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MEDIATIC LANGUAGES AND LEARNING: NEW POSSIBILITIES FOR NEW PARADIGMS IN TEACHING PHYSICS

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Abstract
Physics has been suffering prejudices throughout history, mainly due to a teaching that, even nowadays, is practiced through outdated methodology, based on oratory and exposures through chalk and black board. In turn, the new technologies give us opportunities to revitalize and rethink Physics teaching, making it attractive and efficient. The disruption of the current paradigm, however, goes beyond the insertion of new materials. It is necessary to involve students and teachers, checking their real needs. Thus, here we discuss a technology used as a support tool in Physics teaching: computer animation. We present some reasons for applying animations in teaching as well as the methodology used to create animations and results in the classroom. These results show that although the use of animations is viable, it is necessary to invest in strategies that, on one hand, make the new resources more accessible to teachers and, on the other hand, enable teachers to extract the most from new technologies.

Keywords: Mediatic languages, Physics teaching; New technologies; Computer animation

1. INTRODUCTION

Human beings are constantly changing the environment in which they are inserted, requiring new technologies that eventually modify mankind, their attitudes and their society as a whole. A growing concern with the integration of technology and education for the good of society is gaining more space, especially since the second half of the last century, when technological development gained momentum. From this perspective, new educational policies have been proposed, pointing to the use of new technologies in teaching and learning processes (Veraszto et al., 2012a).

This new point of view is not limited to the use of new tools in specialization or training tasks, but assuring the students with a solid education that will help them generate and manage, in the future, the demands of our society. The integration between technology and education must, therefore, contribute to the integration of individuals in society, complementing their training, making them more critical and more human (Veraszto et al., 2012b).

The current stage of our technological development ultimately makes clear, therefore, the limitations of the old teaching and learning model – which is still widely used, based on oratory and "chalk and blackboard". However, even though Brazil is considered a country in "development", several initiatives demonstrate the increasingly intense and diverse use of new technologies applied to education, as we can see in several studies, such as Barros Filho *et al.* (2011), Camargo et al. (2011a), Camargo et al. (2011b), Veraszto et al. (2012b), Camargo & Veraszto (2013), Mota et al. (2013), Santos *et al.* (2013) and Veraszto et al. (2013).

Thus, the use of Information and Communication Technologies (ICT) in the educational context gives us more perspective in revising old teaching and learning processes. The possibility of developing new communication methodologies that facilitate the construction of knowledge is a way to approach teachers, students, curriculum and differentiated and attractive education (Padilha & Alcoforado, 2011).

However, we must state that the solution of the problem is not only the development of the teaching resources. The use of new efficiently technological resources can indeed improve the educational process, taking into account the students' real needs, not to mention their difficulties, their skills and their different ways of learning. In the same direction, so that the process can be really efficient, we also need to think about the teachers, considering that they have different skills and often need training for new languages and technologies (Veraszto et al., 2012a).

So, this work proposes the use of a new technological resource, the animation made by computers, as a support tool to the teaching-learning process in a discipline considered "difficult" by both teachers and students: Physics. We hope that, through the use of this resource, teaching can become more attractive, breaking the myth of a discipline that frightens, demonstrating, even if partially, the feasibility of using new technologies in education and also helping education to become more attractive and efficient for students.

In this context, the following topic shows our theoretical foundations, presenting concepts on the application of new technologies in education, in addition to fundamentals of animations made by computers.

2. THEORETICAL BASIS

Physics education challenges teachers at all levels and with different backgrounds. On one hand, the traditional teaching has consolidated strategies used in the classroom. On the other, the world has become more dynamic (Mota et al., 2013). Access to information has enabled knowledge acquisition in a way never seen before in human history. Interactive and mediatic technological resources connected in networks often contrast with the lack of creativity of teaching methods.

The abstraction required for Physics teaching also provides a barrier increase between the need to learn it and the stimulus that it provides to students. A student accustomed to interactive games and easy access to information on internet and television cannot envision interest in equations from Physics studies. The student accustomed with a dynamic society that entertains, but also informally educates through images and sounds, will not feel familiar with lectures that reduce real phenomena to solutions of numerical exercises. The daily life, full of attractive information, images, sounds and interactive resources makes the emerging student of a technological environment feel a stranger in the classroom (Barros Filho et al., 2009).

However, access to technologies is not enough. Often, the inclusion of alternative resources in traditional classes ends up in fear or distrust of teachers and educational leaders. Simply mentioning the word "technology" can generate amazement in a group of teachers trained in another generation, who do not feel prepared to use it and much less to develop it. However, technology has always been present in the classroom, through simple forms like chalk and blackboard, book and copies or, nowadays, through software and hardware (Padilha & Alcoforado, 2011).

For some time the academy has reflected on the adoption of new procedures and methodologies for an attractive teaching of Physics. However, the classes still have the same traditional posture. Innovations often come from other areas of knowledge and are not in parallel with the findings and requirements of the new methods of teaching (Miranda et al., 2006).

Oftentimes different strategies come from areas more directly linked to technological innovation than from areas related to education. While the speech calls for new teaching methods, digressing in theories often disconnected from reality, professionals of engineering and computer science find solutions that could be applied efficiently in almost all levels of education in sciences (Cardoso et al., 2010).

It is not difficult to realize that society has changed, that students are not the same of long ago and that the main difficulty today is breaking barriers and paradigms. Technology does not paralyze us, the mediatic language does not alienate us, the machine does not replace the man. After understanding the teacher's role in the teaching process, it is easier to choose the best strategies to pass a particular content for students. After understanding that the student is the main actor of the learning process, it is easier to direct all possible resources to make a more attractive and reflective class. It is different to require content and require reflection (Camargo et al., 2008; Veraszto et al., 2009).

In this scenario, however, there is no one to blame. It does not make sense to require a teacher to use technological resources, not even ask him/her to approach the content in different ways if he/she was not trained to do so. Nowadays, teachers even more than students need support to handle new technologies effectively, so they can be able to use the machines and their audiovisual and interactive languages as much as possible (Veraszto et al., 2012b). This is a unique moment in time, where new technologies have grown exponentially in recent years, putting aside professionals who failed to closely follow these developments.

Thus, the use of computational tools for modeling Physics educational concepts has been presented as a great potential resource in the learning process. In Physics, the paper version of a model shows its static nature, in which it is privileged an instant version of reality. A computational version is dynamic, since we can feedback or restart it. These dynamics help to reflect and think a new understanding of reality, allowing calculations that envision a better evolution of the situation studied (Cardoso et al., 2010).

Thus, based on the scenario quickly described, this study aims to contribute to Physics teaching so it can be more attractive from the production of digital animations. For this article specifically, we used empirical data about the difficulty of students in abstracting many Physics phenomena in all their possibilities. We designed the animations from these data, in order to facilitate understanding by inserting videos in the educational context.

From the empirical findings we obtained through interviews with teachers of Science from Elementary School and teachers of Physics from High School, in this study we aimed to build tools (in this case for Physics) able to represent visually some Physics phenomena – thereby facilitating the learning of these concepts. These tools can also lead to construction of critical and reflective thinking; relations between the sender and the receiver; intention of narratives and messages; building of schemes, arguments and themes; language sense; and, of course, the necessary paths for implementations, including through the mastery of technological tools (Padilha & Alcoforado, 2011).

2.1. Animation made by computers and Physics

The journey from the Gutenberg press, through typography and typing for optical media and the internet, shows a constant reinvention of an old habit of human beings: the practice of storytelling (Murray, 1999). The act of transmitting information – playfully, enigmatically or in a formal way – is still alive and, why not say, more present than ever. Men reinvented and improved the habit throughout their social and technological developments. Orality gained new allies with print, radio, cinema, disks, CDs, DVDs and other digital media. Handwritten pages have evolved into interactive virtual pages (Dorneles, 2006; Van de Pol, 2010).

The cinema, in its turn, was a pioneer in capturing moving images and displaying them. The display of still images sequences allowed the film to show the real idea of movement, thanks to small changes in time intervals. This was only possible because of the "persistence of vision" in the retina.

After a while, animation also appeared – word that itself derives from the Latin verb *animare*, meaning “giving life to something”. Thus, we can understand “animation” as the art of creating a series of individual and continuous poses (Patmore, 2003). The animation surpassed the film limitation on only showing photographic scenes movement. The use of graphic arts along with the film peculiarities allowed the man to transport imagination to the screen. With this new way of showing the movement, the man created different rules by mixing design, physics, anatomy and the unusual. In general, animation is possible only with four crucial components: object, behavior, space and time. Over the years and with the arrival of computers, virtual reality gained strength thanks to special softwares developed to give life to the imagination (Padilha & Alcoforado, 2011).

As in the movies, in an animation we have a sequence of frames (images) being presented at a certain rate (usually between 24 and 30 frames per second for film and conventional TV) simultaneously with its soundtrack. Thus, an animation with an hour and a half can get to 1.5x60x60x30 = 162,000 images. This number alone is enough to show that an animation creating process consumes, undoubtedly, a great deal of resources.

In its early days (early twentieth century), the animations were built from hand-drawn sketches, often on acetate sheets, which were then photographed for the final animation synthesis. With the advent of the computer and its subsequent evolution, animations practically stopped with acetate and were built almost entirely through computers. Initially, the construction of animations was only "aided by computer", which performed just a few steps in the creative process – such as camera control that photographed the animation frames. Subsequently, the extent to which computers and softwares became more complex and powerful, the animation has become almost completely "modeled by computer", where it is possible to perform the majority of the activities envisaged in the animation creation process. Thus, in "computer modeled animation", this machine is closely linked to virtually the entire creative process, being used from the artistic conception of the "actors" and "scenarios", through the animation frame generation, to the film synthesis and its soundtrack. We can obtain more detailed historic and general information on animations in Kuperberg (2002), Patmore (2003) and Williams (2001).

The creation of animations, modeled or not by computers, involves a sequence of steps that begins with the story definition (theme/plot). Set the plot, creation of the script is the next step, i.e., "how" the story develops. Next, it is usual the creation of a story-board, i.e., a comic, which has the proposed script in a simple graphical form. The story-board is also used to begin to shape the actors and scenes of the animation. Until then, the computer influence (or use) may be minimal.

Set the script and the story-board, the computer takes part of almost the entirely creative process. From this point, the computer is used for the creation and modeling of the actors and the animation scene. Once the animation elements have been created, the computer is used for image synthesis (frames) that comprise the animation. The generation of "key-frames" is a widely technique that marks important events in a sequence of animation – and later the computer automatically interpolates them. This technique significantly optimizes the animation process creation (Patmore, 2003).

When all animation frames are generated, the next step is to “glue” them together, thereof the film will be generated. Subsequently, the soundtrack is associated with the film and eventually there may be an editing and post-production process where parts of the film may be edited or removed.

Parallel to the evolution of the creative process in an animation, many efforts are made to reduce the barriers between traditional education and daily life, thanks to the insertion of videos or animations in classrooms. We know that Physics is not the most popular discipline among students. The dreaded complexity of this science can be the result of a historical trajectory of prejudice combined with the excessive formalization of the content taught in school. Thus, Science teaching, specifically Physics teaching, lacks visual help so we could better interpret its abstract phenomena.

The implementation of a "physic animation" or "simulation" includes the development of more complex steps, as we describe below, due to the need to physically represent a valid model.

i. **Prior description of the physics phenomenon in an informal way, through texts and sketches:** before building an animation we need to know the basics of what we intend to model and animate. In a physic phenomenon case, in this step we collect information about it, describing, not strictly, the phenomenon behavior. The main question to be answered at this stage is: How does this phenomenon interact with the environment and the elements around it?
ii. **Determination of the mathematical model that represents the physics phenomenon that we intend to simulate**: "physics reality" is described by models that can be fully defined by mathematical language. Thus, to represent a physics phenomenon, even as graphic, we need to know the mathematical model that defines its behavior. The mathematical representation, graphically encoded in an appropriate manner, produces an animation able to represent faithfully the physics phenomenon.

iii. **Mathematical model transcript for computational form through a graphical language:** as we mathematically coded the physical model, the next step of the creative process of a physics animation involves the translation of this model for the computer, using a graphical language capable of transcribing the model developed for a visual form, which the computer may synthesizes. In order to build efficiently and accurately the animation, at this stage the selection and use of a specific software are crucial.

iv. **Synthesis of the animation frames:** after the translation to the graphic computer language, the next step in creating an animation is the frames synthesis. At this stage, an appropriate software generates all the images that are part of the animation.

v. **Choosing the animation "soundtrack":** After the animation frames synthesis, the soundtrack is defined. The chose/synthesized audio must be compatible with the concepts that the animation wants show.

vi. **Fusion of the animation frames and soundtrack:** finally, the last stage of the creative process involves the final animation construction, by merging the synthesized images with the soundtrack.

We can find additional information on physics "simulations or animations" in Barzel (1992).

2.2. Software for the development of animations

The phase of digital creation of actors and scenarios and the synthesis of the animation frames can be achieved through a large number of packages available. For example, we can cite "*Renderman*" from the Pixar/Disney Studios; "*Maya*" from *Autodesk*, usually used by *Dreamworks*; "*Cinema 4D*", eventually used by *Sony*, plus a few more packages available. All packages we mentioned are called "proprietary", as they imply the purchase of licenses for their use.

Contrary to the proprietary packages we can name some freeware, with public use and great potential for creating animations, simulations or games. We chose a freeware package to use in this project. As example, "*PoV-Ray*" (Pov-Ray, 2010) (*Persistence of Vision Ray Tracer* – http://www.povray.org), is a script-based language (scripts or programs properly) through which an user can model and synthesize individual images or sequences of an animation. As an alternative software there is "*Blender*" (Brito, 2007) (http://www.blender.org), which aggregates in one package several interesting tools for development of animations, simulations and games modeled by computers.

We chose the software *PoV-Ray* for development of animations that were the basis for the purpose of this study. This is a *freeware* created and in constantly development directed to the synthesis of images with photo-realistic quality. In addition to synthesize images, *PoV-Ray* can generate sequential frames of an animation. *PoV-Ray* operating principle is based on a ray tracing algorithm, through which the path of each ray of light present in an image is drawn. It is, therefore, an algorithm that creates images with high degree of realism, as it is expected of an animation that is intended to represent a physics phenomenon.

3. METHODOLOGY

In this paper we present a qualitative approach to the use and viability of new technologies applied to Physics teaching, being guided by quantitative data describing the teachers' perception on current teaching tools and opportunities offered by new technologies.

We divided the practical activities of this work into three stages. The first consisted of an exploratory survey, conducted through informal interviews with seven teachers of elementary and high schools, from public and private institutions in the state of Sao Paulo, Brazil. In the second step we used the data obtained in the development of three-dimensional animations for Physics teaching. Finally, in the third step, we applied the animations in the educational environment.

3.1. First step: characterization of the observed sample

The interviewed teachers were: two high school Physics teachers in the city of Mogi Guaçu, SP, one that worked on a particular institution and one that worked on public and private institutions; a Science teacher of a public school in the city of Mogi Guaçu, SP; a Science teacher of a public school in the city of Mogi Mirim, SP; three high school Physics teachers of a private school in Campinas, SP. We interviewed these teachers in order to know common problems faced in Science teaching, especially in Physics education. We summarized the data in Table 1.

Based on the data, it is clear, empirically, what the theory quickly pointed out in the introduction of this study: Physics education is discouraged by excessive formalism and disconnection from the student's routine. We can, therefore, justify the major objective of this study: to generate learning objects that may contribute significantly to the educational processes improvement. Thus, as we describe below, in this study implementation phase we produced a 3D animation with a freeware support, as we showed previously.

Table 1: Exploratory research results carried out with science teachers. Major problems they have in classroom.

Questions	Answers
What is the main problem currently found in Science and/or Physics teaching? (only one answer)	Two teachers pointed out the difficulty with the operation of formulas. A teacher said it was the lack of interest in this science. Four teachers cited a difficulty to abstract the phenomenon, to view it, relating it to the everyday.
How do you perceive the student's interest in Science disciplines?	Six teachers said that almost all students have no interest. A teacher has pointed out that among five groups that he teaches only one is interested.
Have you ever thought about a solution to diversify Science and/or Physics teaching? If you answer yes, what is your suggestion?	A teacher suggested revising the Physics and Sciences curriculum. A teacher suggested increasing the number of Science classes in public schools. Five teachers mentioned the importance of trying to differentiate lessons by using videos, games or other mediatic technology.

3.2. Second step: creating animations for Physics Teaching

We based our creative process by using *Pov-Ray* (Pov-Ray, 2010) which, as seen, is a freeware directed to the synthesis of images of photo-realistic quality by computer. However, given the *PoV-Ray* characteristics and other graphics software, although the tools for the development of the desired activities are available to everyone, creating animations or simulations modeled by computer requires a particular set of knowledge; what is not, therefore, a trivial activity. In this way, it is expected that the person interested in this area acquires basic knowledge in computer graphics, such as those presented in Foley (1994), Schneider (2003) and Vince (2006). This person shall also acquire knowledge in animations, according to Parent (2002) and Kuperberg (2002), besides knowing the tools that should be used for the work development. Artistic skills are also desired (Williams, 2001).

Thus, from the data we presented in the previous subsection, we started the development of didactic animations for Physics teaching, whose results we partially present through the frames shown in Figure 1.

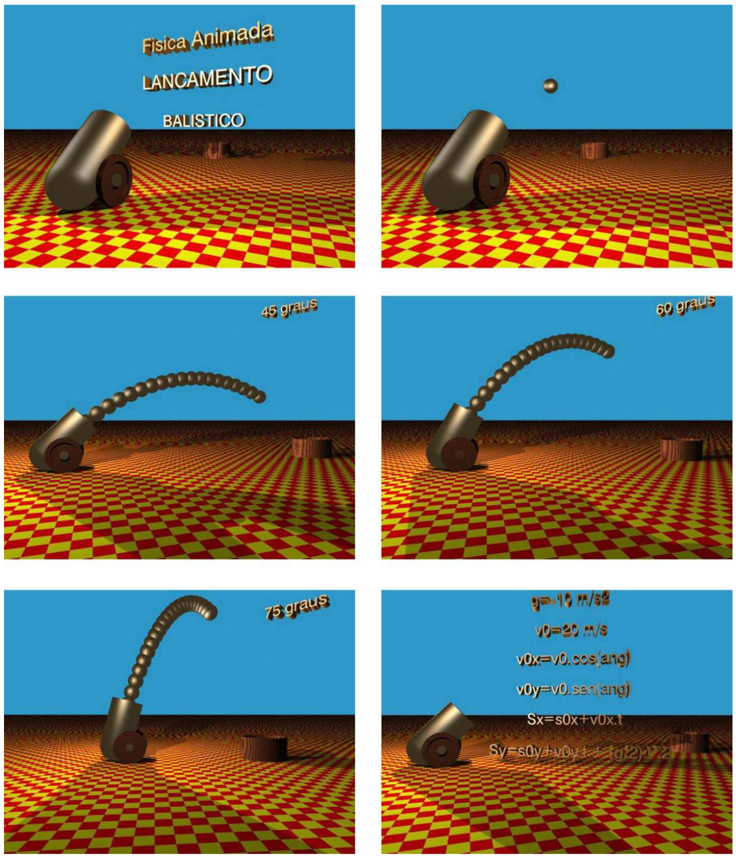

Figure 1: Tables relating to an animation on ballistic launch.

3.3. Third stage: presentation of animations in classroom

As a final step of the practical part of this experiment, after the development of the animations, we presented them to the high school students, in Physics classes, taught by the interviewed teachers. We showed these animations after the teacher presented their topic in the conventional way. The results we obtained by this procedure we described and analyzed in the following section.

4. FINAL CONSIDERATION

To verify, even partially, the feasibility of using animations as part of the educational process, after having seem the animations, the students were oriented to anonymously opine in their use as a support instrument to their learning. Considering the Rensis Likert scale built in 1932 (Likert, 1932), which consists of a set of assertions in which respondents are asked to point out one of five response options ("strongly disagree"; "disagree in part"; "neither agree nor disagree"; "partly agree" and "strongly agree") the students evaluated the statement: *"the animations created by computer significantly helped the learning of Physics topics"*.

As a result, in a sample of 155 students, 53 answered "strongly agree"; 61 answered "partly agree"; 26 answered "neither agree nor disagree"; 13 answered "partly disagree" and 2 answered "totally disagree". Through a quick analysis, we could see that 114 respondents (i.e., approximately 73% of the total) consider that the use of this technology brings some benefit to their learning.

Despite the relative simplicity which we accomplished this test, we can infer that there is indeed a positive correlation between the use of new technologies and the teaching-learning process. It is necessary, however, further studies to define the real extent of the impacts of new technologies in education. In particular, in addition to animations, more mediatic resources should be explored in this context. A very promising resource is the use of "interactive simulations" (or games) as a construction tool and knowledge consolidation.

There are other aspects that should also be considered. The creation of animations, simulations or games is still a task that requires mastery of specific knowledge, which is beyond the traditional teacher training. There is, therefore, the need to invest in strategies that, on the one hand, make new resources more accessible to teachers and, on the other hand, enable them to extract the full potential offered by new technologies.

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