JOURNAL OF EDUCATIONAL AND INSTRUCTIONAL STUDIES
IN THE WORLD
November 2012, Volume: 2 Issue: 4 Article: 01 ISSN: 2146-7463

LEARNING OBJECT TO TEACH THE INTERACTION BETWEEN TWO MAGNETICS USING AUGMENTED REALITY

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Abstract
This paper presents a Learning Object for teaching the interaction of magnetic fields between the two poles of different names developed in Augmented Reality environment. In the environment created in Augmented Reality there is the simultaneous presence of real and virtual objects. In this environment are shown the magnetic fields of two magnets, demonstrating their interaction. In this Learning Object, the student can see this interaction in 3D and interact with the fields. This work was based on the theory of Meaningful Learning, which, according to Ausubel, occurs when a concept is related in a substantive way and not arbitrary concepts with pre-existing in the cognitive structure of the individual. A test with a novel question was conducted to determine if there was a Meaningful Learning. Reviews and evaluations were done to complete the work, highlighting its advantages in the learning process.

Key Words: Magnetic fields, augmented reality, meaningful learning.

INTRODUCTION

The energy matrix of Brazil is based on the electricity. This electric energy, almost in its entirety, is obtained through a process of energy conversion mechanics associated with the winds, the waterfalls, gas turbines, oil, steam, and others. The conversion of mechanical energy into electricity is only possible thanks to interaction of magnetic fields whose scientific basis is electromagnetism. The industry uses the same principles to generate electricity from the movement, which becomes the subject of great importance in the career of an electrotechnical.

In technical courses of Electricity, the process of teaching-learning of Electromagnetism is very important because the understanding of electromagnetic phenomena is scientific basis to the study of Electrical Machines that are the fundamentals of energy conversion mechanical to electrical and vice versa. So, these are fundamental concepts in the development of this professional.

The difficulties of Electromagnetism learning content focuses on the impossibility of visualization of magnetic fields by students in three dimensional space. According to Paz (2007), the difficulties of Electromagnetism

studies focus on understanding the interactions and behavior of electromagnetic variables in three dimensional space.

In this work, a learning object based on Augmented Reality environment was developed. This will provide to the student the interactivity and 3D visualization of the interaction between magnetic fields of two magnets. In this learning object the student can view the phenomena of attraction between the poles of different names and repulsion between poles of the same name. According to Guillermo *et al*. (2005), the simulations have emerged as objects of great learning, especially in engineering area, or even the exact sciences. This goal will serve to expand the horizon of the student, allowing interaction with the physical phenomenon under study, causing it to view objects in the virtual world that human beings do not can view in the real world. The use of mechanisms that provide the interactive manipulation of virtual models with the aid of the computer allows educational institutions to experience situations that go beyond the traditional blackboard, and also the initial experience of computer-mediated education only mechanisms of reproduction of information (Matos, 2008).

In the study of the interaction between magnetic fields the figure 1 or similar is usually presented to the student, where people can visualize two-dimensional form of the interaction between these magnetic fields.

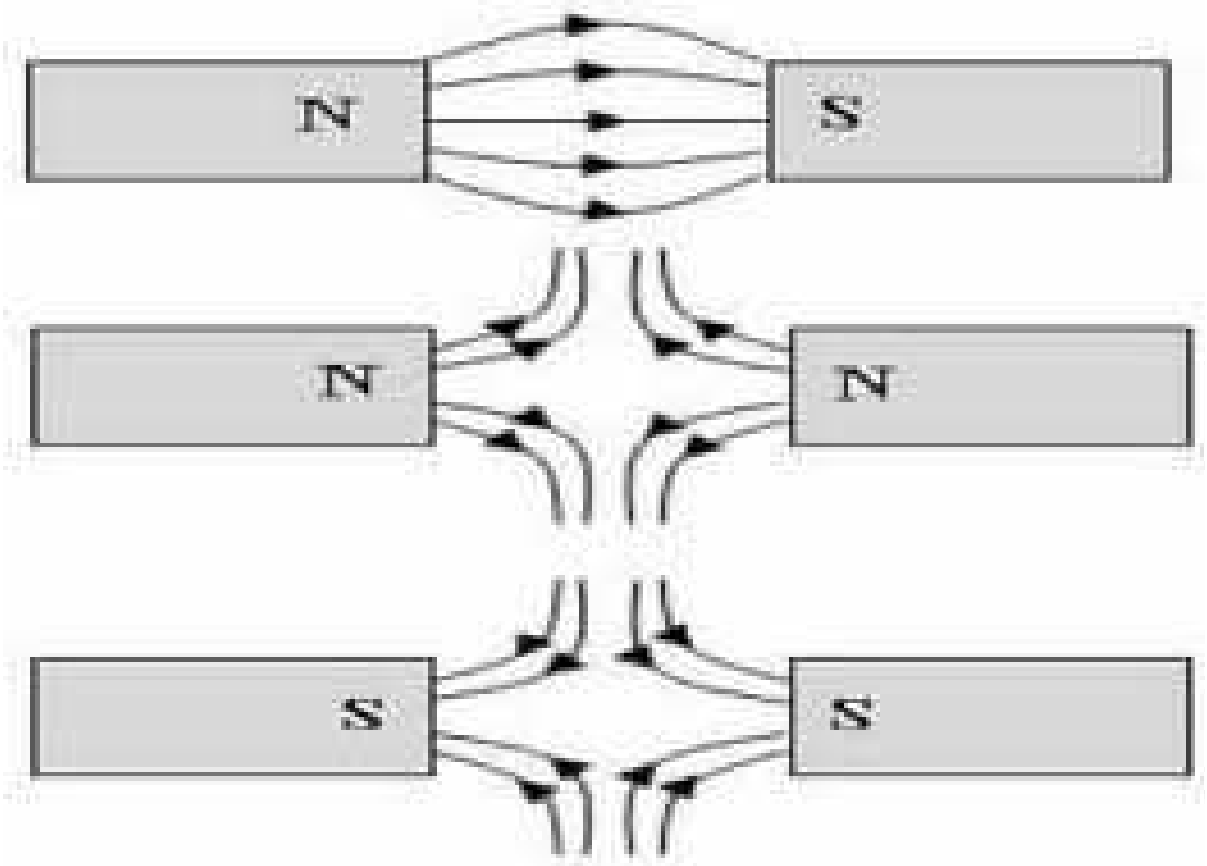


Figure 1: Interaction between magnetic fields (Smith, John Davis)

Note that this view is very rudimentary, mainly because presents a two-dimensional visualization and magnetic fields are three dimensional. In this sense, the computer can be a great ally of the teacher. According to Costa (2004), knowledge acquires new representations, either through simulations that allow for experience virtual mode situations, whose real way often do not realize. In many of the experiments that are done with computers in schools, the computer is used only as a breeder of traditional teaching methods.

With this learning object the student can visualize the interaction between the magnetic fields of two magnets as never experienced before. With the support of Augmented Reality the student can see in the third

dimension the interaction between magnetic fields of two magnets. This phenomenon can not be seen with the naked eye, because the magnetic fields are not visible to the human eye. In this sense, Augmented Reality will serve to broaden the horizon of the student, where he can view in three dimensions and also interact with magnetic fields studied. In other words, the student can see the invisible.

Although some proposals for the use of Augmented Reality in education are relatively new, this technology has been used successfully in several areas. Some proposals about the use of Augmented Reality in Education will be discussed as following. Buchau et al (2009), created three applications based on Augmented Reality to show the magnetic field of a magnet, the magnetic field solenoid and a magnetic field of an antenna.

These applications allow the student to visualize the magnetic fields in three dimensions. This work do not presents the results of use with students. Also using the Augmented Reality in education, Lemos and Carvalho (2010) created the SISEULER, which acts as learning object, where the student may have a better understanding of the Euler relation through visualization and manipulation of objects. This experiment was tested with a positive result with the teachers of basic education who are attending professional master's degree in mathematics education. Macedo et al (2010) presented a method of teaching solids using Augmented Reality.

1. The experiment using augmented reality

This experiment was built in Augmented Reality environment, which can be defined as a system that supplements the real world with virtual objects generated by computer, with the impression of coexistence in the same space (Azuma, 2001). This learning object was designed using the tool SACRA (Collaborative Authoring System with Augmented Reality). The system SACRA was developed in 2008 by a graduate student named Rafael Santin under the guidance of Dr. Claudio Kirner. According Kirner (2010), from the difficulty that people had to work with ARTool Kit, this tool was developed to allow users not computer experts develop applications with a simpler tool. The SACRA is a collaborative authoring system for augmented reality, which incorporates technical authoring and collaboration of augmented reality interface for highly interactive, offering its users new ways of interaction for the construction of virtual environments (Santin, 2008).

Initially is presented the first marker that is found in figure 2 called "reference" in order to initiate the process.

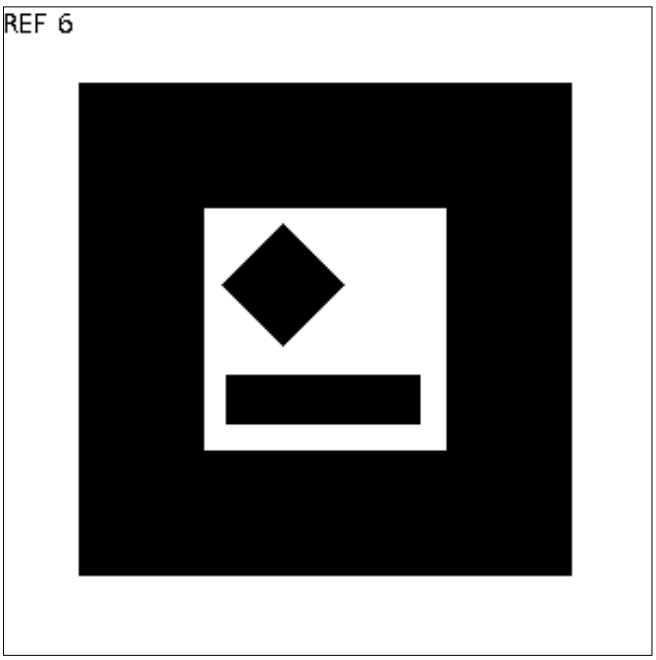


Figure 2: Bookmark "reference"

The sphere comes presented in figure 3, corresponding to the marker shown. A second marker arises, called "inspection marker" which is found in figure 4, bringing a second ball. This should first be docked in order to give the sequence programming. When one ball is over the other, then there is the first magnet, as seen in figure 5.

Figure 3: Sphere

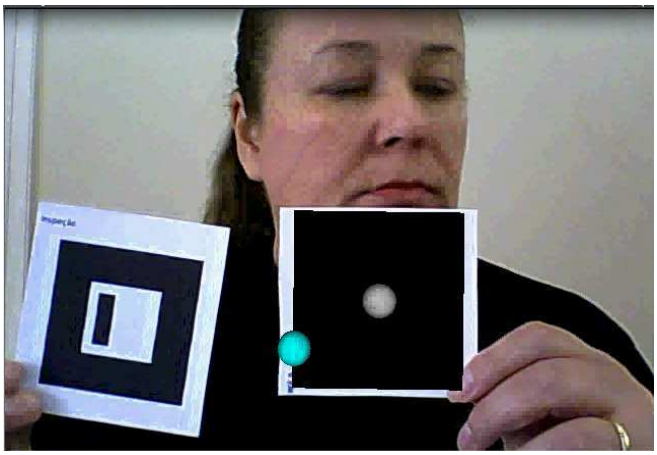


Figure 4: Approaching the second marker with the second sphere

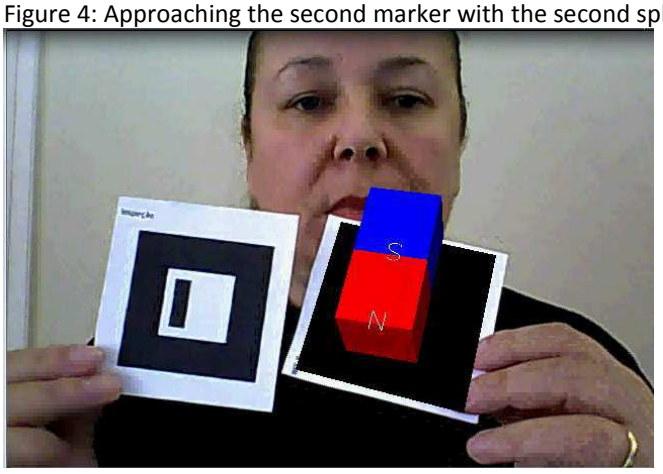


Figure 5: Emergence of the first magnet

This magnet based in Augmented Reality environment can be manipulated freely by the user in the third dimension. Figures 6 and 7 show it in other positions.

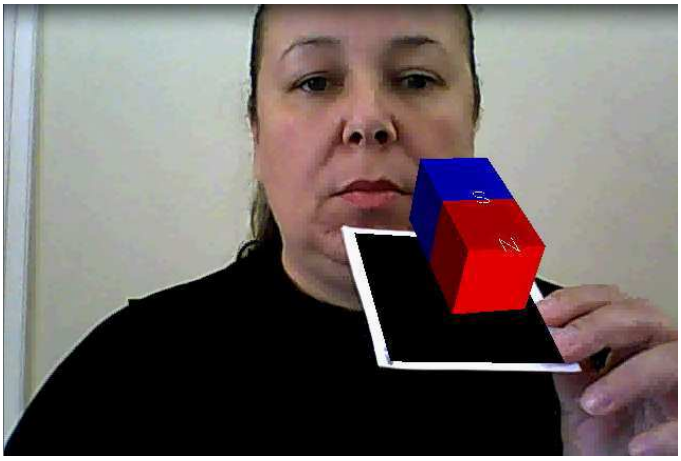


Figure 6: Magnet in a second position

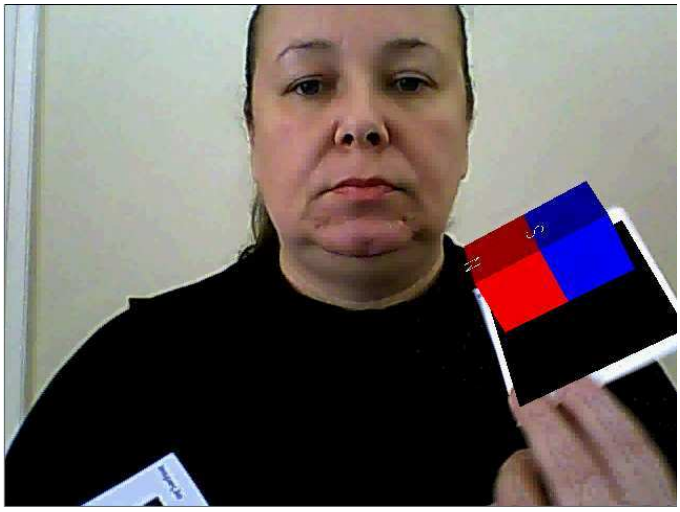


Figure 7: Magnet in a third position

There is the third marker, called "control", shown in figure 8, which will define the next actions to be triggered on schedule.

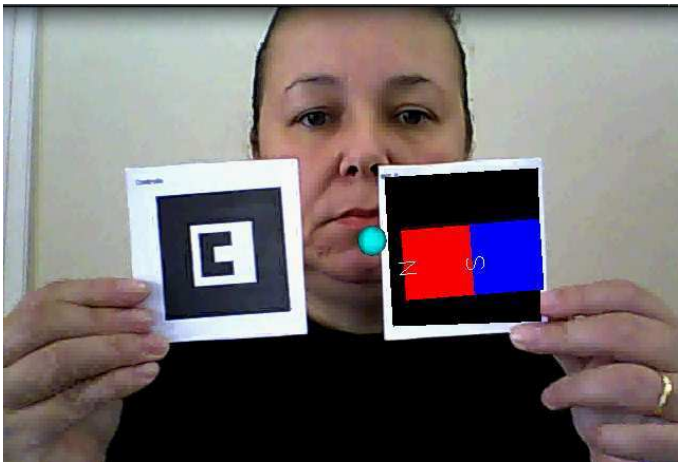


Figure 8: Magnet in a second position

The magnetic field arises from the first magnet, shown in figure 9, as was scheduled for action defined by the marker control.

Figure 9: Magnetic field of the first magnet

This magnetic field also can be freely manipulated by the user as can be seen in figures 10 and 11.

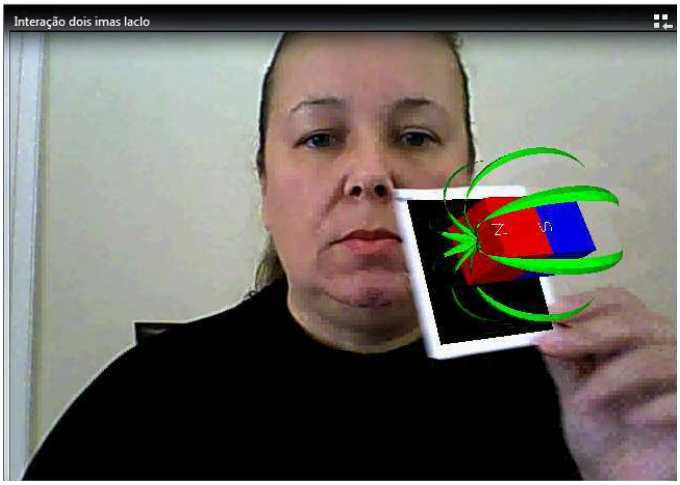


Figure 10: Magnetic field in a second position

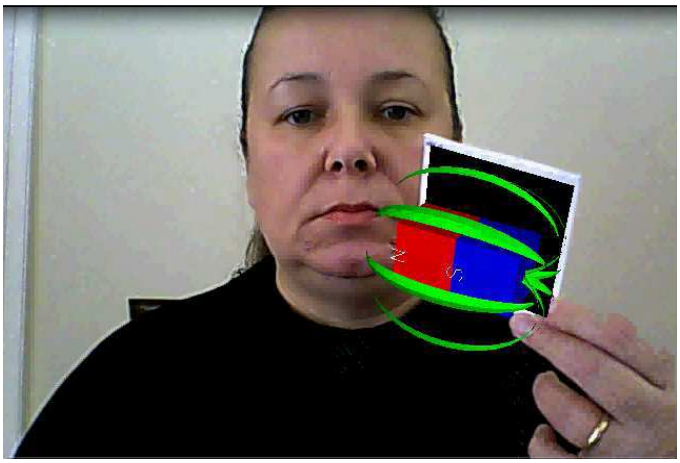


Figure 11: Magnetic field in a third position

The following is the label "control" in figure 12, again to the programming sequence.

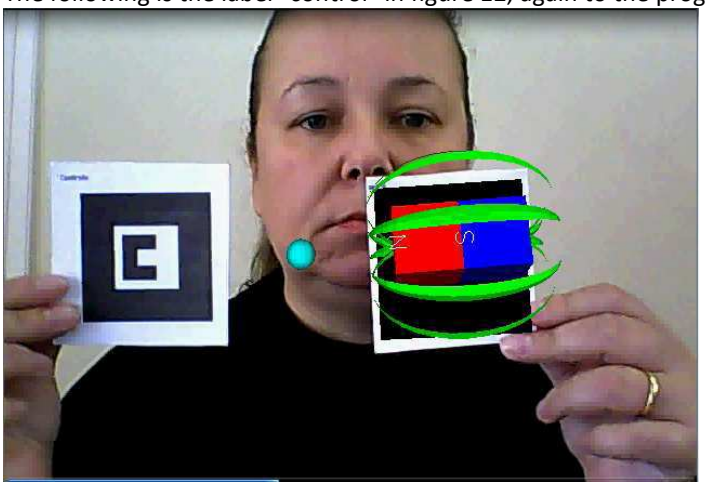


Figure 12: Marker "control" being approached

When the label "control" is presented to the camera, it brings the image of the magnetic field of the magnet representing the repulsion that occurs between poles of the same name, as can be seen in figure 13.

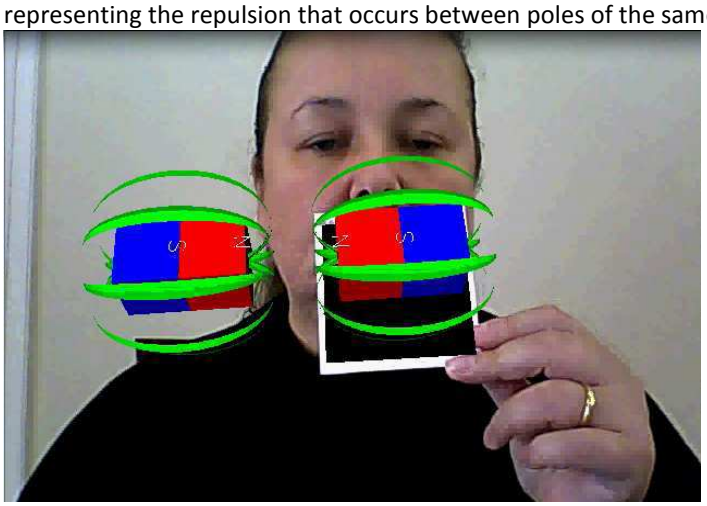


Figure 13: Interaction between magnetic fields: repulsion

The figure 14 shows these magnetic fields in a second position, and there may be manipulation by the user.

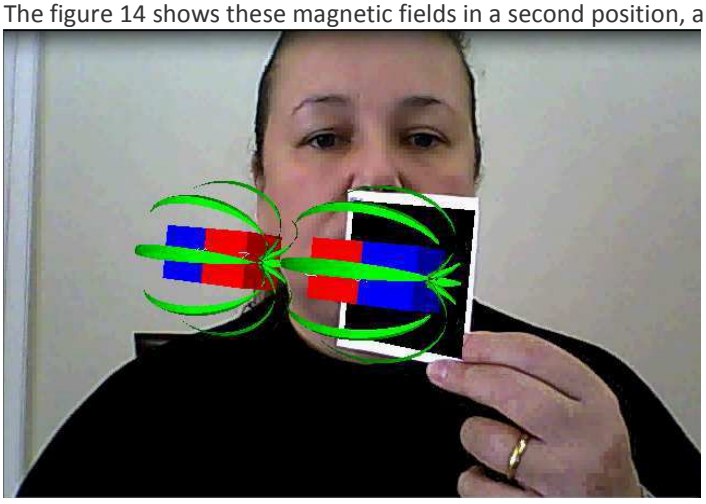


Figure 14: Interaction between the magnetic fields in a second position

Continuing the experiment, the camera is shown on the label "control" again and the magnets are now with the poles of contrary names facing each other. Occurs then the attraction, as seen in figure 15.

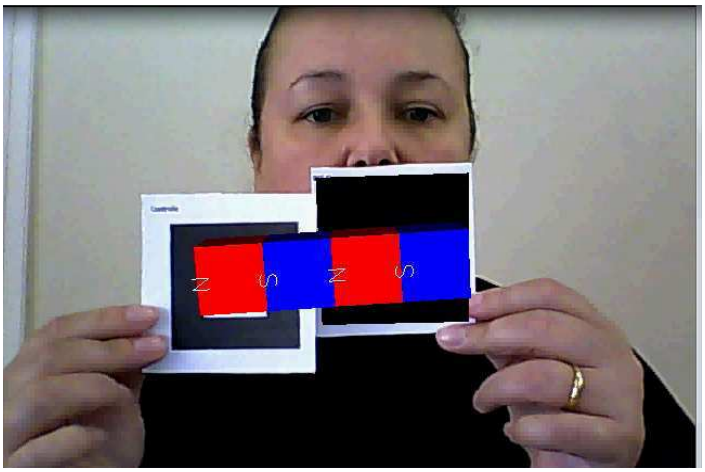


Figure 15: Attraction between two magnets

The following label, named "control", appears again and also the interaction between the two magnets in figure 16. At this time, shows the formation of a field resulting from the attraction between them.

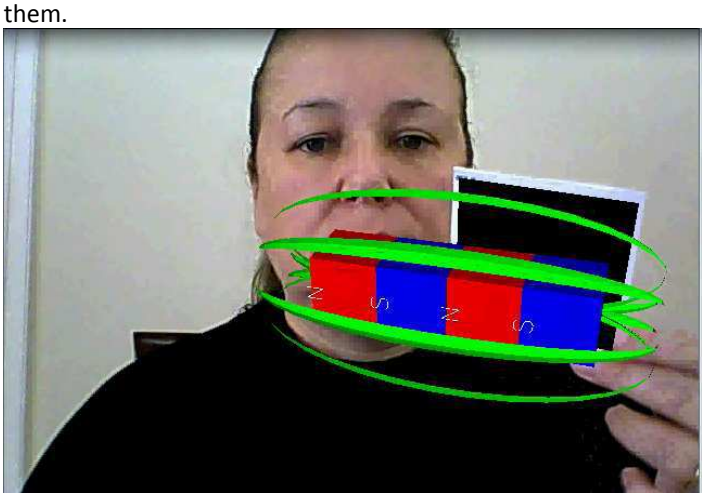


Figure 16: Magnetic field resulting from the attraction between two magnets

This experiment aimed to create an environment where students could see three-dimensional interaction between the magnetic fields of the magnets. It was also objective of this work to create a playful environment for the student.

THE PEDAGOGICAL EXPERIMENT

This pedagogical proposal is based on the Theory of Meaningful Learning proposed by David Ausubel. Meaningful Learning is a process in which a new information relates to an important aspect of the knowledge structure of individual (Moreira and Masini, 2001). This paper aims, from concepts already existing in the cognitive structure of the student of electricity, concepts such as current, voltage, the student uses them as subsumers underpin the new concepts to be learned, as the interaction between magnetic fields. According to Moreira (2006) the subsumers are a concept, an idea, a proposition in the existing cognitive structure that can serve as an 'anchor' to a new information. In this respect the concepts previously "anchored" in the student's

cognitive structure, such as voltage electricity and electric current, will serve as subsumers so that a new information is acquired by the student.

As new information, understand the concepts Electromagnetism required the teaching of Electrical Machines. Guimarães (2009) says that Meaningful Learning can be seen when is created a new situation that requires transformation of the original knowledge. In this experiment, Meaningful Learning was observed as follows: (a) was performed the experiment in Augmented Reality where the students could observe attraction and repulsion between the poles of two magnets. In this case the subsumers were concepts of voltage and current. (b) Subsequently, watched a video about the principle of operation of the electric motor. (c) Finally managed to write with their words using knowledge gained as new subsumers what had learned about attraction and repulsion of magnets.

A preliminary test was made in June 2011 with 58 students of Electrotechnical of Instituto Federal Fluminense, in Itaperuna city, state of Rio de Janeiro, Brazil, day shift, in their own classroom. Those students were divided in two groups: “A” Group, 44 students using Augmented Reality and “B” Group, 14 students who don’t.

The inedit question proposed for the observation of signs of Meaningful Learning was:

“From the figure 17, explain the operation of the elementary DC motor:”

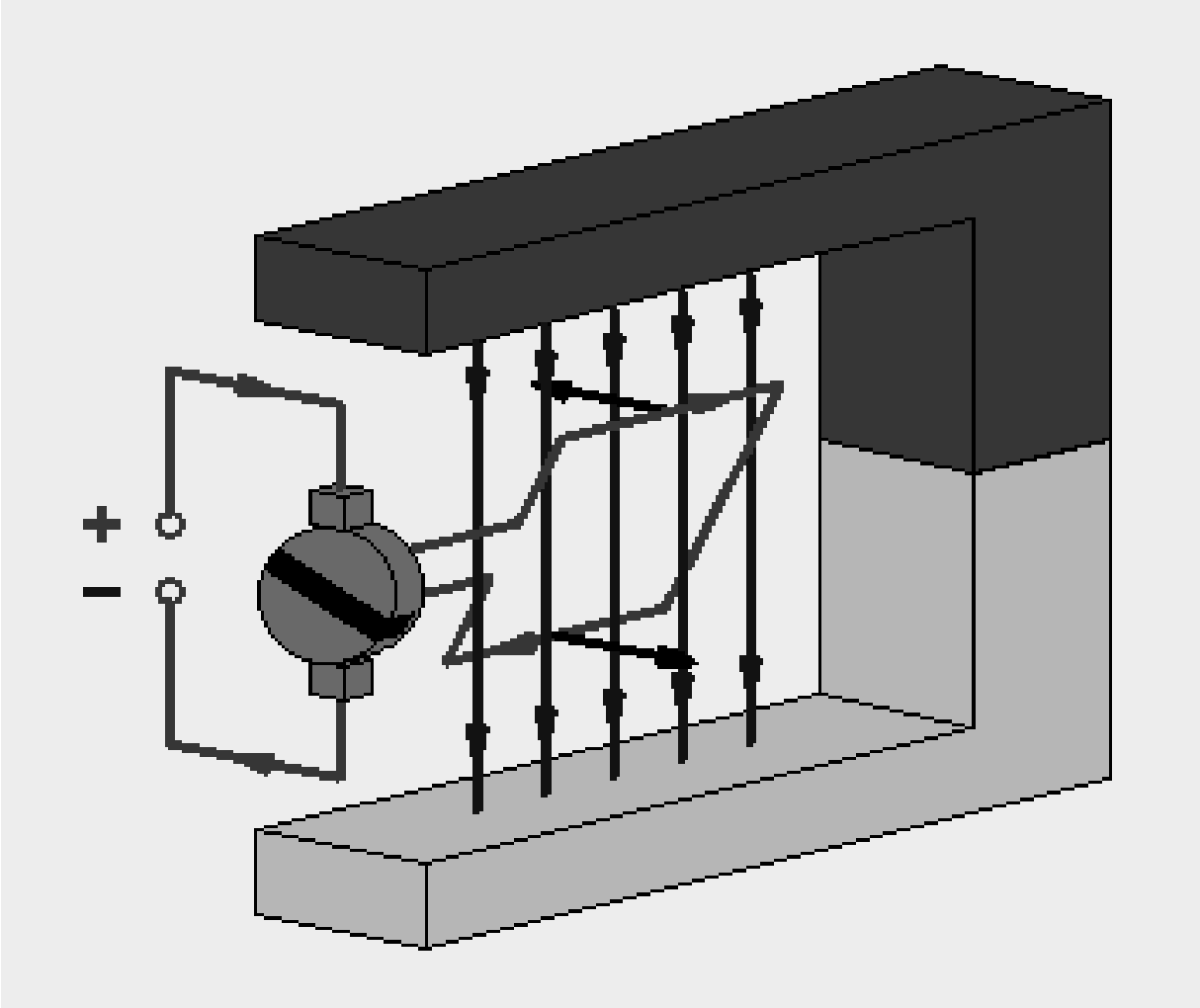
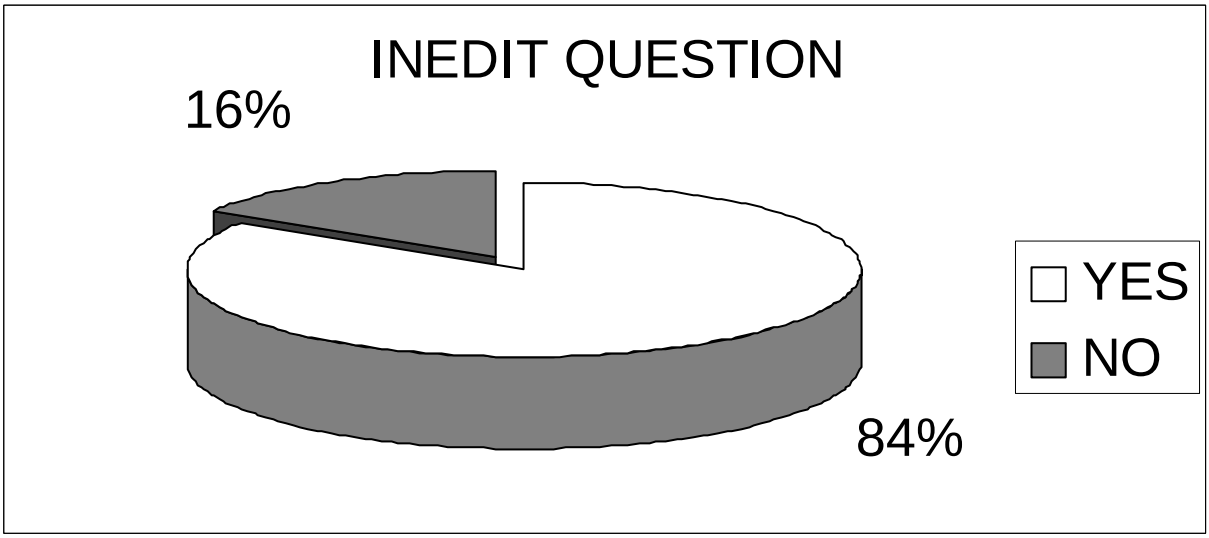
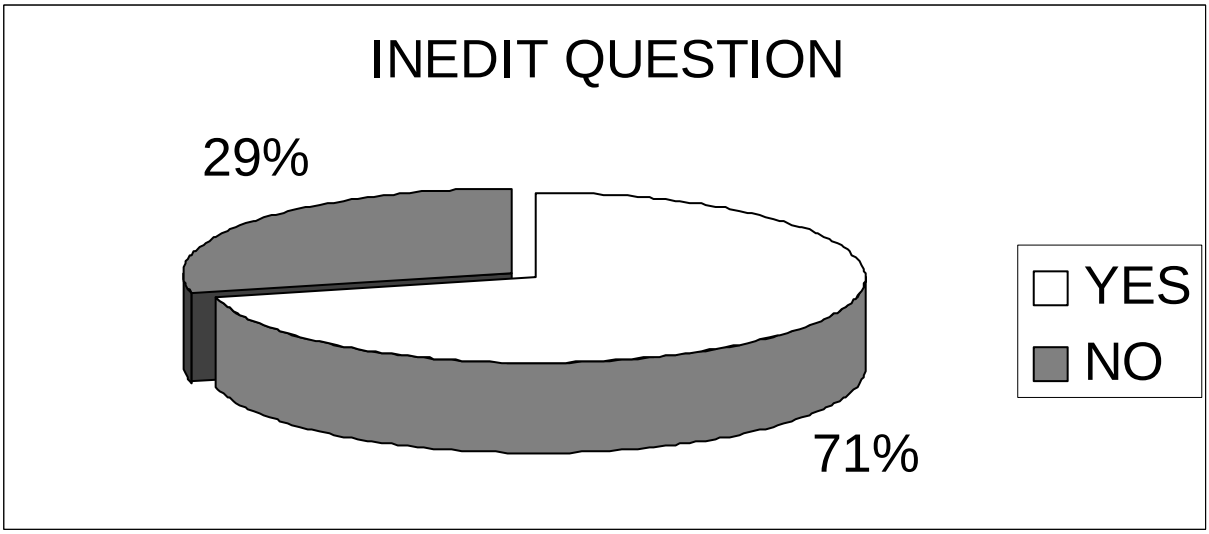


Figure 17: Question proposed (http://www.walter-fendt.de/ph14e/)

The graphics 1 and 2 shows the results:



Graphic 1 : Percentage of students who had correct answer – "A" Group



In this experiment was used a laptop with Webcam. Initially the students were able to observe the teacher and later each one could manipulate the experiment. This small test was conducted with the objective to enrichment of the learning object for later use as support in conventional classes. The results will be demonstrated and discussed below.

RESULTS AND DISCUSSION

In the test performed, the 58 students responded to a inedit question in order to observe indications of Meaningful Learning. In "A" group (students that used Augmented Reality) 84% gave the right answer to the inedit question, while in the "B" group, only 71% did.

The Learning Objects in Augmented Reality aimed to present to the students a way to interact and visualize in three dimensions the interaction between magnetic fields of two magnets, and can see the attraction and repulsion between them.

This work aims to propose a new way of teaching magnetic fields. With this experiment, students were able to visualize and interact with magnetic fields of two magnets using the Object Learning based on Augmented Reality.

CONCLUSIONS

From what was shown, students were able to actually visualize the 3D magnetic fields of two magnets and also could interact with these fields. Augmented Reality enabled the direct interaction between the real environment and virtual environment by improving the understanding of reality, since the magnetic fields are not visible to the human eye. The use of The Meaningful Learning Theory was successful. As shown with the statistics study, the group who used Augmented Reality had better performance than the other.

The environment in Augmented Reality allowed students to observe the interaction between the magnetic fields of two magnets, where it was possible to study the attraction and repulsion between them, which does not would be possible without the Augmented Reality. The use of the environment in Augmented Reality is very easy and inexpensive. This study used a laptop with webcam.

Students were able to interact with the environment in Augmented Reality too, and, therefore, with the magnets. Also, it can be concluded that the approach to this issue using Augmented Reality techniques can be very profitable for teaching.

WJEIS's Note: This article was presented at World Conference on Educational and Instructional Studies - WCEIS, 07- 09 November, 2012, Antalya-Turkey and was selected for publication for Volume 2 Number 4 of WJEIS 2012 by WJEIS Scientific Committee.

REFERENCES

Azuma, R.; Baillot, Y.; Behringer, S. F. Julier & S. MacIntyre, B. Recent Advances in Augmented Reality In: *IEEE Computer Graphics and Applications 21*, 6 (Nov/Dec 2001), 34-47.

Buchau, André; Rucker, Wolfgang M.; Wössner, Uwe & Becker, Martin. Augmented Reality in Teaching Eletrodynamics. *The International Journal for Computation and Mathematics in Electrical and Electronic Engineering*. Vol. 28 No. 4. 2009. pp 948- 963.

Costa, José Wilson da & Paim, Isis. Informação e conhecimento no processo educativo.(2004), In: Costa, José Wilson; Oliveira, Maria Auxiliadora Monteiro (Org.), *Novas Linguagens e Novas Tecnologias*, Petrópolis, RJ, Vozes.

Guillermo, O. E. P.; Tarouco, L. M. R. & Endres, L. A. M. Desenvolvimento de Objetos Educacionais: Experimentos em Hidráulica (2005), *In RENOTE – Revista Novas Tecnologias na Educação*, Porto Alegre, v. 3 Nº2, novembro, 2005.

Guimarães, C. C. Experimentação no ensino de Química: Caminhos e Descaminhos rumo à Aprendizagem Significativa, *Química Nova na Escola*, vol. 31, agosto, 2009.

Kirner, C. (2010). *Funcionamento e Utilização do Sistema de Autoria Colaborativa com Realidade Aumentada*, http://www.ckirner.com/sacra/, Acess in 04/abril/2011.

Lemos, B. M. & Carvalho, C. V., Uso da Realidade Aumentada para Apoio ao Entendimento da Relação de Euler. RENOTE. *In RENOTE - Revista Novas Tecnologias na Educação*. V. 8, p. 1-10, 2010.

Macedo, S. H.; Lima, J. V. & Azevedo, F. C. Uso da Realidade Aumentada no Ensino de Sólidos (2010), In*: Congresso Iberoamericano de Informática na Educação*. Santiago: Universidad de Chile, p. 179-183.

Moreira, M. A. *A Teoria da Aprendizagem Significativa e sua implementação em sala de aula*. (2006) Brasília: Editora Universidade de Brasília.

Moreira, M. & Masini, E. S. *Aprendizagem Significativa – A Teoria de David Ausubel* (2001), Centauro Editora, São Paulo, SP.

Paz, A. M. *Atividades Experimentais e Informatizadas: Contribuições para o Ensino de Eletromagnetismo* (2007), Universidade Federal de Santa Catarina, Florianópolis, 228 p. PhD Thesis.

Santin, Rafael. *SACRA - Sistema de Autoria Em Ambiente Colaborativo com Realidade Aumentada*. Piracicaba: UNIMEP - Universidade Metodista de Piracicaba, 2008. 125p. Master Dissertation – Mestrado em Ciência da Computação, Faculdade de Ciências Exatas e da Natureza.

Silva, J. F. *Representação Geométrica do Campo Magnético* In: http://educacao.uol.com.br/fisica/campo-magnetico---representacao-geometrica.jhtm

Smith, John Davis; Education Uol. In: http://educacao.uol.com.br/fisica/campo-magnetico---representacao-geometrica.jhtm)