Micro-documentary as learning resource

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This paper discusses possibilities of use of 3D animation as a tool for teaching Chemistry support. The research proposes to investigate the conception process and development of educational animations to use in a Blended Learning environment in undergraduate chemistry. Associated with general chemistry teachers, were raised the demands and difficulties on the content transmission, and the most relevant topics, about "Atomic Theory" with propose to create appropriate animations to meeting needs of themes. Thinking on offering more dynamic materials, we elaborate animations in a format of "micro-documentary", with a length between 4 and 7 minutes. We use the narration aloud to the subject-matter understanding, leaving the external text as a complement of the animation. The conclusions were positives, students accepted well the format and they proved are able to remember, organize and systematize several information presented in animations. These skills do not ensure knowledge acquisition, but may be considered prerequisites to learning occur.

Keywords: 3D animation; Blended Learning

1. Introduction

Over the last decade, advances in Information Technology allowed incorporate features such as animations, simulations, and videos on Web environment. Previously, these features were restricted to physical media such as hard disk drives (HDDs), CD-ROMs and DVDs. The great advantage of this evolution is the fact of information on the Internet circulates more quickly and can be easily reproduced and presented in different media and interfaces. The point of view of educational goals, this evolution is important since it facilitates the distribution of digital content, allows customization and adaptation for use in various situations of teaching and learning. In this context, we have observed the growing interest of teachers in using the technology as additional learning environment to interaction with students. Although face-to-face interaction between students and teacher still plays the main role in the teaching/learning process, it is important raise a new model called Blended Learning. It is approach blend face-to-face classroom learning environment with web-based contents, for increase the support, information access and activities to students. This modality is also called “hybrid learning” since it is an approach that supports the use of more than one learning/teaching component in the learning process. This blending can include such components: learning environment, instructional technology, pedagogical approaches and any other educational tools [1-3].

The importance of blended learning is the idea behind it. According Singh (2003) [4], the most problems in the use of e-learning is his focus on presenting classroom-based instruction over the Internet. All the planning and design has been made according to traditional classroom settings and e-learning environment was used to support these method, but results revealed that this single mode of delivery is not sufficient enough for promote on-line learning [4,5].

The blended learning breaks this paradigm, offering multiple delivery media that are designed to complement each other and promote learning and application/learned behavior [4]. Oliver and Trigwell (2005) [6] indicated some of common characteristics for blended learning approach:

- It is the combination of traditional face-to-face learning with on line learning.
- It is a combination of several media and tools used in Internet environment.
- It is the combination of pedagogic approaches to create optimal learning outcomes.

Valiathan (2002, quoted by Oliver and Trigwell, 2005) [7], presents a different approach to the definition of blended learning about forms of learning approaches. He cites three types of approach to learning that are classified as skill-driven learning and competency-driven and attitude-driven learning. Skill-driven learning shows the importance of self-learning and e-learning. Learning Attitude-driven is the mixture of various events and delivery media that aims to enhance learning using technology. And the competency-driven learning, on the other hand, combines support tools with knowledge management capabilities to integrate two different approaches. These definitions show us that there have different experiences and conceptions of blended learning, and the tendency to use blended learning is towards combining learning face-to-face with online learning environment. All this leads us to a conclusion about the theory of blended learning and we can say that this is an approach that supports the use of more than one component of learning.
and teaching/learning process. This mixture may include some components: learning environment, instructional technology, pedagogical approaches and other educational tools. This work reports some research results obtained in the use of blended learning environment as a solution to support face-to-face learning and knowledge improve. In this study, we have introduced a series of animations, in the micro-documentary format, in a learning environment to support learners. The choice for publish animation in blended learning environment had several motives, among them we can mention: a) providing dynamics supplemental materials; b) increasing flexibility on student support; c) provides a learner-centered environment; d) increasing student engagement; d) best use of time in the classroom; e) testing and validate a particular model of animation, we are calling “micro-documentaries”.

Create learning environment is a challenge that is not limited to simple incorporation of digital content within the learning environment. We should also consider learning as a result not only production of content available in one environment, but also the exploration activities conducted through interaction, collaborative processes and contextual knowledge [8].

2. Theoretical references

All days, students are surrounded by hundreds of stimuli in a variety of forms, and specific features of information design affect how and whether students perceive and build usable knowledge from the information they encounter. The multimedia can replicate and integrate a wide variety of media for learning and education: text, video/film, animations, graphics, photos, diagrams, simulations, and others. In this case, the technology can be designed to provide much richer learning experiences than traditional learning offer. Technology can mix variety information in only one media to illustrate, explain, or explore complex ideas and phenomena, such as interactive visualizations of data, chemistry reactions, physics processes, and more. Digital contents, for example, can help learners to explore phenomena at extreme spatial or temporal scales or to visualize models of machines and equipments rare. This type of educational tools opens up many domains and ways of learning that were formerly impossible or impractical, in most educational institutions.

In the educational area, the animation has been presented as a promising possibility in the teaching and learning, due to its ease of demonstration of a process, viewing time of a given event, exhibition rare phenomenon, dangerous or harmful, and also to improve the ability of abstraction [9]. Thus, educational animations, understood as the combination of pictorial, written, with sound and graphics, has as main objective, the facilitation of learning.

The animation it's the simulation of movements created from the exposition of a sequence of images exhibited in a frequency that aloud the human eye to consider them as movement. Until the beginning of the 90's predominated the classic way of animation production in 2D, were thousands of drawings were created and photocopied to a film or scanned to a computer, that participated only in the final stage of production. With computational hardware and software evolution, has become common the production of all the stages of an animation on the computer. The appearance of software that allows drawing and composing sequences of images opened a path to fully develop the computer animated productions. At the same time, 3D modeling softwares emerged, allowing the construction of very precise and accurate virtual objects, very close to the real objects [10].

Comparatively, digital 3D animation, demands further effort during the initial state, the so called modeling stage; however, it can reduce considerably the total time of the animation development, because once the 3D object is created, it can be manipulated easily, creating movements, changing its view angles, dimension, colors, etc. Thus, 3D animations are becoming every day more common, not only in cinemas and TV's, but also in multimedia systems and Internet.

Considering the possibility of use of 3D animation as a tool for teaching support, this research proposes to investigate the conception process and development of educational animations to use in blended learning environment in chemistry course. Associated with general chemistry teachers, were raised the demands and difficulties on content transmission, and the most relevant topics, about "Atomic Theory" with propose to create appropriate animations to meeting needs of themes.

Educational Animations literature, reports several works that shows the animations benefits. Rieber and Boyce (1990) [11] research about Newton’s laws, didn’t find relevant differences on subject’s learning, but verified that the learner’s that used animations were capable to recover information easily. Rieber (1991) [12] verified positive results about incidental learning, and in other work from 1995, observed that animation would be more efficient that images for procedural teaching. Huys (1996) [13] suggest positive results of animation used on learners with little spatial ability. In the context of chemistry teaching, Kozma and Russell (2005) [14] felt that the animations and simulations can help students understand abstract and complex concepts such as the evolution of atomic theory, the formation of molecules and compounds and processes involved in chemical reactions.

On cognitive psychological scope, a broad part of the papers about animations use, are based on the Dual Communication Theory [15] that suggests the existence of two cognitive systems: one channel specialized on non verbal language processing, as objects, events and images; and another one specialized on verbal language representation and processing. From that argument, Clark and Craig (1992) [16] complement that the use of two forms of simultaneous media, when properly used, contributes to a better information retention compared to their isolated use.
From a series of empiric studies, Mayer (2001) [17] proposes three presuppositions that must be considered on multimedia as an educational element:

1. Dual codification presupposition, following Paivio’s [15] same parameters, in which humans have separated information processing channels to represent visual and audio materials;
2. Limited capability presupposition, that is, that each channel (visual and audio) have a limited simultaneous information processing capability, therefore, for an effective learning, its needed a balanced information presentation on each channel;
3. Active processing presupposition, is needed the active learner’s participation, that includes being motivated and aware to assimilate and organize the new information and integrate them to pre existing knowledge.

Another aspect to be considered on learning is that, consequently, on multimedia material elaboration, is the amount of information shown to the students. According to Sweller (2003) [18], learning occurs more consistently when the information volume offered to the student is compatible with his comprehension capability.

To deal with the amount of information issue, Sweller (2003) [18] introduced the Cognitive Load theory. According to the author, the working memory, that is linked to our manipulation of symbols capacity during the learning process, is limited and rests on the natural impossibility of the human being to process much information into memory at every moment.

This limitation affects learning directly, since it every information process demands some kind of effort, mental cost of energy on attention level, memory and reasoning. Therefore as more cognitive load involved during the learning process, greater is going to be the learner’s difficulty to efficiently retain the information.

According to Mayer (2001) [17], in content elaboration for teaching material, must considerate the three main kinds of cognitive load:

- **Intrinsic Cognitive Load** – Imposed by the content complexity of the teaching material, that is, the symbolic manipulation involved in the new knowledge acquisition.
- **Natural Cognitive Load** – Imposed by the teaching activities, including the relevant information retention and the necessary reasoning to content understanding. This kind of load is necessary and beneficial to learning and teaching process.
- **External Cognitive Load** – Not directly related to content, generally irrelevant and consequently, consuming limited mental resources that could be used to aid the natural load.

Considering the three kinds of cognitive loads, when developing a teaching material, we must dose and optimize the first two, and rather eliminate the external cognitive load. How can we optimize the intrinsic and natural cognitive loads? On the first case, the most practical solution is to divide the content in a way that not much simultaneous information is given, but progressively. On the second case, selection of suitable resources for content presentation can be a practical option for its reduction.

Getting deeper into animations production context, we can verify that another aspect to be considered is communication. At the end, educational multimedia animations are characterized as a form of communication, they rely on an emitter (animation), a code (images, texts, sounds, stories) and a receptor, the student. Therefore, appears to be relevant consider attributions of the Relevance Principle of Sperber and Wilson (1995) [19], made during a research that looked for understanding how receptors of a message recognized and interpreted a statement. According to these authors’s theory, when we interpret a message, our attention turns always towards what we consider most relevant a reliable, that is, a listener infers in the meaning of the emitter based on given evidence. Still, according to these authors, that occurs due the search of relevance, which is a basic characteristic of human cognition.

Therefore, when more relevant is the input or stimulus received by the learner, that is, more context effects are produced by statements and less effort is used to process them, more easily is going to occur comprehension and greater is going to be the probability of learning.

**3. The Study**

The report of the teachers involved in this research and an Internet search on digital content, led us to identify some problems with regard to digital content available on the Internet:

- Although there are many hypertext on this subject on the Internet, there are a lack dynamic and interactive content.
- No didactic concern with the images, animations and simulations available on the Internet. We often find images and animations with low visual quality, very complexes or with conceptual errors.
- Animations and simulations very simplified, that omit parts of objects or part of a process that may cause misconceptions in students.
- Much of the material available is two-dimensional format, creating limitations to the interpretation and proper use of the material. Chemical phenomena, physicists and mathematicians when presented in 2D lose many
The vast majority of good materials, such as simulations and animations are in English language, causing interpreting difficulties for students or "lack of motivation" to use them.

The problems identified in the content, in some cases hamper their use by students or teachers.

Considering methodological-theoretical aspects adopted, the researchers/teachers team, involved in the research, had decided to develop narrated animations, according to Mayer (2001) [17] suggestions, and not only moving images, that are commonly found on the Internet. Each animation developed explores an unique subject or topic of the matter, looking forward to prioritize relevant information for the subject-matter and to reduce the cognitive load.

Looking to consider the Relevance Principle, we opted to create animations that depart from a concrete matter, for example, an experiment or a real problem situation and contextualize in tridimensional scenery, as real as possible. The 3D animation development makes possible showing several angles of an experiment, apply zoom on important details, and observe with more precision the spatial disposition of objects, among another advantages.

The scenery and the semi-realistic quality of the animations seek, on one hand, reduce the cognitive load, once that, due to its resemblance to the real situation, demands less processing effort to its recognition and interpretation; and on the other, create in the learner one reliability on the fidelity of the animation according to the real situation. Besides that, according to Lidwell, Holden & Butler (2003) [20], the aesthetic aspects and attractive appearance are important elements to create reliability on the users.

Normally, animations found on the Internet and CD ROMs are extremely short, used as complements of a text, that is, for the comprehension of the matter the text is more important than the animation itself. Thinking about offering more dynamic materials, we seek revert that situation, and elaborate animations in a “micro-documentary” format, with a length between 4 and 7 minutes, were narration aloud the subject-matter understanding, leaving the external text as a complement of the animation. The animations produced can be seen in Table 1.

Table 1 – Animations produced and used in the research

<table>
<thead>
<tr>
<th>Animations</th>
<th>Relationship with the atomic model</th>
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</thead>
<tbody>
<tr>
<td>(1) Crookes and Thomson Experiments</td>
<td>Proved the existence of negatively charged particles.</td>
</tr>
<tr>
<td>Duration: 04:20 min.</td>
<td></td>
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<tr>
<td>(2) Rutherford experiment</td>
<td>Rutherford's model for subatomic structure.</td>
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<td>Duration: 4:08 min.</td>
<td></td>
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<tr>
<td>(3) Millikan oil drop experiment</td>
<td>Measure the elementary electron charge.</td>
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<tr>
<td>Duration: 05:32 min.</td>
<td></td>
</tr>
<tr>
<td>(4) Spectral emission lines of atomic hydrogen</td>
<td>Electrons Energy levels proposed by Bohr.</td>
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<td>Duration: 07:47 min.</td>
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The production of the animation is made up of several stages, following a basic work flow: A) Each animation, which originated in a theme / topic defined by the teacher, goes through a literature review where existing approaches are checked about the subject-matter. At this stage, materials such as books, articles and materials available on the Internet are consulted; B) This is a stage of Synthesis and specification, where the collected material is used for make a brief summarizing the main ideas of the subject; C) Here the animation and storyboard are created from the text summary; D) At this stage the teacher responsible for the course examines and approves the proposal of the animation, assessing their overall suitability and development; E) Development: The team defines the tools to use and develop animation, F) Final Review: animation, as in final stage, the teacher is sent to possible corrections and / or changes; G) content is published on the website. Figure 1 show, in summary, the flowchart work.

To develop the learning environment was used a customized version of the software Joomla, that is a Content Management System widely used to creating and maintaining web sites. This software allows publishing and managing web content more easily, even by people without knowledge about Hyper Text Markup Language and web programming. We believe would be appropriate two ways to access the environment, the first is a restricted area where only students have access to environmental resources (forums, email lists, list of exercises and downloads) and another area with free access to any internal and external community. The animations were published in the public area.
To produce the animations were used three software, the "Google SketchUp" was used for the preparation of three-dimensional scenes, the "Kerkythea" to render the animations and "Sony Vegas" for video editing and finishing. Figures 2 and 3 show the screenshot of the final quality of the animations created.
4. Conclusions

The first aspect to the analysis of the results was the knowledge of users, their needs, habits, behaviors and experiences. This information can be considered fundamental to the full implementation of the proposal due to the fact that we believe students should not be forced or coerced to access Internet content, but must decide individually by the use of this material, and analyzing whether this feature is useful to improve or facilitate their learning.

Initially a questionnaire was administered to characterize the habits of students in the use of the Internet as a research resource, their knowledge of the various media types and their preferences regarding the use of digital resources. We consider these important issues, because students, in performing the interaction with digital content offered, probably using prior knowledge and adopt behaviors acquired in interaction with other Web pages and other software used in other everyday situations.

The analysis of this research showed that Internet search for more information from the classroom is a practice or habit common to most students (76%). It was found also that students already have experience with the use of multimedia resources, knows and distinguish the various types of media and digital educational content available, like animations and simulations, and are able to use them for purposes of increasing their knowledge.

Still, with respect to the habits of students in search of additional subject-matter classes, we find that the optimal frequency of updating or adding new content on the site is to weekly as it is with the frequency that most students consults on web sites and search engines to find information about the subject-matters studied in class. Regarding the preferred type of digital content, 61% of students consider the animations and videos as resources that help to better understand the subject-matter covered in class, 21% chose the simulations, hypertext and finally, with 18%. The data show a clear preference for dynamic subject-matter.

To evaluate the animations as didactic resource, was administered a questionnaire in 43 first-year students of chemistry course. The questionnaire was divided into two sessions. In the first session, composed mainly of multiple choice questions, the students evaluated the adequacy of aspects of the media format as viable tool to support learning. In this session, the students was asked about aspects of use the 3D technique, narration, quality of images and others relevant aspects of animation.

The opinion of students about the proposed animations format was positive, 97% of them considered three-dimensional technique improved visualization and comprehension of the experiments demonstrated in animations. The same percentage of students approves the quality of the explanations. Most of them (74%), prefer narration than subtitles. As regarding the background soundtrack, 85% of students believe that the background music didn’t disturb the narrative and thus not negatively influence the understanding of the animation. The students' responses to the question about the background soundtrack received a special interest in research, since it this could be considered as element of split attention or increase cognitive load. However, students argued about the intensity or rhythm of music, but not about its presence. All of them consider music as intrinsic factor to animation.
About improving the animations, 52% of students made some sort of suggestion. The most significant were:
"increase the technical details" (19%) and "make animations a little slower" (18%). The other suggestions were very
specifics and diverse to be considered relevant.

The next questionnaire session was composed by non-directive questions (Open Questions), trying acquires
spontaneous comprehension about each animation. The goal of this session was to verify the acquisition of information,
concepts and phenomena presented in the animations.

The content of open questions containing the perceptions and understanding of students about animation's subjects
were analyzed using the technique of content analysis, to categorize responses into groups with similar meanings. The
percentages of occurrence of concepts and phenomena expressed by students are presented in Table 2. The second
column presents students responses organized in categories and third column shows quantitative results.

Considering the spontaneous responses, the results were positive, since it the students could describe with their own
words several information presented in the animations. Among most common mistakes made by students, we can be
emphasized: a) anode and cathode confusion; b) do not consider the force of gravity onto the droplets in the experiment
Millikan c) confusion about changing electrons energy levels; d) do not indicate the forces exerted by the nucleus on
deviation of the alpha particles in Rutherford's experiment.

<table>
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<th>Table 2 - percentage responses for all students</th>
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The data analysis of research, allowed us to conclude:

- In opinion of students, 3D animations improve the level of visualization and comprehension of educational content;
- The "micro-documentaries" model, adopted in the production of animations, containing 3D images, narration and soundtrack, was considered by students as appropriate format to educational contents presentation;
- The students proved are able to remember, organize and systematize several presented information in animations. These skills do not ensure knowledge acquisition, but may be considered prerequisites to learning occur;
- The general results were positive for use of 3D animations in demonstration of temporal processes, more accurate and realistic explanation of phenomena and the demonstration of equipment and experiments.
References