio, materiales manipulables accesibles para utilizarse en las aulas. Para identificar los elementos teóricos que sirvieron como guía para el diseño de las actividades y los materiales manipulables, se llevaron a cabo análisis desde los enfoques epistemológico y didáctico. La secuencia didáctica consta de tres partes: la primera se basa en las nociones previas que tiene el alumno sobre fracciones, utilizando sus experiencias con la vida cotidiana; en la segunda parte se contextualiza, tratando de formalizar el objeto, pasando de la mitad a un medio; por último, se introduce al uso de números para representar las fracciones, haciendo uso de representaciones figurales. La secuencia se aplicó a 6 estudiantes, se concluyó que el proceso de ir construyendo su conocimiento sobre fracciones, iniciando con ½, asociándolo a sus experiencias y usando los materiales manipulables, les permitió a los alumnos esquematizar el concepto de fracción y llegar a su representación numérica, dando sentido al numerador y denominador.

Secuencia Didáctica, Matemáticas, Nivel primaria

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Introduction

The teaching and learning of mathematics is one of the greatest challenges in education, since, at the beginning of academic training, there is a predisposition to have conflicts with this subject, since sometimes, the way in which it is taught causes, throughout school life, a lag in the components of basic knowledge, which are considered a fundamental part in the construction of knowledge in mathematics (Gascón, 1994; Larios, 2005; Socas, 2011). In other words, they are like the foundations of a building.

In the process of learning mathematics, from basic to higher levels, there are many problems, in particular and one considered recurrent, is the difficulties in learning and teaching fractions; a problem that afflicts most students and teachers at all levels of education around the world (De León and Fuenlabrada, 1996).

From a very early age, the need to distribute things and the constant use of fractions begins, without taking into account the concept itself. For this reason, it is indisputable that this subject is in the basic education curriculum, as it is and will be present throughout both everyday life and school life. However, despite using fractions implicitly in everyday life, they constitute one of the greatest obstacles for many students, and their teaching constitutes a difficulty for teachers in basic education, extending this problem to higher levels of education (Block and Solares, 2001; Valdemoros, 2010; Cortina et al, 2012; Ávila, 2019; Arenas and Rodríguez 2021).

One reason that, according to researchers (Arenas and Rodríguez, 2021; Martínez and Lascano, 2001; and Block and Solares, 2001), give rise to difficulties in the learning and teaching of fractions is to be found in the nature of these numbers; that is, the origin of these difficulties can be explained by epistemology, given that this nature entails a diversity of meanings that the student has to link in order to form a global concept of these (Malet, 2010). Montrel (2022) mentions that handling the concept of fractions properly implies knowing and understanding in depth the concept of divisibility, which is why it is so important to work on fractions from an early age and in a more formal way at school.

A key moment to intervene in the learning of fractions is when students begin to study them, as it is considered that this is the right moment because it is when they begin to construct the first meanings of the concept of a fraction as a number, which was previously unknown to them. The importance given to this moment is supported by Freudenthal's (1983a) interpretation of what he says about attending to problematic cases of learning when they are detected at the beginning.

It is assumed that, if firm foundations of a content are not built, there are gaps in the construction of the concept, which then constitute obstacles and gaps in knowledge are formed, which eventually become a major problem at higher levels.

With regard to teachers, the authors Castro et al. (2015), Fazio and Siegler (2010) and Gairín (2001) agree in several articles that the meaning of fractions that teachers have is of vital importance, as it has a great influence on the construction of knowledge in their students. Pineda (2012) states that much depends on the teacher's conception of the concept, as well as the student's prior learning. Moreover, within primary education, in most cases, teachers are not specialised in the subject and, therefore, their teaching depends only on their experience as pupils.

Gairín (2001) carried out a study with trainee teachers on the representation systems of positive rational numbers where he analysed three things: learning models, representation systems and understanding of mathematical thinking. After conducting the research it was observed that student teachers tend to reproduce their knowledge as they learned it.

In the process of learning fractions, teachers play a major role. If the teacher has wrong knowledge about fractions or does not reflect on his or her conception of the subject, in most cases he or she passes on these deficiencies to the students, which is one of the difficulties in teaching and an obstacle to learning.

Another obstacle that arises in the learning of fractions derives from the previous one, because the teachers' knowledge is also decisive when it comes to organising the activities to be carried out in the classroom. Brousseau (2000) mentions that:

Nowadays the term didactics comprises the activity of teaching mathematics itself, the art and knowledge of doing it, the ability to prepare and develop the resources to carry out this activity and everything that is manifested around it and in addition to asking the teacher to choose problems that provoke learning in the student that manifests itself through new answers (p.33).

Block et al. (1991) discusses the role of problem solving in the classroom, its uses and what teachers think of it. He comments that in most cases teachers propose a problem and leave similar problems for their students to solve. In this work Block invited the teachers not to use routine exercises, but to propose new exercises to their students, to which the teachers were sceptical, as they think that they will not be able to solve them and if they try, they are very attentive to guide them, marking the error or simply giving them clues for their resolution without leaving them entirely to their own devices to solve them, something that truncates the development of students' skills, as it is by making these mistakes that they can learn.

On the other hand, the difficulties in learning presented by the students could be attributed, in a certain way, to the fear they have of mathematics and even more so to the subject of fractions, which, just by seeing them, complicates the whole exercise, since, from the beginning, they do not construct a good meaning of these.

With regard to the concept of fractions, Fazio and Siegler (2010) consider that the difficulties in learning fractions are the result of a lack of conceptual understanding, derived from the different situations to which they are linked and the different ways of representing them. For this reason, some research (Malet, 2010; Rios, 2019; Cortina et al., 2012) highlights the importance of addressing the different meanings, and from the outset emphasising the clarity of each one of them in order to be able to relate them as a whole and not see them as totally different scenarios.

González and Block (2005), explore the didactic potential for learning the notion of fraction from the division of a unit fraction by an integer, due to the difficulties presented by the students in solving the didactic situations, it cannot be concluded that the use of the fraction in this way can favor the understanding of the notion of the fraction in the division algorithm.

According to these analyses of research on the difficulties of fractions, the factors that could lead to these difficulties are evident, such as: lack of conceptual understanding of fractions, teachers' lack of conceptual understanding of fractions in the learning process, and the lack of conceptual understanding of fractions in the learning process. For this reason, it is important for students, from their first approach to the concept, to construct and make sense of the different characteristics of fractions through reflection.

Target

Develop a didactic sequence that leads students to schematise the concept of fractions, making use of manipulative material and different contexts, allowing them to interact with each other and have references so that they can identify fractions in their graphic and numerical representation in order to give them a meaning when they begin to study them.

Conceptual framework

Epistemological analysis

The epistemological analysis seeks to clarify the origin and nature of fractions; what are fractions, their characteristics, order relations and their different meanings.

Since ancient times, man has had the need to quantify things in a variety of situations that arise, comparing and ordering different sets, for example: sheep in a flock, people in a group, bottles of milk on a shelf and cakes in a bakery, establishing equivalences between these sets and assigning representatives to each class of equivalent sets, which are now the natural numbers. Out of this, relationships such as less than, greater than and operations such as addition and multiplication emerge, which are used as tools to solve problems.

However, although these numbers can be used to model a wide variety of situations in which a collection of separate or discrete objects must be quantified, problems arise in the field of measurement when trying to use natural numbers, as there are situations in which they are not suitable or sufficient for modelling, for example, the case of determining the weight of a sheep, the height of a person, the amount of milk in a bottle and the slice of a cake (Skemp, 1999).

The way of quantifying objects that are not discrete makes it necessary to cut the given object into equal parts until one part is small enough to serve as a unit of reference and when combining some parts they match the given object (Skemp, 1999). This process of quantification, which makes use of slices of objects and their combinations for measurement purposes, has as a product what has been called a fraction: "each of the separate parts of a whole or considered as separate" (Real Academia Española, n.d., definition 2).

The notion of fraction makes sense in measurement situations through the operations of cutting and combining. After a long period, it was decided to separate this symbol from the relationship linked to measurement processes and quantities of measurement; to consider it "a number, an entity in itself, on the same plane as the natural numbers. When a and b are natural numbers, the symbol is called a rational number" (Courant, 1979, p. 61). This identification of fractions as a number is justifiable by the mathematical process of defining a relation between fractions (namely, $a/b \sim c/d$ if $a*d = b*c$) which turns out to be one of equivalence and which produces a partition of these, which is seen as a subset of a formal number system, that of rational numbers, so that the representatives of the classes in the partition constitute the set of fractional numbers.

Intuitively, the identification of these classes of fractions as rational numbers can be seen as bundles or boxes of equivalent fractions. Each box is a rational number, so that the rational represents the fractions and vice versa (Pujadas & Eguiluz, 2006).

Moreover, addition and multiplication of rational numbers follow, among others, the same laws that govern natural numbers, the commutative and associative law of addition, the commutative and associative law of multiplication and the distributive law of the product over the sum. All this leads one to believe that the relations and operations of the natural numbers are extended to the fractional numbers, however, the latter turn out not to be similar nor to have the same meanings.

Courant (1979), explains that although fractions are closely related to natural numbers, being an extension of these, when performing operations such as addition or multiplication, students have difficulties, as they face rules or meanings different from those they are used to with natural numbers, given that, as mentioned before, fractions have different algebraic structures, they have their own essence. He also mentions that rational numbers are their own creation, and that the rules depend on the will.

For example, the rule of addition of the natural numbers could have been extended to fractions, but in calculating the result it would be absurd, since if one adds:

$$\frac{1}{2}+\frac{1}{2}=\frac{2}{4}$$

The result does not coincide with the meaning of the sum, since we would be obtaining a quantity equal to one of the addends.

In this sense, something similar happens with multiplication, only that in this case the rule is the same, what changes is the interpretation of multiplication in the natural numbers, where when multiplying a and b natural numbers, the result is greater than these numbers, on the other hand, with fractions, it is different, when multiplying,

$$\frac{1}{2}*\frac{1}{2}=\frac{1}{4}$$

the result obtained is a smaller number.

On the other hand, while for natural numbers there is only one type of number, for fractions there are different types of fractions: proper fractions, improper fractions, mixed fractions and unit fractions.

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In addition to the differences in the structure and operations with fractions, fractions are used in different contexts, which leads to different meanings for the fraction, adding further complexity to the construction of the fraction concept.

Different meanings of fractions

Moving from the understanding of the concept of natural number to the understanding of the concept of fraction implies a great leap, which goes much further than just following the rules and structure of natural numbers, as the second concept is not a simple extension of the first one. According to Vasco (1994, cited by Meza and Barrios 2010), a reconceptualisation of the units of reference and the process of measuring itself is required. This is due to the different characteristics that fractions have with respect to natural numbers, ranging from their genesis, written representation, types of fractions and interpretation of operations.

In this sense, the fraction can be interpreted in various ways, i.e., it has different meanings depending on the context in which it is used. Thus, the fraction as a mathematical object is considered, according to Kieren (1976), as a mega-concept, since it is seen as a complex synthesis of the different meanings associated with it.

The importance of these different meanings lies in a way in that they break down the possible uses given to fractions in the different contexts of everyday life, contexts that provide meaning to fractions beyond their formal definition as a pair of natural numbers or as a solution of an integer equation of the form $bx=a$ ($b\neq 0$).

Kieren (1976) identifies the different meanings that can be associated with a fraction as: part-whole, quotient, ratio, operator and measure, meanings which are described below.

The fraction as a part-whole

This meaning of the fraction arises in the context of relating the part constituted by a certain number of equal fragments into which the whole has been divided for comparison purposes (Kieren, 1980).

In such a case the relation answers the question what part is of the whole, and the fraction becomes a representative of this relation, in which the given number of fragments that combine to constitute the part and the number of equal parts into which the whole needs to be cut are used.

The fraction as a quotient

The fraction, under this meaning, is associated with the operation of division between two numbers. As a quotient, it answers the question: how much does each one get? Moreover, this meaning, in real situations, gives rise to equal sharing, "The most general representation of fraction in the form a/b leads to the immediate idea of quotient of two numbers: a units in b equal parts, with which appears the notion of sharing in equal quantities" (López, 2012, p.15).

The fraction as a ratio

The context in which the fraction acquires the meaning known as a ratio is when, when comparing two given quantities, it is possible to find two whole numbers a and b whose ratio is equal to the ratio of the quantities, in which case, this ratio can be represented as a/b. This type of meaning is associated with real-life contexts such as scales, proportionality and percentage (Bressan, A. & Yaksich, F. 2001). These authors also mention as an example that in the context of percentage when talking about mixtures, a relation of quantities is established, such as in the case of a solution with 4% of sodium bicarbonate and this is represented in relation to a whole as 4/100.

The fraction as an operator

In this meaning, according to Kieren (1980), the fraction acts as a multiplicative transformer on a set, magnitude or number, which implies a reduction or enlargement on the set to which the fraction is being applied as an operator.

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The fraction as a measure

Fraction as a measure, according to Kieren (1980), arises in attempts to quantify a region that lead to the assignment of a fraction as its magnitude. As part of such attempts, this might start by taking a magnitude as a unit of reference and observing what is the largest number of times that unit fits in the region to be quantified and, if necessary, resorting to a process of dividing the unit into equal parts to try to cover the missing part of the region, until this is achieved. In the end, summarising the process, a fraction (a/b) will be arrived at which quantifies the number of times it is necessary to take the selected reference unit to cover the given region.

Differences in both the structure and the use of fractions in different contexts give rise to different meanings, which are one of the main conflicts that lead to problems for students and teachers in learning and teaching fractions.

Methodology

In this work, a sequence of activities based on the use of manipulative material was created with the aim of allowing the student to use it to corroborate the certainty of what he/she might think is the solution to the problem, or to use this manipulation to propose his/her answer. In addition, this proposal provides the teacher with a guide, seeking to support him/her in directing the activity, and to give him/her ideas on how to relate the contents of the sequence to contexts, so that the students can become interested in solving the problems posed.

Participants and curricular context

The sequence was carried out in two phases: the first phase was aimed at finding out what the teachers thought about putting it into practice, as well as how the students reacted to working with manipulatives. This first phase was carried out in three groups of third grade of primary school with about 25 pupils (8-9 years old) each, in each group there was one teacher. This school year was chosen because this is when the pupils first approached the mathematical object of fractions. It was the teachers who were in charge of guiding the didactic sequence with their pupils, which allowed them to be observers taking notes on how the activity was carried out.

We worked with a preliminary design, which, according to the observations obtained, allowed us to redesign the sequence and thus put it into practice in a second phase. In this second phase, we worked with a group of 6 third grade students, who had no theoretical (school) knowledge of fractions. This time, they had the opportunity to take on the role of the teacher in applying the sequence of activities.

First phase: preliminary design of the sequence

Taking the epistemological and didactic analyses as a reference, it was decided to focus the proposal on the first approach that primary school students have to the study of fractions. One of the strongest motivations for placing the emphasis on this part of the thematic content was derived from taking into account what Freudenthal (1983b) said and ratified by multiple investigations about the importance of giving adequate meanings to mathematical objects from the beginning.

The initial selection and analysis of the conceptual references allowed us to take them as a practical guide of principles to start the design of the activities that make up the Parts of a Whole Sequence, and at the same time, to have a concrete reference for their subsequent evaluation or analysis.

In this staging, something important to mention is that the students already had notions of fractions, so, by doing the sequence of activities with the manipulative material, the aim was for them to reflect on what they had already seen and begin to make sense of the fractions.

Before starting with the staging, we talked with the teachers about what we wanted to achieve with the sequence and we gave them a document where we provided guidelines for each activity, so that each teacher could guide the activity, in order to achieve the objectives set.

In addition to the observation, a series of questions were asked to the teachers, as it was considered important to take into account their experiences working with the students, as well as to have their opinion about this type of activities in the classroom.

In general, the three teachers were very enthusiastic about the use of this type of activities to complement the topics marked in the syllabus, they commented that the wording of some questions was confusing and long for the students, they felt that the sequence of activities was a bit long to put into practice in a single hour of classes, And as far as the manipulative material is concerned, they commented that it was very satisfying to see the students enthusiastic about doing the activities, as these materials helped the students to achieve a better understanding and to be able to solve the activities by themselves, thanks to this, one of them commented that very few students approached her to ask her any questions or what to do.

As the students already knew about fractions, they had already done the instructions in their textbook, the results and the way they worked was not what was expected, because although the material was attractive to them, the premature use of symbolic representations for these numbers is visible, as well as the lack of specific guidelines to clarify the purposes of the questions in each activity and suggestions of contexts that allow the teacher to intervene to promote a link between the experiences of the students and the questions presented in the material.

Based on the analyses carried out in the staging of the preliminary design, a redesign of the sequence of activities was undertaken, incorporating the observations made by the teachers. Against this background, it was decided to rework the original purposes of the sequence design. The final version of the sequence was as follows.

Activity 1. Paper folding of the sequence, is sectioned with the intention that the student builds step by step the characteristics of this first fraction that is being studied $\left(\frac{n}{2}\right)$.

- **Section I. Manipulation: half**. It focuses on the study of the fraction 1/2. Its purpose is for the pupils to begin studying fractions based on the previous notions they have from their everyday life experiences, i.e. at first they are expected to use their knowledge of half, a fraction that pupils handle naturally from an early age. This is done by folding a manipulative circle (see figure 1) so that, through its use in the different tasks, pupils have their first school contact with this fraction.

- Questions are posed that gradually lead students to discover the characteristics of this fraction, such as: identifying that a whole has two halves, as well as that the parts must be equal. In addition, guidelines are given to the teacher in order to give him/her ideas on how to guide the activity so that the student can make analogies between his/her experiences with the half and the activities that the student is asked to carry out, so that the activity flows in an appropriate way and the objectives are fulfilled.

Figure 1 Material used in activity 1

- **Section II. Context: from the middle to a medium**. Students are asked to take actions with this same fraction (a half) in an everyday context, such as buying a kilo or a half kilo of tortillas, with the aim of relating the notion of half to that of a half. In this part, the teacher's guidance is very important, as it will consist of promoting the students' reflection through questions such as: how many halves does an integer have? and how many halves does an integer have? So that they realise that they represent the same quantity and begin to restructure the notion of this fraction. Once they have evidence of fluent use of the fraction by giving appropriate answers to the questions posed, they move on to the next section.

Section III. Introduction to the use of numbers to represent means. It begins with the identification of their numerical representation, still linked to figurative representations (verbalising, but using numbers for this) so that, finally, they manage to approach, with an appropriate meaning, the writing of the fraction one half, associate the fraction two halves with the unit and a first approach to improper fractions with numbers greater than the unit (all referring to the denominator 2).

In this section, a box is added in which the child is shown the numerical representation of the fraction, one half, 1/2, describing what these numbers represent. It is suggested to the teacher that it is read as a whole so that, if necessary, clarifications can be made, as it is considered as a local institutionalisation in his or her charge.

Section IV. Writing proficiency. Students are asked to write down the fraction that certain figures represent, to relate the figurative part to the numerical part and to write the names of the fractions that these represent, all this using different figurative representations and units of reference larger than the unit.

With what has been done in activity 1, the aim is for students to be able to relate the half to its equivalent in mathematical language, the half, both in verbal and numerical language.

Activity 2. Cutting out paper. In this activity, which consists of two sections, the aim is for students to outline the space covered by the parts of fractions, halves, quarters and eighths. In addition, they should be able to make sense of the names of the fractions, construct graphic representations of them, make comparisons between them through graphic representation, construct the numerical representation of halves, quarters and eighths (see figure 2), and make comparisons between them by means of graphic representation.

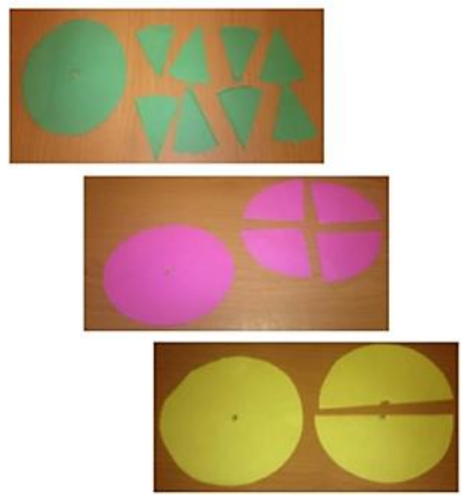

Figure 2 Material used in the activity 2

- **Section I. Naming fractions**, The aim of this activity is to give continuity to the relationships established in the previous activity in order to establish a strategy to obtain quarters and eighths by dividing in half each of the parts obtained previously (having started with half of the circle). The name given to the fractions is also determined, associating the number of parts contained in the unit with the ordinal name they already know (fourths, fifths, sixths, sevenths, eighths); although several are shown, emphasis is only placed on halves, fourths and eighths.

It is noted that the manipulation of the circles by cutting out the requested parts is intended to provoke the relationship of the requested fraction with the space it covers; that is, it provides a different experience from the mere visual perception provided by the fixed parts in a drawing, since these cut-out parts can be superimposed on the reference circle and make their relative size palpable depending on whether they are equal denominators (the sizes are related to the numerators), or different (these denominators are related in unit fractions).

Section II. Identifying and comparing fractions. Manipulation makes it possible to isolate parts and compare them; not only to see which is larger, but also to determine how many times one fits into another (how many eighths cover certain quarters, or how many of these cover certain other halves, etc.). These manipulative comparisons are associated with the corresponding writing of the fractions represented, so that they can make sense of the order of the fractions and the role played by the denominator of the fraction in these orderings and comparisons. Of course, questions about the equality of fractions (matching their size as parts of the reference circle) written with different numerals are also included.

Activity 3. Jigsaw puzzles: in this activity the aim is to extend the previous notions recently acquired about halves, quarters and eighths, but taking a reference that could bring them closer to the handling of discrete objects, in this case 40 square pieces of a rectangular jigsaw puzzle (see figure 3). They are also asked to compare fractions using the same numerator and quarters and eighths as denominators, with the aim of identifying the differences between the order relations of naturals and fractions. In addition, three items are proposed as an assessment of the knowledge acquired by the students, in which order relation schemes and graphical and numerical representations are put into play (using as a reference unit, units larger than the unit).

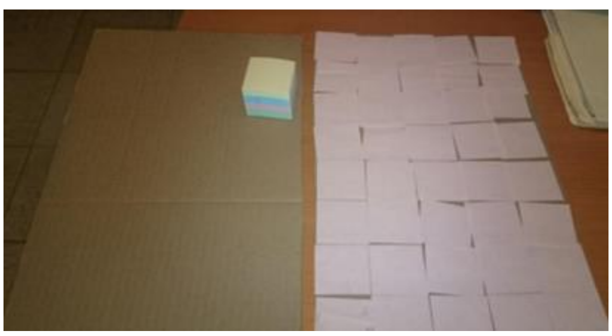

Figure 3 Material used in the Activity 3

- **Section I. Constructing halves, fourths and eighths, with discrete objects** the aim is to associate a half and a quarter with the number of pieces they represent of the total, using this rectangle as a framework so that the pupils can use the figural partitioning they have already mastered for these fractions.

In this context, they are asked questions that lead them to count pieces for different partitions; they are also asked to make comparisons between the number of squares that make up the different fractions that represent them, so that they become familiar with this type of partition by carrying out counting strategies that finally lead them to handle the numerical expression of the fraction they already know.

- **Section II. Comparing fractions with the same numerator.** Comparisons are asked to be made between fractions with the same numerator using as a medium the squares and the base; placing and removing squares from the base (see figure 4), to form the fractions and identify which is bigger or smaller, according to the number of squares associated to the fractions to be compared. Finally, three questions are presented, one of which asks students to relate the figurative representation to the numerical representation and, based on these, to put the fractions in order. The last test shows a series of figures in which different combinations are made to obtain halves, quarters and eighths, with the aim that the student is not left with only one way of dividing the figures.

Figure 4 Forming parts from discrete material

On the other hand, as a product of the previous interventions that were made in a first staging, a teacher's guide was incorporated into the design, since it became clear in those experiences that the teachers in charge of conducting the sequence required precise orientations to continuously clarify both the specific purposes of some of the proposed actions, to know what to expect as an adequate response or how to guide the students without directly giving them the answers or carrying out the procedures to achieve them.

In order for these clarifications, orientations and suggestions for the teacher to be integrated into the actions requested of the learners in each activity, they were included in a two-column table format (see figure 5), so that the text for the teacher would be next to the text for the learners, right next to the paragraphs referred to. On the other hand, as a product of the previous interventions that were made in a first staging, a teacher's guide was incorporated into the design, since it became clear in those experiences that the teachers in charge of conducting the sequence required precise orientations to continuously clarify both the specific purposes of some of the proposed actions, to know what to expect as an adequate response or how to guide the students without directly giving them the answers or carrying out the procedures to achieve them.

In order for these clarifications, orientations and suggestions for the teacher to be integrated into the actions requested of the learners in each activity, they were included in a two-column table format (see figure 5), so that the text for the teacher would be next to the text for the learners, right next to the paragraphs referred to.

<table>
<tr><td colspan="2">Activity 1: parts of a whole

Materials:
- 4 colored paper circles of the same diameter (2 white, 1 green circle | cut into two different parts of half and 1 pink circle cut into halves).
- Colors.
- Scissors.
- Pencil.
- Worksheet.

Part one: parts of a whole

1. Manipulation.</td></tr>
<tr><td>Instructions:

1. Take the white circle, folded into two equal parts and color one of the parts yellow:

A) What part of the circle is colored yellow?
______

B) How many halves does the circle have?
______

C) Which is bigger one half or two halves?
______</td><td>Guidance for the teacher:

It is recommended that you use the manipulative material so that the children become familiar with the word half and can begin to use it in the meaning of part whole. In addition, the partition can be linked to the cast through verbalized questions. For example:

- Imagine that the circle is</td></tr>
</table>

Figure 5 Example of the format of the sequence of activities

Staging the redesign

This staging was carried out in order to observe whether the redesign of the sequence met the stated objectives. The implementation of the sequence of activities was carried out in a public primary school with a group of 6 third grade students, who had no theoretical (school) knowledge of fractions.

The sequence, as mentioned above, consists of three activities, which were carried out one per day in the classroom, each lasting approximately one hour.

At the beginning of the first activity of paper folding, the need to use the experiences that the student has in order to start with the construction of knowledge, as mentioned in the principles of constructivism, as these bases help the student to become familiar with and give rise to new knowledge. In this activity, it was necessary for the teacher to intervene in order to provide the students with contexts related to the questions on the worksheet, so that they could answer, because despite using manipulative material at the beginning, it did not tell them anything by itself, so it was necessary to relate, for example, the parts of the circle with chocolates and put them in a context of distribution.

In the second section of this paper folding activity, the students were asked to work in teams (pairs), so the teacher's intervention was important to be aware of the interaction between the students. As this was the first attempt in which the students would change their scheme from the word half to a half, it was necessary to be aware of what each pair of students was saying about the use of a half or a half. This intervention consisted of guiding the students through appropriate questions related to contexts in which they had a notion of this word according to their experiences.

In activity 2, Cutting out paper, the teacher's intervention was important to institutionalize the name of the fractions, associating the number of the parts with the corresponding ordinal number. In this activity, the manipulation helped the students to create a scheme of how to construct the numerical representation of different fractions.

The last activity, Puzzles, although closely linked to the figurative part that the students had been working on, caused a bit of conflict, partly because of the change of manipulatives, the material they were made of and the context used. However, this could be rescued by placing the pupils in a context within their reach: for example, by asking them to imagine marbles instead of the puzzle pieces and to make piles of them (see figure 6).

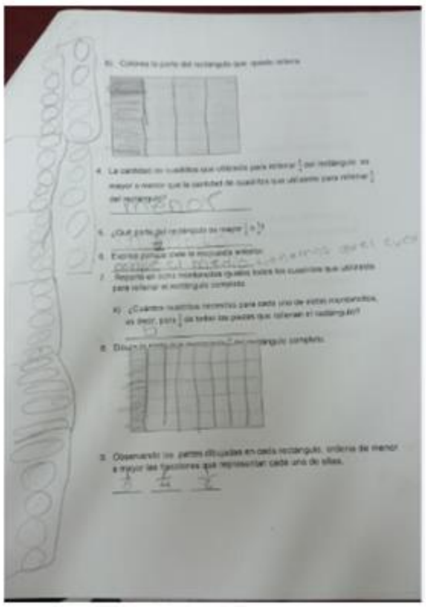

Figure 6 Construction of an octave using discrete objects

Throughout the staging, the importance of the guidance given in the teacher's guide was corroborated, so that the teacher could make use of them. In general, in the interventions that were made, they were used, giving the pupils more ideas on how to relate their knowledge to contexts and this made the pupils interested in learning about fractions. In addition, the redesign of the sequence of activities based on the use of short questions and pictures was very useful, as the students were not overwhelmed with reading and could follow the instructions quickly.

As far as the use of the manipulatives is concerned, there was a lot of enthusiasm on the part of the students to do what was asked of them in each instruction. It was very useful for them to be manipulating the circles, folding, cutting out and colouring, in the second activity Cutting out paper (see figure 7) the cut out parts were useful for them to make comparisons, and this in turn, to start with the recognition of the spaces to which the different fractions correspond, as well as to create an idea of the meaning of denominator.

Figure 7 Use of cut-out material

In Puzzle activity 3, the manipulative was not very useful due to the material it was made of, as it was very difficult to handle. Perhaps if the squares had been made of wood or some other rigid material, it could have been better manipulated and thus avoided some of the conflict that arose when trying to represent parts of the rectangular base by putting the squares on and taking them off. However, part of the objective of using manipulative materials was to make it accessible to the pupils, and if it were made of another type of material, the objective would be lost. The activity could be rescued by making use of drawings that allowed the students to do what was asked of them in a satisfactory way.

In general, the material was very supportive. It was observed that by doing the manipulations of the material necessary to answer the questions; cutting out, colouring and counting, the pupils are entertained and do it with pleasure. Most of the time, when reading the questions, they used the circles or parts of the circles and counted the parts to answer. In addition, they were also useful for the teacher, because sometimes the students asked for help and the teacher manipulated these materials so that they could observe and look for the answer by themselves.

In the staging of the activity, the importance of the previous experiences of the student emerged in order to start the construction of new learning, as stated in the constructivist approach (Chadwick, 2001), since it was the first time that the students were introduced to the use of fractions in the classroom, the teacher had to make an association between a context of distribution and what was described in the first activity, using chocolates, in order to make sense of this first encounter between fractions and students.

Also in this staging it turned out that, far from what one might think, the role of the teachers is of vital importance, as their work consists of leading, through questioning or changing contexts supported by the experiences of the students, to situations where they are presented with obstacles and contradictions, which places them in a conflict and breaks with the expectations that were expected, thus trying to get them to reflect on the situation, in order to achieve the objectives set.

The interventions that were made and the use of manipulative material that was used when carrying out the activities in the classroom, resulted in the pupils carrying out the final evaluation activity on their own, without major problems, making sense of the graphic, verbal and numerical representation, despite the fact that these were the first activities in which they used fractions.

As for the fractions in the sequence, a change of reference unit from a whole to a half as a reference unit is handled intuitively, this is achieved by dividing the circle into halves, making reference to the fact that a quarter represents half of a half and an eighth half of a quarter.

It is considered that giving an initial meaning to half of a half and half of a quarter can contribute later on to give meaning to the multiplication of fractions and thus avoid a recurrent confusion in students when performing this operation, as they will be able to associate it to the action they are carrying out in this activity, by giving the multiplication sign (x) the meaning of, i.e. 1/2 x 1/4 means 1/2 of 1/4, in this way, they can explain why when multiplying two fractions the product is reduced, contrary to what happens when multiplying two natural numbers.

In addition, the design based on properly articulated problem situations and the role of the teacher as a guide to the activity, led the students to use their previous knowledge to provide answers to the problems posed.

With regard to the construction of knowledge about the use of halves, quarters and eighths to express orally and in writing different measurements and divisions, the activities were a great support; firstly because the pupils were discovering these new numbers through the questions, making sense, firstly of what was being divided through the actions of: folding, colouring, cutting out and superimposing, then how they were expressed verbally, and finally numerically. This became visible when carrying out the assessment in the last part of the sequence; in this, in spite of using figurative representations different from those used throughout the sequence and in some cases changing the units of reference to larger than the unit unit, the students were able to give answers to what was asked of them, with minimal doubts.

Conclusions

Throughout this work, fractions were studied, taking into account different perspectives and analyzing the ideas of various authors. From these studies it was concluded that it is necessary to create material to support the learning of fractions.

The didactic proposal presented in this work helps students to make sense of fractions at an early stage, that is, in their introduction, using manipulative material, since, as has been pointed out, the incorporation of manipulative material to support the learning of fractions is a good tool, given that:

- It catches the students' attention.
- By manipulating the material they can associate the part with the whole.
- Manipulation allows them to validate their answers.
- It allows them to confirm their ideas.
- They are able to schematize the parts of fractions through figurative representations.
- They are able to make comparisons between fractions through their different graphical, verbal and symbolic representations.

- They can interact with their classmates clarifying or defending their procedures and answers making use of manipulative material as a reference for their arguments.

- They are able to do a greater amount of autonomous work.

A recurrent problem, not only in the learning of fractions, but of any content, is the lack of interest in reading and, consequently, the students' lack of reading comprehension. This problem could be mediated with the design of activities that included short questions and images.

The question remains about the type of material that students have to develop reading competence; although this is a problem that does not fall squarely within the interest of educational mathematics, it also warns about the quality of official educational materials used by students and teachers to support this aspect.

In concluding this work, it is confirmed how important it was to choose the first moment in which fractions are studied as the focus of the design, because, without neglecting the importance of the other moments, we had the satisfaction of having lived the experience of accompanying the students in the first construction of meanings.

With regard to teachers, their work requires more planning, which is sometimes difficult for them due to lack of time, interest, knowledge, among others. It would therefore be interesting to be able to design guided activities so that teachers can get an idea of what they can do in the classroom.

These guides, made by a team of experts as a long-range project, could focus on each of the meanings of the fraction, covering each of the expected learning at the basic, intermediate and higher levels.

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The impact of the STEAM methodology on the academic performance of students' in learning the Solar System on elementary school

Impacto de la metodología STEAM en el rendimiento académico de los estudiantes en el aprendizaje del Sistema Solar en la educación primaria

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Abstract

The STEAM methodology as a pedagogical proposal in science teaching has been little explored in basic education in Mexico. The present investigation was developed in an elementary school in the city of Ocosingo, Chiapas, Mexico, it focused on applying the STEAM methodology with a focus on inquiry and the development of a group project, in order to demonstrate if this methodology impacts on academic performance of 5th grade students in the learning of the Solar System in the subject of Natural Sciences. The study was carried out under a quantitative approach of a descriptive type with a quasi-experimental design, using as information gathering instruments, tests designed for the study and a survey under the Likert scale that allowed obtaining the perception of the students in relation to the teaching methodology used in its inquiry phases. The results show that the use of this methodology as a didactic tool in the learning of the Solar System, significantly increases the learning of the students, as well as the pleasure to develop their learning through this methodology with the use of technological tools and the development of a group project.

STEAM, Inquiry, Academic performance, Elementary school, Didactic

Resumen

La metodología STEAM como propuesta pedagógica en la enseñanza de las ciencias ha sido poco explorada en la educación básica en México. La presente investigación se desarrolló en una escuela primaria en la ciudad de Ocosingo, Chiapas, México, se centró en aplicar la metodología STEAM con un enfoque en la indagación y el desarrollo de un proyecto grupal, con el fin de demostrar si esta metodología impacta en el rendimiento académico de los estudiantes del 5º. grado en el aprendizaje del Sistema Solar en la materia de Ciencias Naturales. El estudio se realizó bajo un enfoque cuantitativo de tipo descriptivo con diseño cuasi-experimental, utilizando como instrumentos de recopilación de información, pruebas diseñadas para el estudio y una encuesta bajo la escala de Likert que permitió obtener la percepción de los estudiantes con relación a la metodología de enseñanza utilizada en sus fases de indagación. Los resultados demuestran que la utilización de esta metodología como herramienta didáctica en el aprendizaje del Sistema Solar, incrementa significativamente el aprendizaje de los estudiantes, así como, se percibe el gusto por desarrollar su aprendizaje a través de esta metodología con el uso de herramientas tecnológicas y el desarrollo de un proyecto grupal.

STEAM, Indagación, Rendimiento académico, Educación primaria, Didáctico

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Introduction

Currently, one of the main concerns is the lack of professionals in the technological and scientific areas, therefore, it is not possible to meet the needs in jobs that meet the necessary skills to perform them. For this reason, throughout pedagogical history, changes have been made in curricula or initiatives in which various vocations have been developed. At the beginning of the 21st century, the aim has been to develop scientific and technological vocations, as well as competencies related to innovation, in order to improve educational quality and adapt to the changes of a competitive and changing society, with this purpose the STEAM (Science, Technology, Engineering, Art and Mathematics) methodology emerged.

One of the first theories underpinning STEAM methodology is the interdisciplinary theory of sociologist Louis Wirtz (1897-1952). The term interdisciplinarity appears for the first time in 1937, the prefix inter (between) is attributed to the sociologist Louis Wirtz, which indicates that between disciplines a relationship will be established, allowing the fact of incorporating the results of various disciplines from conceptual schemes of analysis. Therefore, according to Piaget, interdisciplinarity ceases to be something occasional and becomes the very condition for the progress of educational models (UNESCO, 1973). This theory proposes the training of students in scientific research activity, which implies the development of competencies, skills and values that foster independence, creativity and, in turn, promote knowledge. Therefore, we can say that the STEAM methodology is a structured learning that allows to address the solution of a problem, through the integration in a related way of the different disciplines that compose it, thus, allowing to respond to the proposed challenges of real problems in an interdisciplinary way (Echeverría, 2019) within a globalized and changing society.

On the other hand, the interdisciplinary learning of STEAM methodology is linked to the functional literacy approach. Yakman (2008) considers that the goal of education is to achieve functionally literate people, students who know how to learn and adapt to a rapidly changing environment. In addition, UNESCO promotes the change from traditional literacy programs to functional literacy programs in which, in addition to training in reading and writing, people are trained based on their environment, encouraging students to learn to learn for life, to learn to transform and intervene in reality. Likewise, the digital literacy approach is related to the STEAM methodology, this approach allows using technology as a communication or networking tool to locate, evaluate, use and create information with a critical sense. Undoubtedly, digital literacy allows us to develop skills to read and interpret the media, reproduce data and images through digital manipulation and evaluate and apply the new knowledge obtained in digital environments (UNESCO, 2011), which is why the accelerated growth of science and technological advances have been a challenge to education, so it can be said that this approach has generated a transformation not only in the way of presenting information, but also in everything related to the teaching and learning process.

For its part, the constructivist approach of the psychologist Piaget (1896-1980) is implicit in the interdisciplinary model that characterizes STEAM, Piaget proposed that the subject interacts with reality, constructing his knowledge and, at the same time, his own mind. Knowledge is never a copy of reality, it is always a construction. We can say that learning is an internal process, which is acquired through interaction with the environment that surrounds the student, hence the importance of providing spaces and educational resources that help promote their interlearning; therefore, it is imperative that the activities must contain a coherent structure, so that it is easily used by the student according to the experiences and contexts that surround him. In this way, we can affirm that the STEAM methodology, being under the constructivist approach, is an active methodology that promotes the construction of new ideas and where the most important thing is the process and not the result, promoting the construction of knowledge in a meaningful and collective way between student and teacher.

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In addition, the STEAM methodology allows students to have an active participation during the development of the activities that are proposed, therefore, it is also linked to the interactive approach, according to Gutiérrez, Gómez and Gutiérrez (2018), the teacher designs a variety of learning activities where students participate in the process of developing knowledge and understanding, allowing them to reflect and practice using new knowledge and skills, in order to develop long-term learning and deeper understanding. From the above, we can indicate that the interactive approach allows learners to engage with and be aware of their own learning.

For its part, the interdisciplinary nature of STEAM methodology requires the integration of a final product so that the different disciplines converge; therefore, Project-based education (PE) is an approach that is linked to STEAM. PE has its first signs with the pedagogue and philosopher William Heard Kilpatrick (1871-1965) formally presenting his theory on project methodology in 1918, establishing that students should carry out research projects, and that these should be the center of the learning process. It is important to emphasize that the theoretical bases are centered on constructivism. Thus, we can assume that it is a model where students plan, implement and evaluate projects that have real-world application beyond the classroom. Likewise, Project-Based Learning generates contributions for the development of scientific and technological competencies, applying it in two to more areas of STEAM Methodology (Domènech-Casal, 2018).

One of the models used to awaken students' interest in scientific vocations is inquiry learning, this "is a dynamic process that consists of being open to experience amazement and perplexity, and getting to know and understand the world" (Gordón, 2001, cited by Vizcarra, 2022), therefore, it is necessary to design learning situations where students develop scientific competencies from the contents of textbooks (Fuentes, Puentes and Flórez, 2018). Therefore, the STEAM methodology provides an ideal scenario where it allows the development of student learning with a focus on inquiry, to address topics of Natural Sciences.

Background

Bautista (2021) conducted a monographic study, analyzing the validity and effectiveness of the STEAM model in education, as well as the barriers that prevent its application within the school context. Among his findings is that STEAM education is characterized by seeking meaningful learning, eliciting convergent thinking of students (common in STEM disciplines) and divergent thinking (common in the Arts), so he proposes to promote integrated learning of students and/or professional development of teachers.

Ortiz, Greca and Meneses (2021) under mixed methods, analyzed the effectiveness of integrated STEAM education as a possible way to improve the development of competencies in the primary education stage, responding didactically to the complexity of today's world. They found that the STEAM approach not only allows to respond from a didactic point of view to the complexity of today's world, but also constitutes a solid way to improve the development of student competencies, therefore, they affirm that the development of competencies requires a radical change in the way teachers and students conceive the teaching and learning processes, therefore, they propose that integrated STEAM education is one of the most potentially useful and beneficial methodological approaches for the acquisition of competencies demanded by the society of the 21st century.

In the case study developed by Campos et al., (2018), they concluded that the STEAM methodology allows students to be involved in their training, achieving significant learning for a globalized world, which not only requires technical preparation of excellence, but also allows future professionals not only to transform and transfer information into knowledge, but also, to develop in multidisciplinary teams where they face with leadership, critical thinking and creativity, the great challenges that today arise in the industry.

In the project conducted by Garza et al., (2018) conclude that, project-based learning from English Project Based Learning (PBL) facilitates interdisciplinarity and the integration of knowledge, crossing the barriers of fragmented knowledge of disciplines and subjects, being this a method where the student is the protagonist of his own learning, where learning knowledge has the same importance as the acquisition of skills and attitudes. Therefore, we must link PBL together with STEAM methodology to create knowledge and collaboration that allows us to link projects with the real world and provide solutions to the problems that society has.

Another relevant feature of STEAM is the use of active methodologies that contribute to better student performance; therefore, the implementation of a curriculum design based on STEAM that proposes the solution of real problems will allow the development of scientific creativity in students at an early age (Tran et al., 2021), Hsiao, Lin, & Hung, 2021), as well as the implementation of project-based learning will allow teachers to innovate in the planning and execution of activities for students to develop meaningful learning and initiate them in scientific literacy from basic education (Adriyawati et al., 2020). On the other hand, designing a didactic sequence in interdisciplinary subjects, integrating STEAM and Maker education, generates significant learning in students, due to the approach of real problems, increasing self-efficacy in the development of their activities by applying interdisciplinary knowledge (Jia, Zhou, & Zheng, 2021).

For Park, Byun, Sim, Han, & Baek, (2016) implementing STEAM education in classrooms involves providing time, administrative and financial support to teachers, as this type of education helps to develop creative learning in students.

Problem statement

Mexico lacks a scientific culture. In 2009 CONACYT conducted a survey and one of the results it found is that 86.3% of Mexicans trust faith and magic more than science to solve their problems (Aldana, 2009, cited by Martínez, 2019). The above, are regrettable data and this is due to the fact that there is no scientific culture, as indicated by De la Peña (2005), Mexicans accept that science is taught in schools, but they do not want their children to be scientists, in addition, in Mexico there are no educational policies that encourage STEAM skills Science, Technology, Engineering, Arts and Mathematics (Science, Technology, Engineering, Arts and Mathematics) from preschool, therefore, according to UNESCO data we have that in Mexico there are only 244 researchers per million inhabitants (Sandoval, 2019), having a false belief that scientists have boring and lonely lives.

On the other hand, the Organization for Economic Cooperation and Development (OECD) has designed a test to measure academic performance in mathematics, science and reading worldwide, through the Program for International Student Assessment (PISA) where Mexico demonstrates in the results obtained, a very serious lag in the areas being evaluated. The Ministry of Education has tried to implement initiatives and programs, however, these have had little progress.

Education in Mexico presents a large educational backwardness, Chiapas is one of the states that leads these statistics (Martín, 2017). The municipality of Ocosingo is located in the state of Chiapas, at the entrance of the Lacandon Jungle, in addition, it is one of the municipalities with the largest territorial extension within the state. According to data from the State Coordination of Continuing Education for In-Service Teachers (2020) of the Ministry of Education of the State of Chiapas, the percentage of teachers trained in pedagogical topics is very low in relation to the total number of teachers at the basic level, so that, for them, educational innovation is something complex to assimilate and above all to contextualize.

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Objective

The present research project aims to measure the impact of the STEAM methodology with a focus on information inquiry and the development of a project, on the academic performance of students in the learning of the Solar System in the subject of Natural Sciences in the 5th grade of elementary school.

Methodology

According to Hernández, Fernández and Baptista (2014), this research was conducted under a quantitative approach with a quasi-experimental design, with two paired groups, having STEAM methodology as an independent variable and academic performance as a dependent variable; therefore, the following hypothesis was proposed "The teaching of the Solar System under STEAM methodology with a focus on the inquiry of information and the development of a project, increases the academic performance of students in the 5th grade of the Elementary School Marcos Villanueva López of the city of Ocosingo, Chiapas. On the other hand, descriptive statistics are used to evaluate the application of the STEAM methodology.

The study sample was intentional and consisted of 40 students in the 5th grade of the Marcos Villanueva López Elementary School in Ocosingo, Chiapas. The sample of the study was intentional and consisted of 40 students in the 5th grade of the Marcos Villanueva López Elementary School in the municipality of Ocosingo, Chiapas, divided into two intact groups, with the teachers present only as observers during the study. The age of the students ranged from 10 to 11 years old, of whom 20 were male and 20 female. Table 1 shows the disaggregated data for both groups.

Group	Sex		Totals
	M	F	
A	10	10	20
B	10	10	20
Totals	20	20	40

Table 1. Students by sex and group.
Source: Research data, 2023

Instruments for data collection

For this study, the tests (pre-test and post-test) were designed with dichotomous questions, attached to the contents of the textbook of the Natural Sciences subject, in the topic of Block V. Description of the Solar System, these were validated in content by expert educators in the primary grade where the study was conducted; the reliability of the instrument was verified through the Kuder-Richardson coefficient (KR20) using RStudio software version 2022.07.1, yielding a value of 0.8314 located in the Very High magnitude range, being an instrument with Acceptable reliability coefficient (Ruíz, 2013). The results obtained by the students in both tests were converted into scores with a scale from 0 to 10, in order to perform a statistical test of difference of means to validate the hypothesis.

On the other hand, a two-dimensional survey was designed to know the perception of students on the implementation of the teaching of the Solar System under the STEAM methodology, this was validated in content by experts in educational research; the survey has 21 questions under the Likert scale with answers "Very much", "A lot", "Regular", "Little" and "Nothing", the reliability of the polychotomous instrument was calculated, through Cronbach's alpha, obtaining a value of 0. 9104 located in the Very High magnitude range, making it an instrument with an Acceptable reliability coefficient (Ruíz, 2013).

Development

The intervention was carried out in both groups, designing a didactic sequence centered on the student, which was developed in three phases:

Phase 1. Design

The researchers designed the intervention according to the topic: Description of the Solar System, from Block V of the SEP free textbook for 5th grade of elementary school, through the design of a didactic sequence to apply the STEAM methodology with a focus on the inquiry of information, therefore, the areas of this methodology were analyzed to implement it in the development of a group project.

Phase 2. Intervention

The researchers carried out the intervention to address the aforementioned textbook topic, using an interactive presentation and the NASA Solar System Exploration application.

Figure 1 Teacher intervention
Source: Research Images, 2023

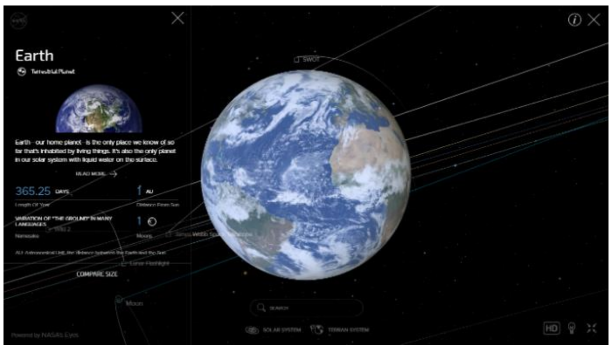


Figure 2 NASA Solar System Exploration application
Source: NASA (2023). Our Solar System. [Photograph]. https://solarsystem.nasa.gov/solar-system/our-solar-system/overview/

On the other hand, the students elaborated a homemade telescope for sky observation and made the representation of celestial bodies as part of the group project, with the help of the Arloon Solar System application, where they applied Science, Engineering, Arts and the use of Technology from the STEAM areas.

Figure 3 Construction of the homemade telescope
Source: Research Images, 2023

Figure 4 Arloon Solar System application
Source: Research Images, 2023

Figure 5 Representation of the celestial bodies of the Solar System
Source: Research Images, 2023

Finally, the students proceeded to assemble the Solar System in the classroom, applying mathematics in the calculation of the distances from the Sun to each of the planets, through an established scale, in addition, they presented what they had learned during the process to their classmates.

Figure 6 Assembly of the Solar System in the classroom
Source: Research Images, 2023

Figure 7 Exhibition of what was learned during the development of the group project.
Source: Research Images, 2023

Phase 3. Data collection

During the sessions used for the intervention of the study, in the first session, the pre-test was applied to measure the students' previous knowledge about the Solar System; in various sessions in the intervention phase, the survey was applied for the study on the implementation of the STEAM methodology in the development of the group project; and in the last session, the post-test of the study was applied to obtain the results of the students' learning.

Figure 8 Application of the pre-test
Source: Research Images, 2023

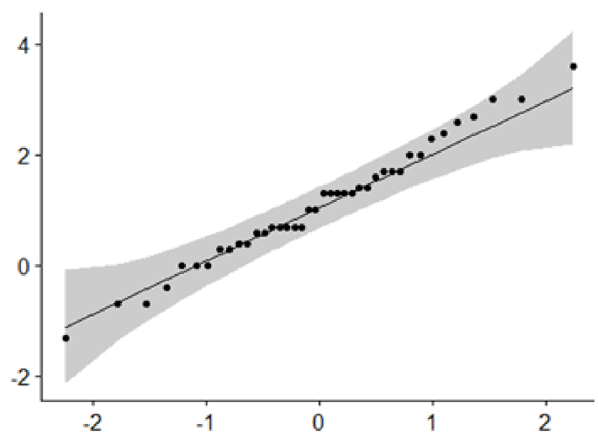
Figure 9. Application of the survey
Source: Research Images, 2023

Figure 10 Post-test application
Source: Research Images, 2023

Results

Instrument 1

To determine the hypothesis test to be used; first, the normality of the data was verified, through the Shapiro-Wilk test with RStudio software, where a value of p = 0.9475 was obtained, higher than the established significance level value of α=0. 05, concluding that the data behave normally, as shown in Graph 1; next, the equality of variances was verified through Fisher's test, obtaining a value of p = 0.9838 higher than the value of the established significance level of α=0.05, indicating that the tests (pre-test and post-test) present equality of variances; therefore, the calculation of the t-Student test for dependent groups was performed.



Graphic 1 Quantile plot for the normality of the data
Source: Research images, 2023

Finally, for the validation of the research hypothesis, the t-Student test for dependent samples was performed, obtaining a value of p = 0.0033, which is lower than the established significance level of α=0.05, so it is concluded that there is a significant difference, rejecting the null hypothesis and accepting the hypothesis of this research, in which the teaching of the Solar System under the STEAM methodology significantly increases the academic performance of students in the 5th grade of elementary school in the elementary school Marcos Villanueva Lopez in the city of Ocosingo, Chiapas.

The above result agrees with the study conducted by Asrizal, Dhanil and Usmeldi (2023), who demonstrated that the use of STEAM increases the students' capacity in understanding the subject and improves their learning, in the teaching of science in elementary schools. Likewise et al., (2021) demonstrated that the use of augmented reality with STEAM improves students' learning in natural science in primary education.

Instrument 2

The results obtained from the instrument to know the students' perception of the implementation of the STEAM methodology with a focus on the inquiry of information and the development of a project, is divided into two dimensions; in the first dimension, the 5 Phases of the inquiry where the topic "Description of the Solar System" was addressed are analyzed; in the second dimension, the scientific vocation demonstrated by the students during this study is analyzed.

Dimension 1

Phase 1. Inquiry

In this phase the following questions were asked: Q1. How much do I know about our solar system?, Q2. How much do I know about the characteristics of the celestial bodies, that is, planets, moon, meteors, meteorites found in our solar system?, Q3. How much do I know about the instruments and techniques used to study the celestial bodies of our solar system?

Table 2 shows that 40% of the students have the perception of knowing regularly the characteristics of the celestial bodies of the Solar System and the instruments required to study them; however, 42.5% think they know a lot and very much about our Solar System, being the majority of the group.

Item	Very Much	Very much	Regular	A little	Not at all
P1	8	13	15	4	0
P2	4	16	14	5	1
P3	4	6	19	10	1
Total	16	35	48	19	2

Table 2 Perception of students in relation to the Inquiry Phase
Source: Research data, 2023

Phase 2. Development of the Inquiry

For this phase the following questions were asked: Q4. When I researched about our solar system, how clear was I about the information to look for, Q5. When I investigated about our solar system, how clear were the steps to follow to obtain the information?, Q6. How much information did I investigate about the characteristics of the celestial bodies of our solar system?

In Table 3, it is observed that 42.5% of the students have the perception of being very clear about the information to look for and the steps to follow to obtain it; however, there are 21.7% of the students who know how to carry out an information research.

Item	Very Much	Very much	Regular	A little	Not at all
P4	10	21	7	2	0
P5	11	15	13	1	0
P6	5	15	16	4	0
Total	26	51	36	7	0

Table 3 Perception of students in relation to the Inquiry Development Phase
Source: Research data, 2023

Phase 3. Organizing and structuring the Inquiry

For this phase, the following questions were asked: Q7. How well do I identify the shapes and colors of the celestial bodies of our solar system?, Q8. How well do I know the technological instruments used to study the celestial bodies of our solar system?, Q9. How well do I differentiate between the different ways of studying celestial bodies, for example, with the naked eye, a home telescope or a space telescope?

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Table 4 shows that 36.7% of the students have the perception that they have managed to identify a lot, the shapes and colors of the celestial bodies of the Solar System, the technological instruments used to study them and the ways in which they can be studied (with the naked eye, home telescope and space telescope), however, there are 20% who think that they identify a lot the characteristics, instruments and ways to study the celestial bodies, organizing the information in a poster, but 35% do it regularly.

Item	Very Much	Very much	Regular	A little	Not at all
P7	11	8	18	2	1
P8	7	16	14	2	1
P9	6	20	10	3	1
Total	24	44	42	7	3

Table 4 Students' perceptions regarding the Organizing and structuring the Inquiry Phase
Source: Research data, 2023

Phase 4. Results of the Inquiry

For this phase, the following questions were asked: Q10. How much did I learn how to handle the types of colors that exist and how to create them? Q11.With respect to the planet I built, how many characteristics and colors did I apply, Q12. With respect to the planet I built, how much did I learn about calculating distances to locate the planets in relation to the sun, Q13. How much did I collaborate as a team to build our giant solar system?

Regarding the results of this phase, where the students built the Solar System in the classroom and the construction of a homemade telescope, Table 5 shows that 37.5% of the students liked very much the handling of colors and how to create them, the amount of colors applied in the construction of their respective planet, knowing how to calculate distances to locate the planets in relation to the sun and how much they collaborated with their team, on the other hand, there is also 35.6% who said that they liked it very much.

Item	Very Much	Very much	Regular	A little	Not at all
P10	17	12	9	2	0
P11	15	16	6	3	0
P12	9	15	9	7	0
P13	16	17	3	4	0
Total	57	60	27	16	0

Table 5 Perception of students in relation to the Organizing and structuring the Inquiry Phase.
Source: Research data, 2023

Phase 5. Metacognition

For this phase the following questions were asked: Q14. How much did I enjoy investigating the information about our solar system?, Q15. How much did I learn to differentiate the sizes and dimensions of the planets?, Q16. How much did I learn to measure the distances between the sun and the planets? Q17. How much did I enjoy using art materials to color my solar system work?, Q18. How much did I enjoy building my telescope?, Q.19 When I presented my work to my classmates, how satisfied did I feel?, Q20. How enjoyable was it to work with my classmates?, Q21. How much relevant and important information about our solar system did I learn?.

In relation to this phase, it is the result of the learning obtained by the students, through the implementation of the STEAM methodology, in Table 6, it is observed that 41.9% have the perception that they liked very much to investigate, differentiate the sizes and distances between planets, the art material for coloring, the elaboration of the homemade telescope, the presentation to their classmates and collaboration with their work team, as well as the relevant and important information learned about the Solar System, and 37.8% liked very much the development of these activities to generate their learning.

Item	Very Much	Very much	Regular	A little	Not at all
P14	17	18	3	2	0
P15	8	20	10	2	0
P16	15	11	11	1	2
P17	32	8	0	0	0
P18	25	11	3	1	0
P19	12	17	10	1	0
P20	17	16	6	1	0
P21	8	20	9	3	0
Total	134	121	52	11	2

Table 6 Perception of students in relation to the Metacognition Phase
Source: Research data, 2023

Dimension 2

In this dimension, the scientific vocation developed by the students during this study was evaluated through the following questions: Q22. How curious and interested am I in learning what celestial bodies exist in our solar system?, Q23. How much do I observe the sky to see what happens in space?, Q24. How interested am I in learning about the professions dedicated to science and technology to study space?, Q25. By doing this work, how much did it allow me to think about what I want to do when I grow up, Q26. How much would I like to use technology to build things?

Table 7 shows that 46% are very curious to learn information about the celestial bodies of the Solar System, have frequently observed the sky to know what happens in space, have awakened interest in knowing what professions study the universe and what they would like to be when they grow up, as well as the use of technology to build things, likewise, there are 37% who thought on the scale of very much, being the great majority of the students.

Item	Very Much	Very much	Regular	A little	Not at all
P22	21	15	2	2	0
P23	12	16	11	0	1
P24	13	16	11	0	0
P25	19	16	4	1	0
P26	27	11	1	1	0
Total	92	74	29	4	1

Table 7 Perception of students in relation to scientific vocation
Source: Research data, 2023

Regarding the results obtained in question 25, it is observed that 87.5% made them think about what they would like to dedicate themselves to when they grow up, that is, they could work in professions dedicated to science, these results are similar to the study conducted by Muñoz (2020), when asking the question "*When I grow up, I want to study something that has to do with science*", within the group of questions to measure enthusiasm, he found that more than 50% of the students were enthusiastic about science.

Contrary case found by Verde et al., (2013), where they conducted a study to know the scientific perception at the end of primary education, it is highlighted that more than 77% would not like to dedicate themselves to the study of science, however, when asked the open question "*Explain how you usually worked in the class of Knowledge of the Environment?*" more than 59% mentioned that through the "*Traditional methodology (as usual, with the book doing exercises, the teacher explains, homework, nothing, studying)*" and "*Neither experiments nor outings*", so implementing the STEAM methodology is an opportunity for the development of scientific vocations from primary education.

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Conclusions

The results obtained in the study show that using the STEAM methodology with a focus on the inquiry of information and the development of a project, allows to increase the academic performance of students in the teaching of the Solar System, due to the interdisciplinary nature of the areas of this methodology, in addition to the development of communication skills and teamwork.

The perception obtained from the students during the phases of the inquiry shows that 30.6% liked learning through this methodology very much, 37% liked it very much, 24.4% liked it regularly, 7.1% liked it a little and 0.8% did not like it. 8% did not like it; therefore, it is concluded that this type of methodology can be applied in the learning of the Solar System in the fifth grades of elementary school, in addition, it offers the possibility of being implemented in lower and later grades, through the inquiry of information and the development of a large-scale group project.

Therefore, the implementation of this methodology requires a change in the attitude of elementary school teachers to be trained in the use of current pedagogical strategies and the inclusion of ICT in the classroom, which allows exploring situations that cannot be contextualized daily in a classroom, since several studies have shown an increase in learning, creativity, critical thinking, communication and teamwork of students.

Federal and State Education Authorities are urged to make joint efforts to provide training to teachers for teaching under STEAM methodology, inquiry-based learning and project-based learning and implement them in the classroom, in order to develop scientific skills and abilities at an early age, and increase scientific development in Chiapas and Mexico, as well as, in the future, to increase the number of scientists in our country.

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Teaching tasks of teacher trainers: study of their influence on initial teacher training

Las tareas de enseñanza de los docentes formadores: estudio de su influencia en la formación inicial de los profesores

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Abstract

The present work arises from evaluation results (OECD, 2017) that reflect low learning in primary school students in the subject of mathematics, as well as the difficulty of understanding fractions. The study was carried out with the aim of identifying strategies used by teachers' trainers for their students to appropriate the planning of mathematics in the subject of fractions, as well as the elements they take into account for their design. A qualitative approach was used with the case study methodology. The sample consisted of two teachers attending the second semester of the Bachelor in Primary Education and 6 students. The results show that teachers in training identify elements that should be considered to design the planning and are based on the Theory of Didactic Situations, this by influence of the strategies designed by the trainers of the normal school.

Planning, Theory of didactic situations, Fractions

Resumen

El presente trabajo surge a partir de resultados de evaluaciones (OCDE, 2017) que reflejan bajos aprendizajes en alumnos de las escuelas primarias en la asignatura de matemáticas, así como la dificultad de comprender las fracciones. El estudio se llevó a cabo con el objetivo de identificar estrategias que utilizan los formadores de docentes para que sus alumnos se apropien de la planeación de matemáticas en el tema de fracciones, así como los elementos que toman en cuenta para su diseño. Se utilizó un enfoque cualitativo con la metodología de estudio de casos. La muestra constó de dos profesores que atienden el segundo semestre de la Licenciatura en Educación Primaria y 6 alumnos. Los resultados muestran que los docentes en formación identifican elementos que deben considerarse para diseñar la planeación y se basan en la Teoría de las Situaciones Didácticas, ello por influencia de las estrategias diseñadas por los formadores de la escuela normal.

Planeación, Teoría de las Situaciones Didácticas, fracciones

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Introduction

Planning is an essential tool in the teaching-learning process that serves as a guide for teachers in order to encourage their students to acquire the competencies established in the study plans and programs; "a substantive element of the teaching practice to enhance student learning towards the development of competencies" (Secretaría de Educación Pública [SEP], 2011, p. 27).

Planning is understood "as a roadmap that makes the teacher aware of the learning objectives he/she seeks in each session" (SEP, 2017, p. 121), a tool that teachers should know in order to elaborate it, subsequently put it into practice and obtain efficient results, both in their professional development and in the training of their students.

With respect to planning, its appropriation, is one of the professional competencies that teachers must acquire in their initial training process. "Design planning by applying their curricular, psycho-pedagogical, disciplinary, didactic and technological knowledge to propitiate inclusive learning spaces that respond to the needs of all students within the framework of the plan and programs of study" (SEP, 2018a, p. 7) professional competence with which students at the undergraduate level in Elementary Education who are trained with the 2018 Curriculum must comply.

The Ministry of Public Education (SEP) in Mexico, in the Plan de estudios, aprendizajes clave para la educación integral of 2017, states that in order to plan effectively, didactic strategies must be related to pedagogical principles that are embodied in the same document.

In the PLANEA national assessment regarding mathematics, it shows results obtained on June 12 and 13, 2018 from students in 6th grade of elementary school that show that 59% of these are in the first level, 18% in the second, 15% in the third and only 8% reach the optimal level for the school grade (Instituto Nacional de Evaluación Educativa [INEE], 2018).

The program for teacher training in the course Arithmetic. Decimal and fractional numbers of second semester of the Bachelor's Degree in Elementary Education states that: In teaching, it is basic to master the contents of the subject being taught. We need to dedicate time and effort to achieve a deeper understanding of the mathematics to be taught and how to teach them in order to develop autonomy and taste for mathematics in basic education students. (SEP, 2018c, p. 6)

Mathematics is a subject in which basic education students present difficulties, as well as teachers themselves (Organization for Economic Cooperation and Development [OECD], 2017), which implies having difficulty in planning and developing their class effectively. (Hernández- Gutiérrez and Lizarde, 2016) in their research argue that "The specialized knowledge of the mathematics teacher" reflects that in the contents in which teachers find it difficult to teach (say in mathematics contents) it is also difficult for students to learn. Although, in order to teach something we must first master it, without this, it will be difficult to elaborate strategies according to the expected learning, adding at the same time, the correct design of the didactic device to be implemented based on the approach of the subject and the competencies they seek to develop. That is to say, it is fundamental for a better teaching and learning process of mathematics, the design of lesson plans that contemplate the aspects of mastery of the mathematical content, as well as its didactic knowledge (Hernández-Gutiérrez, Pacheco and Lizarde, 2022).

Theoretical framework

Didactic planning

(Ander-Egg, 1993) mentions that the raison d'être of planning is to achieve an objective, which is acquired through the implementation of actions and the use of organized and coherent means. The aim is to make things happen and not simply to leave it as a wish or for other factors to make it possible (Monroy-Farías, 2009).

The latter author points out that didactic planning is a task of the teacher. It favors the development of students, meeting the expectations of the institutions, of the people, as well as enriching teacher training through the implementation of actions (the strengthening of practice is obtained by evaluating the actions, which allows seeking better alternatives to meet the goal).

Planning requires the implementation of the teacher's knowledge. He/she must have mastery of the mathematical content, didactic mastery of the content (Hernández-Gutiérrez, Pacheco and Lizarde, 2022) and a professional attitude that allow them to design them effectively. The expectation is to favor significant learning of students, that the contents are adequate, learning environments are generated, students progress in their learning, the strategies are adequate and provide sufficient and coherent resources, activities are organized in a pertinent manner and there is a formative evaluation of whether the objectives were met.

Didactic sequences and situations

Díaz-Barriga (2013) mentions that designing learning situations in a didactic sequence (organization of activities) is an important task of the teacher. The author provides a guide with the main elements that should be considered: subject, topic, content, duration and number of sessions, intentionality (objectives), whether the choice of a project, case or problem is desired, guidelines for evaluation (what and how to evaluate), the didactic sequence (beginning, development and closing, responding to content, reality, context and resources), the evidence of learning and the resources to be used.

The structure of the didactic sequence is obtained by having interrelated activities. To begin with, we start by choosing the content and its intention. Then, the design of the activities implies being aware of the goal to be achieved, how it will be evaluated, the achievements and which activities will favor it, so that the sequence of activities and evaluation (diagnostic, formative and summative) are carried out at the same time.

It is important to mention that at the moment of implementing the sequence, obstacles are also detected, as well as factors that favor learning, which would lead to readjustments in the sequence to meet the goal. Then, to obtain the structure of the sequence, the activities and the evaluation are integrated at the same time.

Another proposal with greater specificity and relation to the interaction of the didactic triangle mentioned by Brousseau (2007): Student-content-teacher; is the proposal developed at the Escuela Normal Rural "Gral. Matías Ramos Santos" de San Marcos, Loreto, Zacatecas, Mexico, in which elements of the MTSK (Specialized Knowledge of the Mathematics Teacher) (Carrillo, et al., 2017) and the TSD (Theory of Didactic Situations) are related (Brousseau, 2007), cited in (Hernández-Gutiérrez, Pacheco and Lizarde, 2022).

In said study conducted in the normal school, a didactic planning device design is proposed, which in its sections contemplates:

- Epistemological analysis of the subject, Knowledge of the mathematical subject. Definitions, properties, fundamentals, mathematical applications are written about the content to be worked on in the session and that its use is explicitly suggested with the concrete explanation of the teacher in the phase of institutionalization.

- Knowledge package (Ma, 2010), Knowledge of the structure of mathematics. It is contemplated considering connections of complexification, simplification, transversal or auxiliary, the path of the content to be addressed, this aspect allows to concretely locate the heterogeneity of the students' learning processes, to be able to use didactic variables for more advanced children or with areas of opportunity in the mathematical content that will be worked on, even, it allows a greater knowledge of a horizontal, longitudinal and transversal vision of mathematical contents.

- Knowledge of mathematical practice.

- Planning aspect that is drafted in this section and its execution is observed in several of the parts of the device (Phases of action, formulation, validation, etc.). Ways of proceeding to solve the problem, validation, demonstration, language, specific practices of mathematics are contemplated.

- Curricular framework, Knowledge of the. Mathematics Learning Standards. Those elements are taken into account that for planning, show learning expectations, level of development, sequencing of contents; some aspects that are considered: Thematic axis, Mathematical theme, content, expected learning, mathematical standards, competencies, didactic intention, for example.

- Knowledge of mathematics teaching: Although the MTSK does not make a direct relationship with the TSD, in the study of (Hernández-Gutiérrez, Pacheco and Lizarde, 2022) this possibility of relationship between the theories is justified, confirmed and studied. In such a way that a specific teaching theory that is considered pertinent for the realization of this device to build a lesson plan in the teaching of mathematics, is the TSD. Some aspects taken into account are: The didactic material, ICTs that could be used, strategies, techniques, examples, counterexamples, didactic strategies, learning environments, situated cognition, etc.

- A priori analysis, Knowledge of the Learning Characteristics of Mathematics. Concrete diagnosis of the group around the content to be addressed in the session: strengths, difficulties, ways of interacting with the mathematical content.

- Preparation of the medium. As its name indicates, these are initial activities to prepare and organize the didactic situation that will be developed such as: Questions to visualize the didactic memory, previous knowledge about the
- content, organization and logistics of the group and space around the didactic situation.

- Action phase. The slogan of the activity with the rules, instructions, organization, possible restrictions. In this part we can also observe: the a-didactic situation (autonomy in solving the problem posed based on the knowledge that the student has) returns of the slogan, use of possible didactic variables considering the diagnosis of the students.

- Formulation phase. Activities in which the teacher visualizes the oral or written dissertation to be made by the students to formulate the procedures used to solve the problematic situation posed.

- Validation phase: This section is related to the mathematical practices. In this phase the students, with the guidance and intentional management of the teacher, validate the procedures used to solve the problem, it is a space for analysis and discussion of the procedures used, that is, the procedures are validated as a group and this allows the construction of mathematical knowledge.

- Institutionalization Phase. This section is related to the epistemological analysis section, in this one the teacher, from the assessment of the learning process, in the different moments of the didactic situation, institutionalizes the valid mathematical knowledge, pertinent and recognized by the mathematical community.

- Evaluation. This is the space where the instruments (rubrics, checklist, products, etc.) that will allow evaluating the knowledge, skills and attitudes of the planned mathematical content, both from a formative and summative evaluation perspective, are placed.

The Theory of Didactic Situations (TSD)

In addition to what has already been mentioned in previous paragraphs regarding the TSD, Brousseau's (2007) Theory of Didactic Situations is a scientific instrument that aims to improve the teaching and learning of mathematics. It assumes that the learner learns by adapting to an environment that presents contradictions, difficulties and imbalances.

The theory allows understanding the interactions between the teacher, the student and mathematical knowledge for the construction of learning, in which the students themselves reveal the characteristics of the situations they face.

According to the author, the "didactic situation" is the medium in which the subject interacts to acquire knowledge, which is designed and manipulated by the teacher, where the student takes into account the resources (previous knowledge) he/she has to achieve them and "the medium", the circumstances in which the subject is immersed.

Methodology

The methodology of this research is case study (Stake, 1999), defined as "the study of the particularity and complexity of a singular case, in order to understand its activity in important circumstances" (p. 11).

The same author mentions three types of case studies: intrinsic, instrumental and collective case study. For this research article, an instrumental case study is taken up again; this type of case study is carried out in response to the need for a general understanding, which is possible with the study of a particular case.

By means of this methodology applied in the research, it is possible to know the strategies that the teachers of the normal school propose to their students, students in teacher training, for the appropriation of the design of efficient mathematics planning. All this will lead us to have a general understanding of the implications that lesson plans have on the teaching work, consequently, on the learning acquired by elementary school students in the subject of mathematics.

Research Assumption

Based on the above, the following research assumption can be contemplated:

It is considered that the strategies used by the teacher trainers of the Escuela Normal Rural "Gral. Matías Ramos Santos" de San Marcos, Loreto, Zacatecas in the second semester students of the degree in Elementary Education favor the appropriation of the didactic devices of mathematics in the topic of fractions, besides improving the didactics they implement in elementary schools from the strategies they develop in their sessions.

Research design

To understand the way in which teachers guide their students in the appropriation of didactic planning in mathematics in the topic of fractions, an interview was applied to the teacher of the mathematics course, in which questions are asked in which the teacher reveals strategies used to develop in students the competence of planning based on pertinent didactic devices for the teaching of mathematics.

From the course on planning and evaluation for learning, a diary of two class sessions was obtained where elements that are considered in the planning are discussed, data that were recovered by the students from their regular teachers when attending the observation visit.

From the products obtained (diaries, letter, students' products, planning) we will analyze the strategies implemented by the teachers, the importance they give to planning and the elements they take into account for its design.

Results

The importance of planning in teacher education

In the course for the training of Primary Education graduates "Planning and evaluation of teaching and learning" activities were carried out with the purpose of having students design planning with theoretical-methodological foundations as mentioned in the course syllabus: Its purpose is that teachers in training build solid frames of reference to sustain didactic interventions appropriating theoretical-methodological foundations regarding planning and evaluation (SEP, 2018b).

One of the activities "Planning, interview analysis" consisted of designing and applying an interview on aspects of planning and evaluation (importance, process and elements of these). It was applied to students from the institution's major academies (2nd, 3rdand 4th grades) and practicing teachers. After each student elaborated and applied his or her interview script, the answers obtained by teams of five members were analyzed by means of a table. The analysis considered questions, the number of responses that yielded similar data, the responses themselves, and some added their personal conclusions.

4. Do you think planning is important?	2 questions with similar answers	Yes, because it is the main basis for the class to flow as we expect, it is the way to organize what we want to achieve with the students and how we are going to achieve it. Yes, since it helps me not to improvise what I want the students to learn.	Planning is undoubtedly one of the most important stages in the educational process. This is the first step to achieve complete and effective learning. With good planning, the results are much more predictable and therefore it is a good omen or, there is a greater possibility of achieving a satisfactory evaluation.

Figure 1 Importance of planning. Analysis of interviews
Source: Own elaboration

The previous activity corresponds to one of the suggestions provided by the course. Apply to basic education teachers an interview in which they recover the procedure they follow to plan and evaluate, the factors or elements they consider, as well as their importance (SEP, 2018b). In the one implemented by the teacher, the teacher also takes into account students in higher grades higher grades who surely observe a broader knowledge.

The work is addressed in one of the modalities in which the course mentions: collaborative learning. "Students work in small groups in order to maximize their opportunities to intervene in addressing a learning content; thereby intensifying the personal experience of learning" (SEP, 2018b, p. 11). After individually retrieving the conceptions of peers and teachers, the opportunity is offered to strengthen their perceptions by contrasting both the correspondences and the new information obtained by their other peers.

The students concluded that planning is one of the main tasks of the teaching function, given that it favors learning in students to a greater extent.

In the products, they state that planning is fundamental in the teacher's work, which implies designing learning strategies, organizing activities to achieve an objective and avoiding improvisation, which requires considering several aspects. It is mentioned that the aim is to comply with what is stated in the Plan and programs of study (approaches, competencies, expected learning) and to consider materials and resources that allow it, time, The students' previous knowledge, the context in which they develop, their motivations, interests and evaluation strategies to assess the learning they obtain.

It is necessary to take into account what is stated in the study programs, since these contain the graduate profiles of the subject that will be formed with the education we provide. These offer the approaches of the subjects, competencies to be favored, the expected learning to be acquired, so they guide the teaching practice, "they constitute the guiding axes of planning" (SEP, 2011, p. 9) that, although some of them are presented in a broad sense (profile of graduation), all of them are presented in the same way (profile of graduation). (graduate profile), everything is the basis for obtaining effective lesson plans.

In the programs of study, the goals to be achieved are presented. The competencies for life and the traits of the profile of graduation (what they will consolidate throughout basic education). The competencies of the subjects refer to the skills, knowledge, attitudes and values that will be acquired in each of the subjects taught "implies knowing how to do (skills) with knowing (knowledge), as well as the valuation of the consequences of that doing (values and attitudes)" (SEP, 2011, p. 29).

The curricular standards on which external evaluations are based to assess student learning "referents for the design of instruments that externally evaluate students" (SEP, 2011, p. 42). The organization of learning (axes, areas, topics, contents), the expected learning that indicates the achievement indicators of what students should acquire (knowing, knowing how to do and knowing how to be), and the learning contents, aspects of the expected learning that "indicate in a specific way the learning that students should achieve" (SEP, 2011, p. 11).

All of the above are mentioned as necessary for the design of the plans in the interviews they applied. Undoubtedly, they all respond to the intentionality or objective that we expect, such aspects allow us to address the question "what do we want to achieve? as can be seen, this guides the teacher to immediately establish the learning situation, an element that will allow the significance of the lesson plan, all of this responds to the question "how to obtain the objective? which leads to consider the material and technological resources that will be used (books, cubes, maps, movies), the context (interests, motivations, culture) and their previous knowledge to provide a situated and meaningful learning, since relationships are established with the knowledge that students already have and with the environment in which they live. Another of the elements mentioned in the students' products is the evaluation, which allows to see the progress of the students, which implies, as mentioned by (Monroy-Farias), that the teacher asks himself what, how and when to evaluate, the strategies to be implemented and/or products to be considered, which will help to improve the students' learning and the trainer's practice.

In another of the activities implemented by the teacher, "My ideas, from teachers and authors about planning", they review bibliography both from the course and from other sources to build a frame of reference for planning and evaluation, a suggestion of the course (SEP, 2018b). In a table they capture their own ideas they have about planning and evaluation (importance, elements, process), once they have acquired the information from the members of the other academies and teachers, they also integrate the opinions of their head teachers (teachers in charge of the group they attend in their observation days), and theoretical referents provided by the trainer teacher, in addition they ask the students to look for more on their on their own. This allows them to base the answers of their classmates and teachers, give them meaning and accept them in order to put them into practice when designing lesson plans.

In their opinions, from teachers and theory, they recover aspects that have already been mentioned, although new ones emerge. One student recalls the following:

Planning and evaluation		
Planning		
Previous ideas about planning	Definition of the teacher	What the theory tells us
Organization of the contents to see during the class. Taking into account times, days, space and number of students.	Head teacher. What I define as the preparation of our pedagogical work, several elements are taken into account, such as: expected learning, strategies, learning environments, as well as the characteristics of both the student, as well as their social and family context. teacher 2. Planning is the way to organize a teaching process.	Didactic planning constitutes a proactive activity in which the teacher expresses his mastery and perspectives regarding the curriculum: he considers his goals, approaches, thematic contents, times, resources, and confronts these elements against the potentialities and forms of learning of his students and the particularities of the social and cultural context in which they are registered.

Figure 2 Importance of planning. Theoretical reference
Source: Own elaboration

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He states that planning is the organization of the teaching process in which the curricular elements of the curricula (goals, approaches, contents, resources) are related to the characteristics of the students (context, interests, motivations), so the teacher must know and master both what the plans and programs propose and his students. (Monroy-Farías, 2009) points out that the teacher must have disciplinary, pedagogical and attitudinal mastery that allows designing the planning effectively in order to favor the development of the students. As mentioned, it is necessary for the activities to be coherent, focused on the curricular elements of the study plans, to understand the content to be taught and the way in which the teaching-learning process is carried out, so that it is not only perceived as a permanent activity of the teacher, or an administrative requirement in which actions are simply organized in a document or format "what matters is that the activities to be performed, the resources and strategies to carry them out, are consistent with the approaches of the subjects, as well as the development of competencies in students" (SEP, 2011, p. 13). 13).

In the class diary of the teacher trainer "How teachers plan", it is mentioned that planning is not always carried out as planned. The diary consists of two sessions in which the manner, procedures and elements considered by the teachers of normalistas, recovered in a text obtained by attending an observation visit to the elementary school, are discussed. Activity posed by the study program with the purpose of completing the answers of the interviews they applied and contrasted in the tables. To perform their text involved observation, as well as analysis of lesson plans and children's products (SEP, 2018b).

The following line is shared in the teacher trainer's class: "Purposes coincide. Planning does not always go as planned...it should" (Classroom journal).

The previous record coincides with what the Study Plan states, it mentions that putting planning into practice does not ensure that it will happen the way it is designed because there are situations that cannot be predicted, however, it allows acting in a critical and effective way to achieve the objective:

Planning should be understood as a roadmap that makes the teacher aware of the learning objectives he/she is looking for in each session. learning objectives sought in each session and, even if the classroom situation takes a relatively different course from the one planned, knowing clearly what the specific the classroom situation may take a relatively different course than planned, knowing clearly what the specific objectives of the session are will help the teacher session will help the teacher to lead the students' learning process. (SEP, 2017, p. 121)

The Theory of Didactic Situations in the training of future teachers.

At the Escuela Normal Rural "Gral. Matías Ramos Santos", the Theory of Didactic Situations (TSD) is favored as a basis for the teaching-learning process of mathematics. One of the teacher trainers commented the following:

I had the opportunity to approach the concepts of the Theory of Didactic Situations (hereinafter TSD) that from the beginning seemed interesting to me, what is more, I was enthusiastic about them. I have no doubt that they work in the classroom and are relevant to better understand what children learn or could learn. (Interview with teacher trainer).

Likewise, the Educational Model of the Escuela Normal Rural mentions:

Is it not time to choose the didactics of mathematics as the axis of the initial and continuous training of elementary school teachers? The case of teacher training colleges is different, since the content of mathematics teaching courses is implicitly oriented from this perspective (Hernández-Gutiérrez, et al., 2021, p. 27).

However, TSD "provides a better understanding of the possibilities for improvement and regulation of mathematics teaching" (Brousseau, 2007, p. 12). It seeks to enhance teachers' teaching and learners' learning by understanding the interactions between the learner, teacher and content (performances of the former and how the latter is transformed).

Teacher educators teach the contents of mathematics courses based on TSD and encourage their students to take the same perspective to elementary schools, although in the Arithmetic course syllabus of the normal school, as well as the elementary school curriculum corresponding to the subject of mathematics do not specify that it refers to it, however, both the course guidelines to address the contents of fractions and the approach to the subject in elementary schools make reference to it.

In the syllabus of Arithmetic. Decimal numbers and fractions suggests the teacher to develop activities from the approach of a problem making use of materials and resources, the students will have to solve it with their own means, then proposes to share the way they did it and end the class with the participation of the teacher providing "explanations of greater depth where it is clear to the students the rationale and the meaning of the mathematical content" (SEP, 2018c, p. 11). This in order for them to obtain "a deep knowledge of mathematics" (SEP, 2018c, p. 6) which will imply knowing what to teach (content) and how to teach it (Didactification).

The above will give the possibility to teachers in training to design strategies based on what the curriculum poses. The approach to mathematics consists of "using sequences of problem situations that awaken students' interest and invite them to reflect, to find different ways to solve problems and to formulate arguments that validate the results" (SEP, 2011, p. 65). Both work strategies (way of approaching the content of teachers in training, as well as primary school students) may involve the same methodology. It refers to working autonomously, in this way different procedures will emerge to solve the situation, then be checked by themselves and finally account for the formal knowledge by the teacher.

Broadly speaking, the approach of the subject proposes to design interesting and problematic situations for students, to solve them autonomously with the use of previous knowledge, as well as to communicate mathematical information, validate procedures and handle techniques efficiently.

The TSD favors the understanding of the way in which the teacher and the student should intervene with the content in order to acquire learning in response to the approach.

TSD presents the phases of action, formulation, validation and institutionalization. The first involves responding to the situation in a personal way without the teacher's help in relation to the knowledge at stake (a-didactic situation). The second is to formulate a message for a student or group of students to be able to solve it. The third is to validate or reject proposals (successes) for this situation. Finally, institutionalization, when the teacher makes known the knowledge that was put into play, the official part of the content. Each of the phases contributes to what is expected to be developed in the students, construction of their own learning, finding a variety of strategies, communicating and validating their own actions as well as those of their classmates.

For the students in training to understand what each of the phases implies, to develop them effectively, the teacher trainer suggests that in order to appropriate the TSD they first build spontaneous analyses of what they observe in classes of classmates or other teachers. They identify what happens in class (indiscipline, distraction, disinterest, learning achievement, good attitude...) which then leads to recognize why it happens, the didactic phenomena, at which point they acquire the need to address them since they happen for a reason. In the following lines the teacher trainer mentions:

The use of concepts has made it possible to overcome spontaneous visions ("now the children were more eager to work", "this problem was easily understood by the children", "the teaching strategies now worked for me", etc.), so that the students begin to identify that classroom events have a "logic" that needs to be discovered and that very few things happen by chance. teaching strategies now worked for me", etc.), so that the students begin to identify that classroom events have a "logic" that must be discovered and that very few things happen by chance or by chance. (Interview with teacher trainer).

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After the spontaneous analyses, the concepts of the theory are reviewed in view of the need to know them in order to allow, to a greater extent, the development of the students in the primary schools. school students. In addition, we interpret records or videos, our own or not, and design lesson plans where they are present.

Once the limits of spontaneous analysis have been defined, it is a matter of interpreting the classroom records or videos (their own or those of others) and designing lesson plans where they are present. class videos (their own or others'), as well as the design of didactic sequences (Once the limits of the spontaneous analysis have been delimited, it is a matter of interpreting the records or class videos (our own or others), as well as the design of didactic sequences ("class plans") from a didactic point of view and trying to construct arguments based on what allows us to observe concepts such as didactic contract, return, didactic variable, didactic moments, knowledge, errors (semantic or syntactic), didactic memory, ... And here the panorama widens to include the Theory of Didactic Situations and other theories. (Interview with the teacher-trainer).

In planning or class sessions, they analyze the didactic phenomena that are presented, how they begin to approach the topic, its development and closure, they recognize the characteristics that are considered and which of them belong to the concepts proposed by the TSD. This will lead them to design their own planning in which the strategies they design are justified by this theory. But the acquisition of concepts does not end with the design of lesson plans; they are put into practice.

Applying the lesson plans favors understanding the concepts they study, as mentioned in the Educational Model of the teacher training college according to Astolfi (2008) cited by (Hernández- Gutiérrez, et al., 2021) "it is too often repeated that future teachers do not "see" what is proposed to them during a training process, due to a weak relationship with practices" (p. 32). Often, not making sense of what is taught in schools leads to not applying it, to forgetting it, to downplaying its importance.

As opposed to verifying that such things happen for a reason, this leads to recognizing it and considering it in the teaching work in order to comply with it (favoring the development of students).

The teacher, in view of the way of working that he follows so that his students appropriate the concepts that the theory handles, mentions that, just as it is not appropriate in school contents, such as fractions, to start from symbolic representations, which leads to not understanding their meanings, neither should one begin by approaching the concepts of the theory, but rather recover their spontaneous analyses that would correspond, in the work with fractions, to the informal strategies they use to solve the situation, to later institutionalize the knowledge of which they make use.

An analogy is pertinent here: just as it is not convenient to start from the symbolic representation of the fraction (to institutionalize this representation prematurely), it is also not convenient to propose the concepts of TSD from the beginning, but to allow the "spontaneous analyses" to appear (which would be the equivalent of informal strategies in solving a problem) and then review the concepts (Interview with the teacher trainer). (Interview with the teacher trainer).

It could be said that teachers teach TSD concepts based on the methodology proposed by the TSD. For their appropriation, the previous knowledge of the students is considered, to know why these events arise and how the teacher should guide his students, to favor justifications and arguments, in order to finally review the concepts. Likewise, they are reinforced, but looking for the students to give meaning to each one of them, so they review didactic plans as well as design their own lesson plans in which they will have to justify why each one of their moments will be developed in that way and; finally their implementation, which as mentioned by the teachers, allows them to a greater extent to appropriate them, to value their interventions and the children as important factors in the learning that they manage to acquire, both themselves and of course the student.

In their planning, the students add phases: action, formulation, validation and institutionalization, typical of the Theory of Didactic Situations. In a first moment and as an example of what has been analyzed, they present the action phase and write the slogan to enter it. In the draft that one of the students in initial training made, she states the following: Children take out your math book on page 145 and in teams of 3 solve the problems. In response to this, the teacher trainer makes the following comment:

But, what is your slogan? Here the teacher is supposed to explain the situation and what the children are expected to do, the problem is posed, the unknown question is stated, etc. Then, the return of the task is established or what the teacher will do in case he/she is asked about the procedure to solve the problem is written. (Suggestions made by the teacher trainer in the lesson plans submitted by a student).

In the evidence, the teacher trainer suggests completing the instructions, mentioning to the students the situation they are going to solve, the problem, its unknown, its return and the way in which the teacher will act if the students ask him/her how to solve it. The slogan must consider the rules of the game; conditions to solve it and that these are understood by the students, it must also be a problem; which implies that it cannot be solved with the previous knowledge they have but that these are useful to achieve it, and allow the students to decide which strategies they will follow to answer it. After this, "to make a triple return: of the rule of the game, of the problem and of the decision" (Centeno, 1997, p. 116) to make the students responsible for carrying it out on their own, personally choosing the procedures to follow, making use of their previous knowledge without the participation of the teacher in terms of the knowledge to be put into play, so it does not imply dissociating themselves from the activity. This will be the moment when the students accept the learning situation. The didactic contract is established, they are clear about their acquired obligations, what the teacher expects from them (Brousseau, 2007).

When they accept the slogan, they will begin to solve the problems. 3 problems. According to the book for the sixth grade teacher (SEP, 2014) the challenge they chose corresponds to the content of solving problems involving a division of a fractional or decimal number by a natural number, with the didactic intention that students find a procedure to divide a fraction by a natural number, when the numerator of the fraction is a multiple of the natural number and notice that it is enough to divide the numerator by the divisor. One of the problems (number 3) is the following: In the hardware store La Tía Adriana, they emptied 6/7 of a can of paint in 3 equal containers, the same amount to each one. What part of the paint was emptied in each container? This problem, besides posing a situation of the real context of the students, allows to fulfill the didactic intention (the natural number is a multiple of the numerator of the fraction and implies a division).

When starting to solve the problems, the students will enter the action phase. They will act in the environment (situation that is presented to them) autonomously for something that will lead them to make decisions without being aware of them and these will provide them with information to guide their next actions (Brousseau, 2007). Students will read the problems and solve them based on their previous knowledge, where it may happen that at some point the strategy does not work for another problem and they will have to modify their actions, realizing that what they did in the previous problem must also be modified (Brousseau, 2007).

In the previous problem must also be modified. For example, in this challenge, according to the previous considerations offered to the teacher, a strategy of the students may be (in the first problem) that they believe that the solution is to divide both the numerator and the denominator by the divisor (4/6 by 2) but when moving on to the next ones that strategy will not be useful since dividing the denominator by the divisor gives a decimal number.

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During the situation, questions arise from the children to the teachers to tell them what they have to do where many times they are given the answer, however, it is what the teacher mentions: "write what the teacher will do in case he is asked how to solve the problem" that is why the teacher's intervention is important, he must give feedback to the students which implies not indicating how to solve it and these "are developed during the whole didactic situation and not only in the establishment phase" (Panizza, 2003). As mentioned, it is important that the teacher takes into account the possible doubts, strategies, complications that may arise in the students in order to know how to deal with them so that they themselves build their learning.

Conclusions

One of the purposes of the case was to answer:

In what way the orientation of the teachers of the Escuela Normal Rural "Gral. Matías Ramos Santos" of San Marcos, Loreto Zacatecas allows the second semester students of the degree in Elementary Education to appropriate the didactic planning of mathematics in the topic of fractions, in addition to improving their teaching strategies in elementary school?

Before it, it was found the implementation of various activities by the teacher trainers that do allow observing that the strategies designed have a significant impact on the training of teachers in initial training, which allows confirming an important influence from the design of teaching tasks, towards teachers in training.

It was found that, for the design of the learning situation in the mathematics lesson plans, they are based on the Theory of Didactic Situations. It consists of the students themselves constructing the learning by interacting with a medium (material or symbolic) without the teacher's intervention in terms of the knowledge they must bring into play.

Knowledge that they must put into play. In order to enter the learning situation they will make use of their previous knowledge and the teacher establishes the didactic contract to make the student responsible for solving the situation with his or her own means. The situations in which they will be immersed are action, formulation, validation and institutionalization. The first involves the student acting in the environment to provide a solution by making his or her own decisions. In the second, formulating a message to another subject or subjects in such a way as to enable them to act efficiently in the situation. The third is to provide an affirmation on how to act in the environment and for this to be validated or rejected by his or her peers. The previous ones are developed without the direct intervention of the teacher. The teacher participates by giving feedback on what is manifested during the development of these activities (doubts, strategies, mistakes), without providing the actions to be carried out, but rather the students themselves discover them. Institutionalization requires the teacher's intervention to account for the formal knowledge that was addressed, as well as to establish relationships with what happened during the class.

To appropriate this theory, they go to observe classes in elementary schools. They analyze what happens, which leads them to the need to plan a class and enter the concepts of TSD in order to favor the learning, knowledge, skills and values set forth in the Plan and programs of study. To reinforce this, they review, design, argue and implement lesson plans.

Regarding the acquisition of knowledge of fractions, they acquire it according to the TSD, making use of previous knowledge, providing solutions with their own means, arguing and validating the strategies they implement, and giving the status of the knowledge that was addressed by the teacher who trains them.

Regarding the appropriation of the contents of fractions, students acquire them by solving the situations posed by the teacher trainer autonomously, share, argue and validate their strategies to finally reach the formal knowledge provided by their teacher.

Regarding the appropriation of the lesson plans, as mentioned in the previous paragraphs, the teachers of the normal implement strategies that allow their students to value the didactic planning, recognize the elements that must be considered and design them in a conventional way, in such a way that they manage to to enhance learning in elementary school students. However, the students have areas of opportunity, for example, the way in which they design the moments of the TSD. It is worth mentioning that they are in the initial stage of their training, they have their first approaches both in the design of planning and in its implementation.

Finally, as mentioned above, the study recovered the way in which teacher educators guide their students in the didactic planning of mathematics, which opens the way for future researchers interested in the subject to continue in this line. Among some aspects would be to consider the way in which students in the first grade of the bachelor's degree and how they consolidate it at the end of their training, or the way in which they plan in each of the grades (1st, 2nd, 3° and 4°), the different teaching tasks and their transcendence throughout the undergraduate education, as well as to check the effectiveness of the development of the TSD against or in complement with another methodology such as the MTSK (Hernández-Gutiérrez, Pacheco and Lizarde, 2022).

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Gamification in the field of initial music education. An innovative teaching-learning strategy

La ludificación en el ámbito de la educación musical inicial. Una estrategia de enseñanza-aprendizaje innovadora

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Abstract

This paper presents an alternative way of approaching music education for kids in initial education using gamification as a strategy. Gamification is an educational tool of relatively recent creation, which is based on game theory in the computer field, but in recently days it has been easily adaptable to the classroom and especially in early childhood musical education. This research aims to identify the constituent elements of a gamification based on Marczewski's proposal, to later devise a gamification plan in the field of initial music education. To achieve this objective, an analysis of the main constituent elements of gamification is carried out, with the purpose of structuring them in a way that allows the creation of educational planning with didactic sequences based on the project method, being quite innovative in the musical educational field.

Intrinsic motivation, Gamification, Musical education

Resumen

Este artículo presenta una forma alternativa de abordar la educación musical para niños en educación inicial utilizando la Ludificación como estrategia. La ludificación es una herramienta educativa de creación relativamente reciente, que se basa en la teoría de juegos en el ámbito informático, pero que en los últimos tiempos se ha ido adaptando fácilmente al aula y especialmente a la educación musical infantil. Esta investigación pretende identificar los elementos constitutivos de una ludificación a partir de la propuesta de Marczewski, para posteriormente idear un plan de ludificación en el ámbito de la educación musical inicial. Para lograr dicho objetivo se realiza un análisis de los principales elementos constitutivos de la ludificación, con la finalidad estructurarlos de forma que permitan la creación de planeaciones educativas con secuencias didácticas con basadas en el método de proyectos, siendo bastante innovadora en el ámbito educativo musical.

Motivación intrínseca, Ludificación, Educación musical

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Introduction

One of the keys to teaching is to understand the way people learn in order to adapt education to them and thus develop meaningful learning. Among the many strategies employed, we find gamification, which has been developing in the last decade with the desire to be more relevant, in response to the criticisms that arose at the time of this technique due to its marketing origin. However, it is structured in such a way that it allows to generate favorable environments with appropriate stimuli in a regulated space, on the other hand, intrinsic motivation is especially encouraged, without underestimating other types of motivations or intentions when designing a gamification.

One of the benefits of this strategy is its use in the field of music education, since it becomes quite relevant to attend to music learners in the initial stages, especially during the first phases of school education, whether in preschool or elementary school.

In this sense, a gamification program is presented at the end with an example so that its use can be appreciated, giving teachers the possibility of creative development towards new forms of interaction with students.

Justification

Approximately in 2010 began a wave to use the game as an educational strategy in contexts that are not commonly to be played which is called gamification; this proposal arises with the definite purpose of increasing participation and take advantage of the motivation of users to perform activities that allow some change in the participants; in a way the intention is that the work or activities have some proportion of fun channeled (Chitroda, 2015).

However, the observation of the game as an educational element is not new, although it has accompanied us throughout history; the study to identify the first contributions on the importance of the game in the educational field we owe to psychology, and it is that, from the second half of the nineteenth century the first theories on the game are identified.

Spencer (1855), for example, considered it as the result of an excess of accumulated energy, by allowing it to "spend" surplus energy; on the other hand, Lazarus (1883), argued that play is the result of an excess of accumulated energy, by allowing it to "spend" surplus energy.

(1883), argued that individuals tend to perform difficult and laborious activities that produce fatigue, from which they rest by performing other activities such as play, which allows and produces certain relaxation. Already by 1904 Hall manifests in his theory the link between play and human cultural evolution, while Freud sees it as part of the satisfaction of instinctive impulses (erotic or aggressive), with the need for expression and communication of their life experiences and the emotions that accompany these experiences. Piaget, from 1932 to 1966, emphasized on multiple occasions, either theoretically or in clinical observations, the importance of play in developmental processes; he also based his research on moral development within games. Similarly, Vygotsky, at the beginning of the 20th century, pointed out that play allows the development of conceptual behavior guided by ideas, where the imaginary situation alters the child's behavior, defining himself through his actions (Chamorro López, 2010).

The interesting thing about gamification is that it arises as a consequence of the use of computer technology, being Richard Bartle from the University of Essexx who, in 1978, started with multiplayer experiences through the MUDI program that used Telnet. For 1980, Thomas W. Malone, professor at MIT, works on how children can learn by playing and includes elements of Intrinsic Motivation. It was not until 2004 that Games for Change was created, as a platform for different games that helped people understand the complexities of social conflict and, in turn, aims to drive social change and humanitarianism within their communities. But the term gamification itself was used until 2003 thanks to Nick Pelling, a British programmer and inventor, to achieve a great takeoff in early 2010 when Jesse Schell and Jane McGonigal, who viralized the concept of gamification, made people start thinking about its use for various aspects of life.

Although its approach arises as an element of technology and remains its main key, it has generated strategies that allow its structured development in the educational environment beyond the virtual environment, allowing new ways to harness the power of educational technology maximizing the progress of educational objectives and achieving learning success (Chitroda, 2015).

A more current definition of gamification is provided by Kevin Werbach (2014) who defines it as: "'The process of making activities more game-like' focuses on the crucial space between the components that make up games and the holistic experience of gamefulness." ["'The process of making activities more game-like' focuses on the crucial space between the components that make up games and the holistic experience of gamefulness" (p. 266)."] (p. 266). It is necessary to point out that, in accordance with this definition, gamification will be approached as a trigger of an educational intentionality, exploring it as a strategy within a game-based learning proposal. That is, to take advantage of its possibility of being used outside the classroom, however, not forgetting that it is possible to consider it as a playful tool in which games have the possibility of rewarding the players themselves with their own satisfaction and pleasure of being in the game, taking for this purpose the RAMP theory of motivation, by Andrzej Marcewski: Relationship, Autonomy, Mastery and Proposal; and the 8 Kinds of Fun, by Marc Leblanc: Physical Sensation, Community, Fantasy, Discovery, Narrative, Expression, Challenge and Submission. (Net- Learning, 2015; Toledo Inclán, 2020).

Although, some authors at the time considered gamification outside of game-based learning, due to its utilitarian function in the marketing area and the business world, exposing various criticisms mainly by being an element of consumption promotion, it is true that the development has also been addressed outside of that commercial field, and even as structuring strategies for the creation of games that do not necessarily make use of technology, but of the design of the gamification process (Bagost, 2011; Robertson, 2010).

In any case, these first analyses require consideration, especially if the aim is to promote a critical educational scheme, with the strategic possibility of creating game proposals focused on the development of educational processes. It is also imperative to highlight that even Marczewski is considered at the time responsible for prejudices regarding gamification by focusing on "behavioral changes" or "human-centered design" from marketing (2018, p. 13).

As a consequence of this innovative approach, strategies were outlined in the educational field during the last decade, being that in 2022 researchers Lampropoulos, Keramopoulos, Diamantaras, and Evangelidis from the International Hellenic University, conducted an analysis of 670 articles from 5 databases (Scopus, Web of Science, Google Scholar, IEEE, and ERIC) on gamification in education; In these articles it was observed that in general there were positive behavioral, attitudinal and psychological changes on the part of students and greater commitment, motivation, active participation, knowledge acquisition, focus, curiosity, interest, enjoyment, academic performance and learning outcomes, and teachers also evaluated its implementation positively. (Lampropoulos, Keramopoulos, Diamantaras, & Evangelidis, 2022)

It is necessary to reiterate that gamification is a strategy that allows the use of play in activities that are not commonly thought of as games, hence its importance as a strategy that generates pedagogical games. Lawley, professor of games and interactive media at Rochester Institute of Technology (RIT), notes that, when properly implemented in an educational manner, "Gamification can help enrich educational experiences in a way that students will recognize and respond to." [Gamification can help enrich educational experiences in a way that students will recognize and become responsive to] (Deterding, 2012).

Within the literature on education-focused games, it can be observed that they are most successful when they have elements such as: freedom to err, quick feedback, some progression, and an accompanying comic book (Stott & Neustaedter, 2013). In recent years, it has been included as one of the most important focuses for the gamification process to work with the motivation that game participants have, understanding that it is operating in two different ways, as intrinsic motivation and as extrinsic motivation.

Intrinsic motivation is the natural tendency to seek and overcome challenges as personal interests are pursued and skills are exercised, it is thanks to it that no incentives (or punishments) are required because the activity is rewarding in itself, and thanks to the interest in this motivation is that in the current gamification less interest has been given to the point system, because it served the extrinsic motivation, which arises to obtain something external, points, grades, etc.. The essence of those types of motivation is the locus of control of the cause (the location of the cause), whether internal or external (Woolfolk, 2014).

Problem statement

One of the most important interests in addressing the issues of education, is to understand how people learn, education is therefore a tool for the acquisition of knowledge that over the years has tried to understand and seek strategies that are consistent with the characteristics of human beings. In this interest in understanding the significance of knowledge, we find in the works of Ausubel who, from the cognitivist psychology, approach the description of the principles that converge with the idea of organization and formation of the human mind, and how these reach different states of consciousness.

The perception of the underlying cognitive processes is achieved with a learning that is internalized by transforming the mental structures of the student, therefore, the main objective of his theory was to present how human beings learn, and consequently, Ausubel points out that meaningful learning requires both a significant learning attitude and the presentation of potentially significant material; two basic conditions derive from the latter: firstly, that the material is related in a plausible, reasonable and non-random way to an appropriate and relevant cognitive structure and, secondly, that the cognitive structure of the learner contains anchoring ideas with the new material (Ausubel, 2002).

Although the cognitive structure of each person is unique and therefore the meanings are also unique, it is important to point out that, within this uniqueness, Ausubel (1983) identifies three main types of learning, which are:

1) Representational learning. - This allows the assignment of meaning to certain symbols (usually words) and "occurs when arbitrary symbols are equated in meaning with their referents (objects, events, concepts) and mean to the learner whatever meaning their referents allude to" (Sullivan & Ausubel, 1983, p. 46) meaning to the learner whatever meaning their referents allude to" (Sullivan & Ausubel, 1983, p. 46).

2) Concept learning. - This learning makes it possible to acquire new knowledge, and is whereby symbols take on meaning through the understanding of experiences by means of construction and mental projections that end up being expressed in words.

3) Learning of propositions. - This involves a combination and relationship of several words, each one constituting a unitary referent (component), to be subsequently combined in such a way that the resulting idea is more complex than the simple sum of the meanings of the individual component words, producing new meanings assimilated in the cognitive structure.

As can be seen, it is in these basic learning processes that all other learning processes are derived by combining and linking them together, especially if there is a learning attitude and the material is meaningful, so the question arises: how to bring meaningful learning into the classroom for music students? To answer this question, we propose to use the work of Andrzej Marczewski (2018), who proposes a scheme of gamification, game thinking and motivational design, which mainly employs intrinsic motivation by identifying the main motivations of people. He personally defines gamification as "The use of game design metaphors to create more game-like and engaging experiences." (p. 13). With this information we propose the objective of identifying the constituent elements of a gamification based on Marczewski's proposal, in order to subsequently devise a gamification plan for preschool or elementary school music education. In this sense, Marczewski proposes the following scheme for approaching gamification:

Figure 1 Ludification user journey framework
Source: (Marczewski, 2018, p. 133)

But for a student/player to succeed in following this path of gamification it is required to comply with certain mechanisms that allow to understand the procedures of the game, what makes it fun, what are the stories that will accompany it, the materials or technology that you will place to make it happen and finally, the aesthetics of the environment that allows the greatest impact (Schell, 2019), likewise, it will be necessary to see what the players should think or mentally elaborate and the ethical aspects immersed in the game, the latter leads us to reflect on the deep reason why a game is proposed and where we want to get to with it (Marczewski, 2018).

Methodology developed

For this research, a documentary research on gamification was developed trying to find those proposals that could be used outside the field of computers, that is, that although its origin had been computer science, it could be used in multiple fields with the purpose of being a teaching-learning strategy for any educational environment and, above all, that would allow its inclusion in a planning scheme for children's music education. To this end, a selection of texts was made, discriminating those that did not meet the established criteria, i.e., those that required the use of digital technology as a forced strategy. Marczewski was the main reference, however, his proposal was modified with contributions from other researchers to consequently present a relevant alternative in the field of children's music pedagogy.

Motivation

Undoubtedly, motivation takes on a transcendent importance in this proposal, and the fact that gamification has made it possible to achieve with it a significant attitude:

The most repeated in gamification works is the increase in motivation (AlarteHernández et al., 2021; Fernandez-Río et al., 2020; Monguillot et al., 2015; Navarro et al., 2017) coinciding with the results of Apóstol (2013) where they stated that gamification affected positively on motivation.

Within motivation, both intrinsic motivation and extrinsic motivation are affected by gamification (Fernández-Río et al., 2020; Monguillot et al., 2015). Extrinsic motivation is affected by game elements such as rewards or progress bars according to Malone & Lepper (1987). Many times these classifications favor the social factor (Deci & Ryan 1985), although authors such as Fernández-Río (2020), the markers are not public, to avoid generating that competition with the rest of the students. Even so, it is observed how in the rest of the studies extrinsic motivation increases (AlarteHernández et al., 2021; Monguillot et al., 2015). (López Quero, 2022)

As can be identified, motivation is one of the elements that most manages to promote gamification, however, this part from certain considerations, i.e., trying to enhance intrinsic motivation and thereby identify how to propose gamification, for it identifies three layers of motivation:

Figure 2 Own creation based on the three layers of motivation
Source: (Marczewski, 2018, p. 74).

Humanistic approaches have introduced the notion of growth as a key element. They argue that within every human being there is an intrinsic motivation to expand one's own capabilities and develop inherited talents. This innate motivation is shared by all individuals, although certain circumstances may influence its manifestation, either fostering or hindering it (Elizalde, Martí Vilar, & Martínez Salvá, 2006).

In the graph, the base shows the basic needs of human beings, those that are minimally required to achieve a certain level of fulfillment in order to obtain better experiences; although these have been repeatedly criticized.[1] in general allow us to think of those minimum conditions of a human being to be satisfied in order to achieve an adequate development in life. On the other hand, intrinsic motivations are thought of as those that are inherent to the participating subject, and in Marczewski's proposal, they allow, through their identification, to delineate certain types of players to whom different activities are offered.

Types of players

It is very important to point out that gamification, in order to meet the motivational requirements of those to whom gamification is proposed, it is necessary to identify who they are and what their interests are in general, which will lead to a more transcendent proposal.

– Philanthropists are motivated by purpose and meaning. This group is altruistic, wanting to give to others and enrich the lives of others in some way, without expecting a reward.

– Socializers are motivated by relationship. They want to interact with others and create social connections.

– Achievers, are motivated by mastery. They are seeking to acquire knowledge, learn new skills and improve themselves. They want challenges to overcome. Eduardo Toledo (2020) translates these terms into Spanish as conseguidores who are motivated by mastery.

– Free spirits are motivated by autonomy and self-expression. They want to create and explore.

– Disruptors are motivated by change. In general, they want to disrupt their system, either directly or through other users to force positive or negative change.

– Gamers are motivated by extrinsic rewards. They will do whatever it takes to collect rewards from a system and not much else. They are in it for themselves.

These six types of people (gamers) are participating for specific motivations, identifying in the first four types of people, connections with interests based on their intrinsic motivation, while in the case of the disruptors by four disruptive sub-motivations (Afflicters, destroyers, influencers and innovators), and in the case of the players four extrinsic sub-motivations (Egoists, consumers, networkers and exploiters). Marczewski arranges them as follows in a diagram for further visualization.

[1] Illich, in his article "Necessities", points out that these were incorporated in the imaginary of humanity as a legacy of the developmentalist discourse in the decades following World War II: "The necessities that the rain dance of development provoked not only justified the plundering and poisoning of the earth; they also acted on a deeper level. They transformed human nature. nature. They turned the mind and senses of homo sapiens into those of homo miserabilis. "Basic needs" may be the most insidious legacy left by development. The post-World War II generation witnessed this change of state in human nature, from the common man to the needy man. Half of all men born on earth as homo are of this new class." (Illich, 1996)

Figure 3 Own creation based on the scheme of the types of users
Source: (Marczewski, 2018, p. 115)

Each of these users or players is going to be interested in certain activities, these activities will allow gamification to maintain an optimal development without generating stress or boredom, something called creep. Each of the motivations generates different behaviors, so it will be necessary to reflect according to the type of users, which are the ones we will try to encourage and also what they are expected to stop doing.

Figure 4 Own creation, including Marczewski's previous graph of users and their behaviors

Experiences

For this, some pleasant experiences are going to be included transversally in the project taking into account the 8 types of fun according to Hunicke, Le Blank and Zubek (2004), which are (Hunicke, LeBlanc, & Zubek, 2004):

- Sensation: Play as sensory pleasure.
- Companionship: Play as a social framework.
- Fantasy: Play as fantasy.
- Discovery: Play as unknown territory.
- Narrative: Play as drama.
- Expression: Play as self-discovery.
- Challenge: Play as an obstacle course.
- Submission: Play as a pastime.

Likewise, we find such pleasant experiences in the form of cards created by Ferrán Altarriba and shared by Toledo Inclán.

Figure 5 Pleasant experiences
Source: (Altarriba, Ferrán in Toledo Inclán, 2020)

In order to transmit these experiences, the best strategy is through the creation of a theme that describes a leading situation and that allows the creation of the environment or atmosphere where gamification takes place and makes known the Experiences that will be proposed, whether they are the Activities or behaviors according to the Motivations of each of the players, as well as the Dynamics that will arise at the time of the game and the Mechanics or ways in which they will be carried out.

The story that will be made will provide an introduction to the game and to know the possibilities of the game so that it can be constituted in a personal or communitarian way and, in its case, to show the rewards that will be granted for the achievements.

The general structure of a narrative is: the introduction, the challenge, the transformation and the resolution. It is important to consider that the narrative does not have to be linear and that several characters should be involved, thus inviting many possibilities for the completion of the game. An important issue to note is that the cartoon has meaningful choices for the members, so that they become as far as possible quite immersive, with this it is important to consider that each decision comes to have consequences and, on the other hand, although the cartoons are fictional and from a fantasy world, it is necessary that they remain tied to the reality that we want to promote, so that the players manage to understand such educational interaction without problems (Marczewski, 2018).

Dynamics

One of the issues sought within gamification is to convert what motivates them into actions through the use and interaction between people, through fictitious situations, posed with specific objectives previously established. In this sense, we propose the generation of dynamics with the possibility of generating participatory experiences, that is, from what the participant feels and lives, also if we observe it as a dynamic that takes place with others among peers:

It is an excellent way of community integration, as well as an effective procedure of social education and cooperation. There is a decided satisfaction in participation, communication and exchange (Ortega, 2016).

For this purpose, the 16 desires of Steven Reiss (2002) are used, the idea is to achieve that the thought dynamics have a certain pleasure for the participants, for Reiss, pleasure is the by-product of achieving what we desire, it is not the end of the desire, as an example he puts that, in the case of the health personnel.

For this person the goal of experiencing pleasure is not created in the desire to help patients; rather, in altruism he incites to make sacrifices for his patients. Thus, we have certain desires such as tranquility, social contact, romance, among others that lead us to generate a proposal and story in the games.

The dynamics seen as a set story that gives structure to the gamification, these fall on the fact of having the players interested and connected with their motivations by establishing the context and means of development within the gamification, we could work the dynamics as the structure of the theme of the gamification. Reiss (2002) describes them as follows (Reiss, 2002):

- Acceptance: the need to be appreciated.
- Curiosity, the need to acquire knowledge.
- Eating, the need to eat.
- Family, the need to care for children.
- Honor, the need to be true to the customary values of an individual's ethnic group, family, or clan.
- Idealism, the need for social justice.
- Independence, the need to be distinct and self-sufficient.
- Order, the need for prepared, established and conventional environments.
- Physical activity, the need for work outside the body.
- Power, the need to control the will.
- Romance, the need for mating or sex.
- Saving, the need to accumulate something.
- Social contact, the need for relationship with others.
- Social status, the need for social significance.
- Tranquility, the need to be safe and secure.

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- Revenge, the need to strike back at another person.

Similarly, Toledo Inclán shares graphically the sixteen dynamics with Ferrán Altarriba's designs in which the action to be taken is described.

Figure 6 16 desires
Source: (Reiss, Steven in Toledo Inclán, 2020)

Mechanics

Likewise, we have to consider important the mechanics, which are the implementation of the dynamics, i.e., those situations that will allow to generate activities that will encourage intrinsic motivation itself, to which we could add some extrinsic motivation or disruption mechanics that allow to keep people active that sometimes are not so intrinsic, but that in gamification we will try to encourage or stimulate them towards intrinsic activities or behaviors. Marczewski proposes the following mechanics in which we are going to promote the behaviors to be stimulated.

Intrinsic

1. Socializing:

a. Guilds/Teams. Let people build close-knit guilds or teams. Small groups can be much more effective than large, sprawling ones. Create platforms for collaboration, but also pave the way for team competitions.

b. Social networking. Allow people to connect and socialize with an accessible, easy-to-use social network. It can be more fun to play with other people than to play alone.

c. Social status. Status can generate greater visibility for people, creating opportunities to create new relationships. It can also feel good. It can make use of feedback mechanisms such as leaderboards and certificates.

d. Social Discovery. A way to find people and be found is essential to building new relationships. Matching people based on their interests and status can help people start interacting.

e. Social pressure. People often do not like to feel like outsiders. In a social setting, this can be used to encourage people to be like their friends. It can demotivate if expectations are unrealistic.

f. Competition. Competition gives people the opportunity to prove themselves in front of others. It can be a way to earn rewards, but it can also be a place where new friendships and relationships are born.

2. Free spirits:

a. Exploration. Give your free spirits room to move and explore. Consider that they will want to find the boundaries so give them something to find.

b. Branching options. Let the user choose their path and destination. From multiple learning paths to responsive narratives. Remember, the choice must be (or at least feel) meaningful to be most effective and appreciated.

c. Easter eggs. Easter eggs are a fun way to reward and surprise people just for a glimpse. For some, the harder they are to find, the more exciting it is!

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d. Unlockable/rare content. Add to the sense of self-expression and value by offering unlockable or rare content for free spirits to use. Tied to Easter eggs and exploration, as well as achievements.

e. Creativity tools. Allow people to create their own content and express themselves. This can be for personal benefit, for pleasure, or to help others (teaching materials, levels, equipment, FAQs, etc.).

f. Personalization. Give people the tools to personalize their experience. From avatars to the environment, allow them to express themselves and choose how they will present themselves to others.

3. Achievers:

a. Challenges. Challenges help keep people engaged by testing their knowledge and allowing them to apply it. Overcoming challenges will make people feel they have earned their achievement.

b. Certificates. Unlike general rewards and trophies, certificates are a physical symbol of mastery and achievement. They carry meaning, status, and are useful.

c. Learning/New Skills. What better way to achieve mastery than to learn something new? Offer your users the opportunity to learn and expand.

d. Missions. Quests give users a fixed goal to achieve. Often made up of a series of linked challenges, multiplying the sense of accomplishment.

e. Levels/Progression. Levels and objectives help map a user's progression through a system. It is as important to see where you can go as it is to see where you have been.

f. Boss Battles. Boss battles are an opportunity to consolidate everything you've learned and mastered into an epic challenge. It usually signals the end of the journey and the beginning of a new one.

4. Philanthropists:

a. Meaning/Purpose. Some just need to understand the meaning or purpose of what they are doing (epic or not). For others, they need to feel that they are part of something bigger than themselves.

b. Caregiving. Caring for others can be very rewarding. Create roles for administrators, moderators, curators, etc. Allow users to take on a parenting role.

c. Access. Access to more functions and capabilities in a system can give people more ways to help others and contribute. It also helps them feel valued. More meaningful if earned.

d. Collect and trade. Many people love to collect things. Offer them a way to collect and trade items in your system. It helps build relationships and feelings of proposition and value.

e. Gift/Share. Allow giving away or sharing items with others to help them achieve their goals. While it is a form of altruism, the potential for reciprocity can be a strong motivator.

f. Knowledge sharing. For some, helping others by sharing knowledge with them is its own reward. Develop people's ability to answer questions and teach others. Extrinsic (Use sparingly if working with adults or to maintain attention in long games).

5. Gamers:

a. Points / Experience Points (XP). Points and XP are feedback mechanisms. Can track progress, as well as be used as a way to unlock new things. Reward based on achievement or desired behavior.

b. Physical Rewards/Rewards. Physical rewards and prizes can promote a lot of activity and, when used well, can create engagement. Be careful to promote quantity over quality.

c. Leaderboards / Ladders. Leaderboards come in different forms, most commonly relative or absolute. Commonly used to show people how they compare to others and for others to see. It is not for everyone.

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d. Badges / Achievements. Badges and achievements are a form of feedback. Reward people for their accomplishments. Use them wisely and meaningfully so they are more appreciated.

e. Virtual economy. Create a virtual economy and allow people to spend their virtual currency on real or virtual goods. Examine the legalities of this type of system and consider the long-term financial costs!

f. Lottery / Gambling. Lotteries and gambling are a way to win prizes with very little effort on the part of the user. You have to be involved in it to win! Disruptive (To promote changes in the environment, use wisely).

6. Disruptors:

a. Innovation Platform. Disruptors think outside the box and the boundaries of your system. Give them a way to channel that and you can generate great innovations.

b. Voting/Voice. Give people a voice and let them know they are being heard. Change is much easier if everyone is on the same page.

c. Development tools. Think about modifications instead of hacking and breaking. Allow them to develop new add-ons to improve and develop the system.

d. Anonymity. If you want to encourage total freedom and lack of inhibitions, allow your users to remain anonymous. Be very, very careful as anonymity can bring out the worst in people!

e. Light touch. While you must have rules, if you are encouraging disruption, apply them with a light touch. See how things unfold before jumping in. Be attentive and listen to user feedback.

f. Anarchy. Sometimes you just have to burn it all down and start over - sit back, throw the rule book out the window and see what happens! Consider holding short "no rules" events (2018, pp. 252-259).

7. Feedback.

Within the educational field, but even in games, the repetitive performance of an activity without the possibility of improvement or innovation ends up becoming boring and even a nuisance, and it would not be possible to think that an activity is educational if there are no possibilities of feedback, therefore, it is important to consider that the proposal must involve an interesting challenge where patterns of recognition of progress are established, it is important to consider that the proposal must involve an interesting challenge where patterns of recognition of progress are established, for this the process must have an assurance of learning with feedback at all times in order to adjust what is necessary, therefore, an environment that allows the possibility of failure must be generated; This environment is called in gamification as a magic circle and, finally, to allow that after achieving the fulfillment of a challenge, to give a sense of gratification or reward for the effort spent towards that conclusion to each student. Here it is important to note that the conclusion invites us to try to meet a new challenge with a higher level of difficulty than previously employed, the key is to manage to maintain the enthusiasm to achieve new achievements (Marczewski, 2018). Graphically we observe this feedback scheme with the following figure:

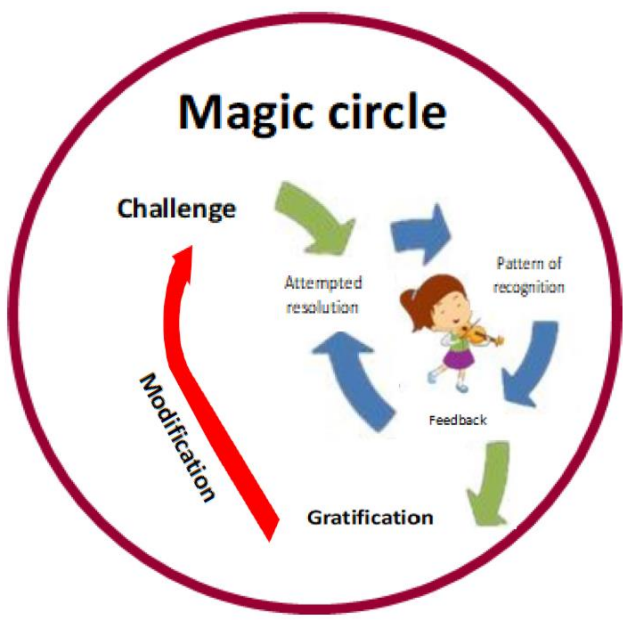

Figure 7 Own creation based on the magic feedback loop
Source: (Marczewski, 2018, p. 179)

After this broad approach to each of the constituent elements of gamification, for now it remains for us to describe the planning scheme of gamification moon to verify how each of these elements interact on some specific topic to be addressed.

8. Gamification scheme, approach to the educational approach

The gamification scheme is a mixture of Marczewski's (2018) proposal and Gojko Adzic's (2012) mapping presented by Toledo (2020) to which we have adapted it for use as a planning tool. This scheme is intended to make the following elements known to whoever intends to implement gamification. According to the following table, the structure of gamification can be understood:

Definir el propósito educativo:	La tabla 2 muestra un ejemplo detallado al respecto.
¿Qué tipo de jugadores interactuarán?:	
• Filántropos • Socializadores • Triunfadores • Espíritus libres • Disruptores • Jugadores	
¿En qué experiencias estarán inmersos, el uso de emociones? Tema y narrativa que construya la atmósfera: 8 tipos de diversión.	
Sensación: El juego como placer sensorial. Compañerismo: El juego como marco social. 3. Fantasía: El juego como fantasía. Descubrimiento: El juego como territorio desconocido. 5. Narrativa: El juego como drama. 6. Expresión: El juego como autodescubrimiento. 7. Desafío: El juego como carrera de obstáculos. 8. Sumisión: Juego como pasatiempo La narrativa del juego: • Introducción • El desafío • La transformación • La resolución	
¿Qué actividades (comportamientos) se fomentarán según el tipo de jugadores? RAMP:	
Relaciones: Colaborar (Ayudar, comentar, compartir, contribuir, alimentar, saludar). Autonomía: Explorar (Buscar, curar, encontrar, recoger, reseñar, valorar, ver). Maestría: Competir (Burlar, Comparar, Comprar, Desafiar, Ganar, Luchar, Robar). Propuesta: Expresar (Construir, crear, compartir, decorar, elegir, personalizar).	
¿Cuál es la dinámica de trabajo?, es decir, las acciones en el momento de juego. 16 deseos:	
1. Aceptación 2. Curiosidad 3. Comer 4. Familia 5. Honor 6. Idealismo 7. Independencia 1 Orden Actividad física Poder Romance Ahorro Contacto social 14. Estatus social 15. Tranquilidad . Venganza	

Table 1 Components of gamification

With this information, we consider that the graphical scheme of gamification is as follows:

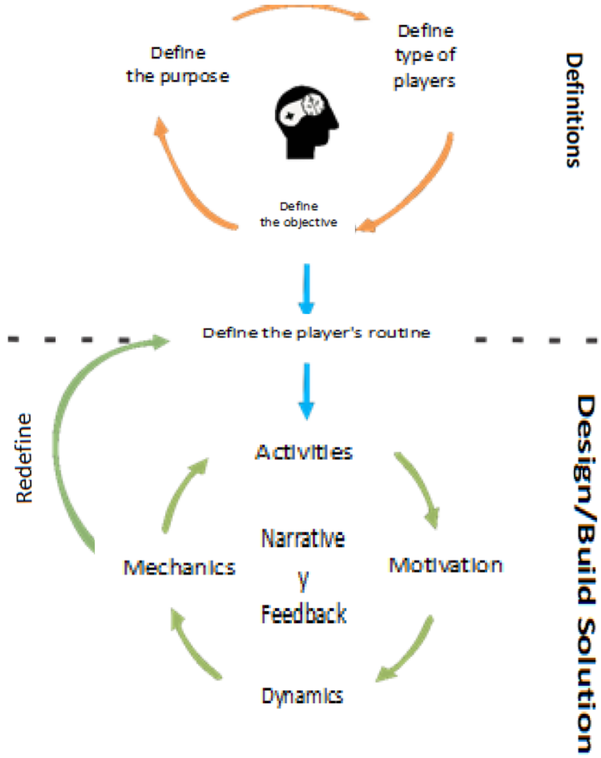

Figure 8 Structure of gamification
Source: own creation based on (Marczewski, 2018, p. 271)

Results

With the information presented above, we show a sample of school gamification planning, as an example, remaining as follows:

TITLE: THE GUITAR AND THE FAMILY

Guitarra inicial	Educ ador:	Bime stre del curs o: 2	Núm ero de sesio nes:	Inici o: tér mino
¿Qué voy a hacer?, ¿Cómo lo voy a hacer?, ¿Para quién lo voy a hacer?, ¿Dónde lo voy a hacer? y ¿Con qué recursos?	Explorar las cuerdas de la guitarra con la finalidad de que logren tener una buena posición y uso de los dedos índice y medio de la mano derecha. Para ello se empleará el libro El cuaderno del guitarrista más pequeño de Nadia Borislova, las tres canciones de las páginas 79, 80 y 81. La propuesta se enfocará en Niñas y niños guitarristas de curso de guitarra inicial. Educación básica de la fase 3. Desarrollándose en clases presenciales con intención de práctica en casa. Teniendo como recursos necesarios su Guitarra, atril y banco, así como el libro respectivo.			
¿Qué queremos que aprendan y logren los estudiante s?, ¿Cuál es el plan para lograrlo?, ¿Cómo hacer el aprendiza je más efectivo? y ¿Cómo evidenciar y valorar el logro de aprendiza je?	Se pretende incentivar el uso adecuado de la mano derecha con los dedos índice y medio, teniendo un buen sonido y ubicación de cuerdas de la guitarra en tanto cuidan su posición. Para lograr se realizarán proceso con cada una de las cuerdas en tanto van pulsando e intercambiando los sonidos de la guitarra con la letra de las canciones. Para lograr la efectividad se pondrá especial atención en la forma de interpretar evitando normalizar los errores durante la ejecución, yendo de una velocidad lenta a más rápida manteniendo el ritmo constante. La estrategia de evidencia es a través de una presentación en frente de sus compañeras y compañeros.			
Describir el tipo de jugadores:	Dependerá del grupo en cuestión. Se recomienda usar la evaluación de motivaciones en la liga: https://www.gamified.uk/UserT ypeTest2023/user-type-test.php Para nuestro caso, trataremos de incentivar las motivaciones intrínsecas de Socializadores y Triunfadores esencialmente.			
En qué experienci as estarán inmersos, el uso de emociones **. Tema y narrativa que construya la atmósfera** **: 8 tipos de diversión.**	Una vez Vlad había salido al campo con su mamá, su papá y su abuelita. Como era costumbre caminaron tratando de encontrar nuevos lugares, por lo que eligieron tomar una vereda que los conducía hasta un espacio lleno de luz, flores y sonidos tintineantes, como de pequeñas campanas. Anita se emocionó tanto que salió corriendo sin darse cuenta de que había entrado a un bosque encantado, así que de repente se vio sola. Se empezó a asustar, pero entre las hojas se escuchó una voz mágica que le decía: "No te preocupes, sólo canta las canciones mientras tocas esta guitarra mágica". Afortunadamente Anita había empezado sus clases de música por lo que rápidamente se puso a la tarea de interpretarlas. Aparecieron unas partituras en hojas de oro y una gran guitarra que parecía tocar por sí sola. Al fondo del bosque veía las siluetas de su mamá, su papa y su abuelita. Conforme iba tocando las piezas respectivas, sus siluetas aparecían cada vez más evidentes y brillantes. Si se equivocaba volvían a desaparecer. Así mismo, observaba que mientras tocaba la guitarra muchos animalitos del bosque se acercaban a escucharle tocar y cantar. La voz del bosque le decía que tenía que no sólo tocar, sino poner todo el corazón. Así que al final logró interpretar las canciones de manera perfecta y todos se pudieron reír.			

Table 2 Example of gamification for subject matter in music

Conclusions

As can be seen, this type of strategy allows to approach music education for children in basic education in an active, immersive way, with stimulation of motivation and also with the use of creative strategies. Having educational materials focused on childhood is a great help, and gamification is a tangible possibility to empower them towards new possibilities by making educational processes an intrinsic part of a motivating game.

Finally, with this structuring we realized that there is a great possibility of taking gamification to the musical educational field, likewise, it was observed that, with the proposal shown, there is the possibility of future applications by linking the strategy with school music projects that are developed within the New Mexican School.

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Abstract (In English, 150-200 words)

Objectives
Methodology
Contribution

Keywords (In English)

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Abstract (In Spanish, 150-200 words)

Objectives
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Introduction

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General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

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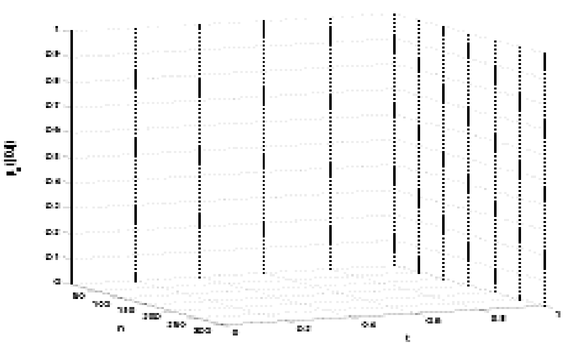

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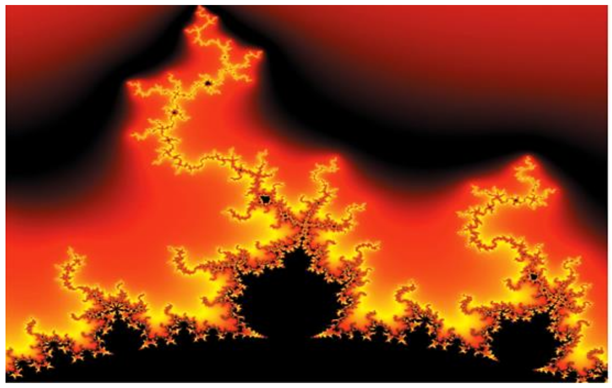

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