FRACTIO: Contemporary Educational Game for the Teaching of Fractions

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Abstract

This paper deals with some reflections on the use of educational games in the teaching and learning process, as well as describes the design of a contemporary game called Fractio, which aims to help students in the process of learning the theme
Fractions, heavily worked content in Initial series of basic education. The use of games for learning is a fruitful space of meaning, and that enhances knowledge through virtual space. Such a space can enable children to reinvent and construct new knowledge, as well as giving new meanings to many concepts, which in general have an abstract character for children in the initial grades.

**Keywords**: Educational Game, Teaching-Learning Process, Fractions, Fraction

### 1 Introduction

The current behavior of children in the classroom illustrates that classical education remains passive and out of step with the technological reality presented to modern society. One of the methodologies that has aroused interest in children, youngsters and adults is called "gaming", which is present in all media, whether through the internet, televisions, computers, cell phones, among others.

The use of educational games promotes a dynamic space that strengthens the player's ability to reinvent, build and re-signify knowledge, making content learning more motivating and challenging (MOITA, 2006).

The game in the educational process can be seen as a referral to work, or rather, a bridge between the student and his practical application. According to Brenelli, 2005, this is because the main points in the use of a game lie in the challenge and difficulties. Challenges and difficulties are targeted both in the teaching-learning process and in the search for a more solid and mature formation of children.

The problem situation for which a child is subject is a challenge to thought and a challenge which, when compensated for, results in the progress of the development of thought. The game also becomes a preparatory exercise in the development of perceptions, intelligence, experimentation and social instincts. Still according to Brenelli (2005) apud Piaget and Terra (2006), the play activity leads the child to assimilation and interpretation of the contents and of himself.

In this way, it is understood that to play is to be interested, is to have no borders, nor so impositions. It becomes a desire for the subject who wants to participate in the challenge and the tasks. Losing or winning is the target for the player or the team. To bring recreational activities (concrete material, games, active methodologies) to the schools makes up an excellent form of pedagogical mediation that evidences the participatory student in the learning process (AGUIAR et al., 2016).

The student experiences, experiences, and absorbs knowledge through the association of the context that gives him meaning, is "know-how” taking its place in learning (TEIXEIRA and AGUIAR, 2009). The classroom is a space and time during which the subjects involved (teachers and students) meet together to carry out a series of actions and interactions (MASSETO, 2009).
This work presents as a proposal for educators the use of a game (called Fractio), used to teach, reinforce and revise concepts inherent to the study of fractions, and can trigger the cognitive restructuring of the orienting, which favors the construction and reconstruction of meanings of concepts treated in the classroom.

2 Literature Review

The feminine noun "fraction", according to the Priberam Dictionary of the Portuguese Language, comes from the Latin "fractio", that means "action of breaking". The mini-dictionary Mini Aurélio (FERREIRA, 2004) presents the term as "part of a whole", which in Mathematics, is defined as: "number representing one or more parts of the unit that has been divided into equal parts".

In some schools, fractions are first seen in the fifth year of elementary school and are commonly encountered in problems from there. In this scenario, if the student does not understand the concepts and their applications at the beginning of learning, the difficulty tends to increase significantly with the passage of time.

The fact that not all people use fractions very often makes the learning process difficult, making few people quickly learn how to use it. This difficulty presented by the students can generate an aversion to the theme. This antipathy is one of the main reasons that impede pleasant and meaningful learning.

Many schools have worked with rules of an algebraic nature before students have developed the central idea (the basis of content). Children have contact with monetary measures and values in which they appear the tenth and the hundredth, however, the daily life of these children does not clearly report to them, significant problems involving fractional numbers. One does not observe people buying 3/4 dozens of eggs, let alone 6/8 of a pizza. At most, the terms "middle" and "the fourth part" of something are used (OLIVEIRA, 2013; IEZZI et al., 2008).

According to Lima and Filho (2013), the difficulties, even for older students, are immense. His research was developed with 35 students of the 7th year in a public school, but only 24 answered the questionnaire proposed (the age of the students varied between 11 and 12 years). The questionnaire was composed of 4 questions containing basic mathematical operations, problems and fractional operations.

The results observed were: in the first question, the authors warned that students have difficulty performing subtraction, multiplication and division operations. In the second, students have difficulty interpreting a problem situation and can not write by means of a mathematical expression the situation described in the statement. In the third, students have difficulty performing operations with fractions. In the case of addition, subtraction and division, there was not even a hit. In the fourth question, the objective was to analyze how the student would interpret the problem situation and select and use calculation procedures in function of the proposed situation.
With the results obtained, the authors realized that most of the students answered that they do not like math because they often do not understand what the problems ask for, but in the meanwhile, they understand that the study of math is necessary for the Its future and that it becomes present in each and every day.

According to Anastasiou (2004) and Masseto (2009), the modern teacher must be a strategist, since he must study, select, propose and organize tools for students to appropriate knowledge. Its aim should be to create new environments (eg games) and conditions for improving the learning process.

Given this scenario, this work presents a game with examples, problems and succinct statements, and can help the educator in the systematic process of teaching and learning of his students. According to Preece (2005), a game can be used as an object of learning, however, for this it is fundamental that the game is effective and efficient in use, safe, with good utility, easy to learn and easy to use. In this way, there was concern that the game Fractio was fun, friendly interface, motivating creativity and emotionally appropriate.

Using concrete games and materials can contribute to the role of the teacher and especially of the students. The game Fractio highlights the main contents in the teaching of fractions, always trying to emphasize the importance of the theme both for schools and in the social life of students.

The game consists of three phases, each with its challenges. In each challenge, the player will have to solve a problem involving fractional numbers to move on and fulfill the ultimate goal. With each complete challenge, other content becomes the player's goal. At the beginning, the player only needs to solve problems involving natural numbers in the composition of the fraction, until at the end he may also find incognitos in the problems, increasing the difficulty gradually.

Mathematical problems will each have a main focus among the contents present in the National Curricular Parameters (BRASIL, 1998), in order to unite the facets of the content of fractions in the end. The game will have reached its goal if the player understands that the fraction plays a part-whole relationship role, quotient, reason and operator in an integrated way.

3 Methodological Procedures

3.1 Platform Used

Game Search Brasil (2016) is a new field reading that traces the profile of the Brazilian Gamer. It illustrates the current market scenario by approaching the consumption habits of major gaming platforms. According to this survey (conducted in February 2016, with 2,848 respondents across Brazil), the most used platform for games is the smartphone, followed by the computer (which led the search until 2013). Figure 1 below illustrates the graph presented in the Brazilian Gamer Survey 2016, which presents the percentage of platforms most used by Brazilian players.
Although Smartphones are the most used gaming device, it is traditional and more common for schools to use their traditional computer labs with desktop computers, rather than offering new labs with smartphones. Fractio is an educational game designed to support fractional study classes, and therefore will be developed for desktop computers using Unity as a game engine.

### 3.2 Some Games in Literature NARRATIVE OF THE FRACTION GAME

The development of the game Fractio made possible the constant study of reference games for the proposed work. Some games aroused great interest due to its easy language and interactive interface with the young public, among them, they stand out:

a) The Counting Kingdom (http://store.steampowered.com/app/302750/),

b) Zeus vs. Monsters (http://store.steampowered.com/app/444430/),

c) Shadow Puppeteer (http://shadowpuppeteer.com/) and


They all have characteristics and gameplay very similar to the game Fractio (object of this work).

### 3.3 Narrative of FRACTIO Game

The game Fractio is guided by the following narrative: the main character is seen in the midst of a fantasy world, where almost all the characters idolize fractions. Everything in the world is related to fractional numbers and the character does everything to get back to his original world, however, he will go through a series of problems until he reaches his goal.
Cássim (main character of the game) is lost and continues walking through this fantasy world in search of help. The character observes a castle, and to get there, it must pass a road full of plates with fractional numbers to a river. Near the shore, there are three brothers arguing and a broken boat next to them. The character borrowed the boat, however, they were too busy discussing their candy. Cássim proposes an agreement. He would help the children share the sweets, and in return, they would lend him the boat. The boat in turn is broken, and Cássim must repair it to cross the river, which according to the brothers, is the fastest way to the castle. On the other side, he is heading for the kingdom.

The character arrives at the castle, and just at the entrance bridge there is a guardian that must pass by. The guardian passes a mathematical problem involving probabilities that, if answered correctly, allows the character to cross the bridge. Otherwise, it gets another problem with the same theme. Upon entering the castle, the character tries to talk to the king to get out of that world, but does not succeed. When it is rejected, it infiltrates the castle wearing a uniform that finds there. He's having a big event at the castle, and he can not let them guess, so he goes into the kitchen in the main hall and starts helping the cooks prepare their meals.

The recipes vary, and the character must help the cooks without realizing that he is infiltrated there. With the dinner served, Cássim leaves for the basement in search of the key that, according to the teacher, is in the castle and is the only way Out of this world. Finding the path leading to the basement, Cássim faces a talking door that demands an answer to his charade. After answering correctly, Cássim enters the basement and falls into a trap: the door locks him inside, and warns the king about his invasion. The king arrives in the basement, furious, and threatens to arrest him. The character explains the situation and says that he is only behind the key to be able to leave that world. The king says that the key has been stolen and proposes an agreement: in order not to be arrested, he will have to help him recover the key.

When leaving the castle, the character searches on the map indicated by the king, which is the most recommended place to find the key. Finding the point, it receives an operation, and its response indicates the coordinates of the next point on the map. From point to point, he finally finds the cave (where the monster is) on the map.

Following the cave, the character encounters a gate. After the gate, he finds the monster that stole the key. After some challenges, the monster gives him the stolen item and justifies the theft by saying that he had done so only to preserve his world of the human race. The player must then decide whether he uses the key to return to his world, or if he hides it so that the monster can retrieve it again, simply returns it to the king, as he had agreed.

4 The game FRACTIO

In this game, the student will be able to walk through the tutorial, which, in addition to illustrating how the game mechanics works, also guides the fundamental
concepts of fractional study (definition, reading, classification and notation). The game is divided into three phases, each containing three challenges. The progression of phases is made as the player is performing the challenges, in this way, he must solve one challenge at a time, until he reaches the last challenge of the third stage. The difficulty is gradual.

Figure 2 below illustrates the game's initial screen after its initial audio-visual presentation.

The following are the stages of the game and their respective challenges:

**1st Phase:** This phase is composed of division of integers and proportions.

**Challenge 1-1:** Signs on the Road

The road is full of signs indicating the path to follow. At each plate, the player must resolve a small operation between fractions of the same denominator. Figure 3 below illustrates the students' first challenge as well as a tutorial on this challenge.
**Challenge 1-2: Division of Bullets**

At this stage, the player must solve the problem of the candy divisions (balloons on a table) by dividing the total quantity of candy for three children (who will receive, respectively, a half, a third and a sixth of the total bullets on the table). Figure 4 below illustrates the bullet challenge and also a tutorial on this challenge.

![FIGURE 4: Bullet Division Challenge](image)

**Challenge 1-3: Repair the boat**

The gameplay at this stage happens by dragging objects on the screen. Cássim (main character) must drag and match pieces of wood with the indications of fractions equivalent to the markings in the boat's assembly manual. Figure 5 illustrates the challenge and its tutorial.

![FIGURE 5: Boat Repair Challenge](image)

**Phase 2:** This phase contemplates the study and learning of fractions with real numbers.

**Challenge 2-1: Castle Bridge**

The castle guardian presents Cássim with a fractional mathematical problem involving probabilities, which if answered correctly allows the character to cross
the bridge. Otherwise, it will receive a new issue with the same theme. Figure 6 below illustrates the Ponte do Castelo challenge and also a tutorial of its gameplay.

**FIGURE 6: Tutorial and Challenge Ponte do Castelo**

**Challenge 2-2: Cook’s Helper**

At this stage there is a set of varied recipes, where in all of them the player must improve his knowledge about fractional numbers, besides having to use the fundamental property of the fractions to assist cooks with the fractional assembly of their dishes, without the character Cássim is perceived. Figure 7 below illustrates the Chef Helper phase and its gameplay tutorial.

**FIGURE 7: Cook's Assistant Challenge Gameplay Tutorial**

**Challenge 2-3: Basement Trap**

At this point (phase), through questions involving several joint operations between fractions (including potentiation and radiciation), the character Cássim can enter the castle basement to search for the desired key, as long as it correctly solves what is requested. Figure 8 below illustrates the Basement Trap phase and its help screen.
3rd Phase: The most complex phase of the game, which addresses real fractional numbers with unknowns.

Challenge 3-1: Map

The player needs to solve a series of expressions at this stage by clicking on the highlighted places on the map until they find the monster's secret hideout. Figure 9 below illustrates the Map challenge and its gameplay tutorial.

Challenge 3-2: Sacred Gate

By choosing the right path the character encounters a gate, which is only open to its entrance if the player hits a set of problems that address the Fractions Generations content. Figure 10 below illustrates the gameplay tutorial for this phase and a help screen.
**Challenge 3-3: Thief of Keys**

In this phase 3 challenge, the player needs to solve a major problem involving fractions, logic and different unknowns. When solved correctly, the player will have a difficult decision to make. Figure 11 below illustrates the Key Thief phase and its gameplay tutorial, and Figure 12 illustrates the player's final decision-making.

![FIGURE 11: Challenge Thief Keys and Screen Gameplay Tutorial](image1)

![FIGURE 12: Final Player Decision Making](image2)

**5 Conclusions**

The mediation of learning using games (such as the Fractio game) highlights the apprentice figure and strengthens him as an actor in the process, helping him to learn and achieve his goals, as well as giving a new Colored the actions of the teacher.

The development of the Fractio game allowed the students (involved in the game design) of the Digital Games course of the Federal Institute of Paraná - IFPR in Curitiba in the state of Paraná to learn several moments, as well as motivate them to develop new researches and New educational game projects.
The next step of this research is the presentation of the game Fractio for a group of academics of the Mathematics Degree course of the Federal Universities of Paraná - UFPR and Federal Technological of Paraná - UTFPR, so that in a new moment, these students can evaluate and validate the game in his projects of supervised stage with children of the public schools of the city of Curitiba in Paraná.

References


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