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TEACHING ELECTROMAGNETISM BY IMAGES SIMULATIONS IN THE TELECOMMUNICATIONS TECHNICAL COURSE

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Abstract
Electromagnetism teaching is developed based on vector calculations studied in university courses. However, electromagnetism is also a high school theme and it is an important issue in technical courses in which calculations of electromagnetism's laws are not in the curriculum. The purpose of this research is the electromagnetism teaching-learning process using animated visual interfaces, allowing the introduction of visual algebra concepts in Telecommunications technical course. Using the theory to provide the Meaningful Learning through computational resources, a methodology using simple application software was developed. The Learning Object was created and the learning was analyzed by questionnaires. It was verified that the interface provided to the students to identify the relation of electromagnetic spectrum compared with real devices operation brought advantages.

Keywords: Electromagnetism. Meaningful learning. Learning Object.

INTRODUCTION

Starting Electromagnetism studies or Electromagnetism readings, people realize the necessity of mathematical knowledge, as formulated by James C. Maxwell in 1861. This relation can become very hard, complicated and boring, contributing to nominate Electromagnetism studies as very hard. Another thing is that graphics that explain Electromagnetism concepts are applications of algebraic concepts.

Electromagnetism applications are huge and the Four Maxwell's Equations, bases of Electromagnetism, are formulated with differential and integral calculus. The high school students do not study these contents, and the students that are at technical schools neither.

Because of this, this research aims to study the teaching-learning process developed at Electromagnetic Waves Transmission, in the second level of the Technical Course of Telecommunications, using a digital artifact.
So, the general goal is the investigation of the teaching-learning about the magnetic field, the dipole antenna, using only visual elements to explain the concepts of the mathematical language of Maxell. Considering that Electromagnetism study is very huge, this investigation has three goals:

- To diagnose the learning-teaching process in Telecommunication Course related to the electromagnetic generation waves of dipole antenna;
- To identify and evaluate the student's comprehension about electromagnetic field irradiated by dipole antenna designed by a visual simulation.

Based in this context and in the goals, the base of this research is: Will this Learning Object increase the Electromagnetism teaching by pictorial simulation? This question is developed in the end of this paper, when student's responses are analyzed.

THEORY OF MEANINGFUL LEARNING APPLIED TO TEACH ELECTROMAGNETISM

This educational proposal is based on the Theory of Meaningful Learning David Ausubel. Meaningful learning is a process by which a new information relates to an important aspect of the knowledge structure of the individual (Moreira and Masini, 2001).

According to Moreira (2006) the subsumers are a concept, an idea, a proposition already existing cognitive structure, able to serve as 'anchor' the new information so that it acquires thus meaningful to the individual (i.e., it has able to assign meaning to this information). In this respect the concepts previously "anchored" in the cognitive structure of the learner, such as atoms, electrons, neutrons, protons, act as subsumers, so that new information is acquired by the learner. As new information, understand the concepts needed.

THE LEARNING OBJECT

This research aimed to use a Learning Object, considering the usability features and availability on the WEB. In other words, it can be re-used and will be available in a public site (Wiley, 2000). The Learning Object is available in https://scratch.mit.edu/projects/100862277/.

THE FREQUENCY SPECTRUM SIMULATOR

Figure 1 shows the first screen. In this image, the balloons show the functions and the letters that can identify the event.

The events can show the concepts that are base to the contents that are needed by students (letters a, b, c and d).

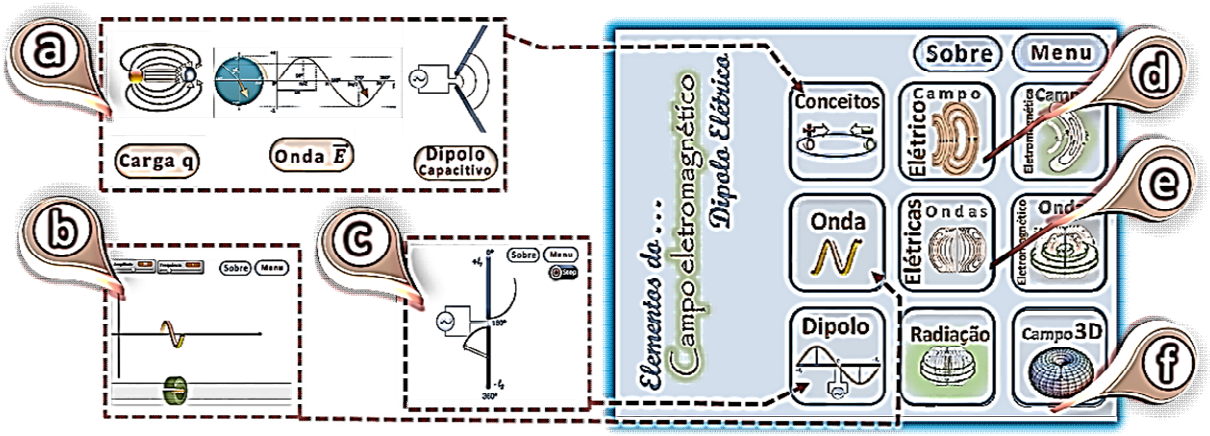


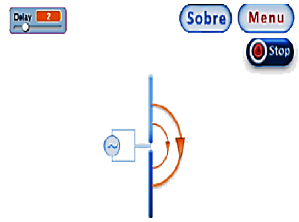
Figure 1: Learning Object - first screen
Source: Authors

The button "concepts" there are three events. The event "Carga q" (Charge q), "Onda" (Wave), and "Dipolo capacitivo" (dipole capacitive).

The event "Onda" (Wave), the student can learn about phase displacement and Telecommunications concepts. The event "Dipolo capacitivo" (dipole capacitive) is about Electric field concept.

The button "Onda" (Wave) show the sinusoid and the magnetic field effect. The user can change the wave frequency and amplitude.

In the event “Campo elétrico” (Electric field), the student will be able to control the time (Figure 2a). There are changes indirection and it is related to electric current (figure 2b).



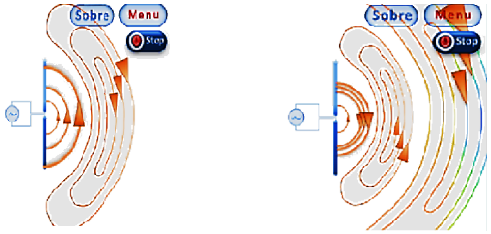
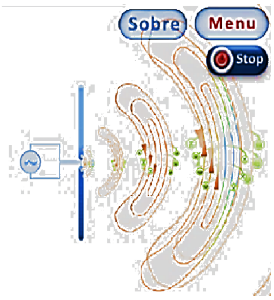


Figure 2a: First waves

Figure 2b - Displacement of the electric wave from the dipole

The event “Onda eletromagnética” (Electromagnetic wave) shows the electric wave and the magnetic field creating the electromagnetic spectrum (figures 3a and 3b).



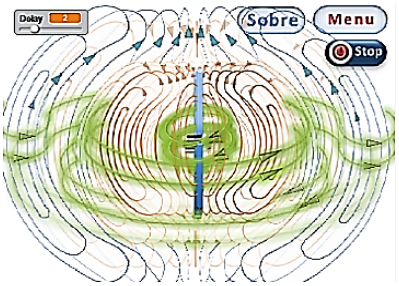


Figure 3a: Electromagnetic field

Figure 3b: Wave and electromagnetic field

The event “Radiação” (Radiation) shows the omnidirectional evolution of the electromagnetic lines in three dimensional images.

In the end, the students can understand the concepts and the electromagnetic behavior. the students can still relate the events of the electric field of alternating current with the wave’s formation.

METHODOLOGY

The activities using the Learning object were developed in Brazil, Rio de Janeiro state, with the students on the second level of a Telecommunications course. The research activities are in the Figure 4.

Activity	Propose
Before the Learning object application:	
Survey	To identify the previous knowledge of the student.
After the Learning object application:	
Evaluation	-To know about student’s opinions about the Learning Object
At the end of the course:	
Learning investigation	-To identify what students really learned -Evaluate the effects in the teaching-learning process after using the Learning object

Figure 4: Activities developed with students

According to figure 4, three checklists were done. First and second ones being at the same day, at the beginning of the semester and the third about 4 months after, at the end of the course.

The testing group was composed by 11 students in all steps and they answered different kind of questionnaires:

- Closed answer (Yes/ No/ Impartial)
- Questions with answers in Likkert scale with five options (Agree, Partial agreement, Impartial, Disagree, Strongly disagree)
- Open questions
  The research began with a review about high school concepts of electromagnetism. After that, was applied the Learning object.

The first questionnaire was applied to detect the previous knowledge of the students about Electromagnetism. After this, the Learning object was introduced for one hour and a second questionnaire was applied. The third questionnaire was applied four months later to check the evaluation of the students.

CONCLUSIONS

This work aimed to evaluate about a Learning Object to support the process of teaching-learning of Electromagnetism. A Learning Object was created using Scratch language and pedagogical activities were structured to achieve this goal.

Activities with students were tested and the results using this tool were evaluated and they showed evidences of improving learning using this Learning Object created based in the Meaningful Learning Theory.

This Learning object presented the following advantages:

- allowed the students to visualize the magnetic fields;
- another advantage is the economic aspect: after the creation, the Learning Object can be used with no extra costs;
- its utilization is simple and practical;
- only a laptop is necessary to show this magnetic fields with this Learning Object. A Data show can be used to increase the experience.

The first questionnaire showed that the students of Telecommunications Technician had not knowledge about Electromagnetic waves that was necessary to learn antennas, that was important part of the course. The Learning object was successful when applied, because, after it, the students could answer the second questionnaire with more right answers.

It was possible to check that knowledge was really seized with the application of this Learning Object, and, four months later, with the questionnaires, it was possible to verify that the students held the concepts and knowledge.

At the beginning, the students didn't know about the concepts about the electromagnetic waves needed to understand the next steps to learn antennas and transmissions. After using the Learning Object, they could answer correctly questions about electromagnetic waves. After learning with this Object, they could learn about antennas and transmissions.

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