**Jigo: a generative learning objects (GLO) for Science, Technology and Society (STS) studies.**

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**Abstract:** Worldwide there is a remarkably large production of digital content such as learning objects, however, seldom does learning object design take advantage of the exceptional characteristics of this media. Our experience in developing digital content shows that technology and programming is a critical issue. This article presents a simple tool that can be used in the production of the contextual representation learning objects for science education through a STS approach.

**Key words:** learning objects, science education, afforestation.

**1. Introduction**

In Brazil and Worldwide, there is a remarkable broadening in the production of digital content in the form of learning objects, the appearance of public policies aimed at broadening such production and the emergence of repositories to distribute such contents.

In this sense, the assessment of an important and interesting experience [1] has shown that learning objects feature a variety of benefits for the students. In general, students appreciate the novelty and find the learning objects to be motivating. In turn, teachers stated an increase in student concentration, enthusiasm and learning levels when they make use of learning objects. The reason for that is that students are encouraged to use the learning objects through challenges, which allowed them to explore and take control over their actions and therefore enhanced collaboration amongst their peers. Thus, learning objects led students who were resistant to traditional teaching approaches and low academic performance to engage in school and learning tasks. In such cases, it was noticed that students who were considered as being problematic were actively taking part in the classes. Also, those students who had little or insufficient reading and writing knowledge could engage deeply in the activities, since the learning objects
provide access to and interaction with the concepts and knowledge through more diverse means other than text.

In that same assessment, from the learning objects designer and producer point of view, it was evident that digital contents can be perfected in several ways, e.g., through better use of animation and visual and sound elements, reducing the size of texts, offering usage instructions, providing browsing paths and considering the use of exploration, problems solving and gaming strategies.

The above reiterates the already known importance of building a multi-disciplinary team in which students and teachers who specialize in areas of knowledge work in collaboration with pedagogues, computing teachers, programmers and web designers. However, our experience in developing digital content shows that one critical point in the production of learning objects is exactly the technological and programming portion [2].

This article seeks to present a simple tool that can be used to produce learning objects for science education by using problem solving and school discussion strategies through role playing.

2. Some science didactics topics as support for educational computing.

The choice of themes and planning of activities to be presented in the learning objects could follow instructions from science, technology and society (STS) approaches for science education. This approach features some relevant contributions for science education: i) the level of abstraction can be reduced; ii) knowledge can be reorganized (‘repackaged’ in the original) by teachers; iii) knowledge can be rebuilt by students; e iv) knowledge can be contextualized [3].

In this sense, for example, technologies related to economic growth and creation of wealth are associated with the main environmental impacts through their demands for energy and other raw materials. This way, the strain between economic growth and environmental outcomes can be explored with education in science through several themes such as rain acidation, deforestation and global warming [4].

It can be argued that the solution for contemporary social and environmental issues requires a generation of citizens politically and scientifically qualified who are not satisfied with the role of “desktop criticism”[5]. Thus, a science program focused on controversial and politicized subjects is suggested for different areas (e.g. human health, subsistence and agriculture, energy resources and consumption, and technical, social and political responsibility). Therefore, it is understood that science education for social and political action is inescapably an exercise in clarification and a shift of values, that is because values can and should not be imposed upon students, but their adoption can be encouraged.

Concerning the use of scenery, it is understood that having stories as the basis to present the contents of a class is a common didactic strategy, often described as a means of “familiarizing” children or youngsters with the program contents and
establish contextualized knowledge. Thus, such a strategy may be used in software to cast users in such a way that they are able to submerge into the story and become players in the activities, making it possible to manipulate the elements in the different interface scenarios and interact with the content of the exercises or challenges that guide students through the software [6].

From the learning psychology point of view, it is suggested that discussion and dialogue in school become essential tools to build thought and socialization. Discussing is an important tool that incites children and youngsters toward creativity, critical spirit, and to confront different points of view. This way, cognitive conflict that instigates diverse points of view between peers allows students to question one another, cast doubts, problematize the reality. This way, discussing and debating are indispensable elements in a pedagogy that intends to develop children's thoughts, citizenship and democracy, that is, the right to express their ideas within a collective and public space that admits pluralism [7]. Thus, in respect to the debate of reasoning environmental problems, such as the identification of sources and causes for atmospheric contamination and the resulting social damages makes it possible to identify the social players who take part in the controversies, such as the social player, industrial player, scientific player, political player, educational player and the mediator [8].

One other proposal for approaching controversial issues indicates that the following must be emphasized: i) groups in society have different views on the subject; ii) the groups base their information on different sets of information or they interpret the same information in diverse forms; iii) different interpretations may occur due to different ways of seeing the world, that is, the diverse world views; iv) the diverse world views may occur because individuals adhere to different value systems; v) not always can controversial subjects be restricted to reasoning, logic and experimentation; and vi) controversial subjects can be resolved by making more information available [9].

Lastly, to close the discussion about the topic we have used as example to launch our learning object editor, there is indication that students should learn about the interrelation between technical, ecological and social economic knowledge underlying management of natural resources and forestry [10]. Thus, it should be considered that decision making in forestry planning involves ecologic, economic and social aspects at local, national and global levels. Therefore, we understand that such recommendation may be followed through didactic strategies that make use of case studies aimed at decision making in scenarios presented in learning objects.

3. Some considerations on learning objects desirable characteristics.

The fundamental idea underlying learning objects is that their instructional designers can build small instruction components (relative to the size of an entire course) that may be reused several times in different educational contexts [11].
However, it must be noted that manipulation and interaction are key aspects for an effective learning, since it is through digital submersion that users build their own understanding about what is being represented, and from which they extract educational purposes and values [12].

Thus, the use of learning objects presents an important supporting role for active learning strategies, such as those based on case studies or problem solving, or in collaborative manners of argumentative debates. Within these strategies, learning objects provide a stimulus and support to put complex tasks to practice by not presenting only information or guiding along a predetermined course as it happens in the collection of static classes with predefined algorithms [13].

It is notorious that learning objects are designed to provide for their use in different educational contexts. This leads to propose a classification for the learning objects, which would contain presentation objects, practice objects, conceptual model objects, information objects and contextual representation objects [14]. According to this classification, the underlying idea for the contextual representation objects is to allow students to explore a realistic scenario where they may gather data, usually with the purpose of solving problems or investigating. The examples involve very diverse themes, such as volcanic activity, climate conditions, atmospheric pollutants, forms of life at great ocean depths, and people's reports about those and other subjects.

Usually contextual representation of an imaginary or inaccessible place for students is used due to, for example, the distance, either in time or space, or the danger involved in accessing and exploring it, or the very small or large scale for data gathering, or the need for sophisticated instruments to do so, among others. One example is contextual representation about water quality. In the learning object produced, students are able to gather data about the factors that affect water quality in an imaginary lake presented as a scenario. Such data can be used for a problem solving activity in which it is suggested that students behave as environmentalists by investigating the situation and proposing a solution for the problem in the form of a report to an environmental protection agency.

That is, this idea is very similar to what we have been producing [15, 16] with inspiration taken from David Whisnant [17, 18]. However, the technological and programming issues are still sensitive points for the production of learning objects.

In this point, the concept of a learning object editor (Generative Learning Objects – GLO in the original) is very relevant, based on separating the learning object and the instantiation of the learning object façade [19]. The key concept in a learning object editor is separating the learning object's profound structure (the pedagogic project or learning project) from the surface structure (the façade or presentation). The learning object façade is seen as a private realization of an underlying learning project. This offers many advantages. Attention is more centered on what is more important, the learning project quality that is supported by the digital object as covered in the previous section. Since the object façade is generated in a series of steps, several variants can be produced with the same project. Moreover, since the learning objects are divided into basic and structural components, this makes it easy to identify and modify individual components. Thus, the learning object editors apply a reusage model for the surface structure,
which is close to the object centered software engineering. This results in several advantages, among which: i) it focuses the attention on the quality of the learning project, which is the core of the learning object; and ii) presents the foundation for a marked broadening of learning objects.

The creation of a learning object editor is divided into two broad parts, the construction of a learning object model (Learning Object Template in the original) and the later addition of specific contents. This learning object template, or model, contains either the deep structure or the learning project. Once the template is created, the tutors (teachers or students, for example) may add different specific contents to produce several learning objects adapted to the purposes of their areas of knowledge, which after being reviewed and analyzed by assessors can be published and distributed over the internet.

However, precisely due to the few examples, there is an urgent need to create friendly tools to support this learning object creation process. The tool we introduce in the following section, Žigo, is a learning object editor that contains a template to produce contextual representations.

4. A learning object editor: Žigo

The objective with Žigo is to provide an environment to create and use learning objects that allows teachers and students to search for the presentation and discussion of environment related topics. With Žigo, the façade or presentation structure can be edited. For the deep structure, we established the use of two pedagogic or learning projects supported on scenarios: problem solving and school debate. Therefore, Žigo is a model, a template for those types of pedagogic activity. To name this template and its editor the term ‘žigo’ was adopted from Esperanto, which suggests ideas of games, riddles, patience and puzzle, for example.

The tool is available at: http://www.iq.ufrgs.br/aeq/jigo/, and was developed with the Flex technology, an open code framework to create rich internet applications (RIA’s), which are highly interactive. Within it, MXML (an XML based declarative language) may be used to specify behaviors and the user interface, and Actionscript 3.0, an object driven programming language that runs on an AVM - Actionscript Virtual Machine – available in the Flash Player plug-in.

Below is a description of the main stages for editing learning object presentation structure. In this sense, we have used as an example the eucalyptus forestation theme.

After registering the user in the learning object editor, a screen is shown in which all information (title, subject, description, key words, and choice of landscape) are inserted to describe the planned learning object.

The top portion of the editor contains two regions to indicate common actions (maximize or minimize - the editing window - save, exit or publish), and editing and creation actions that comprises five stages: i) description of activity; ii) areas and data; iii) characters and media; iv) activity issues; and v) activity FAQ.
In the first stage, learning object description, the user (e.g. a teacher) should choose among the illustrations offered that allow for creating the ambience and context for the activities. At present there are 5 landscapes on offer, urban, rural, coastal and mountainous regions.

The subject of the first learning object produced with Jigo is the paper and pulp industry and forestry’s environmental and social impacts. So in this first stage, it is pointed that:

“According to the debates over sustainable economic development, eucalyptus has become both a target for heated attacks from environmental balance defenders and object of passionate defense from commercial forestry followers simultaneously. Coincidently, the controversy about the advancement of eucalyptus on predominantly plains biomes (such as the Southern Brazilian and La Plata pampas) occurs exactly at the same time as the discussion about the validity of deforestation of the Amazon to plant grain crops (such as soy beans, for example). In this sense, eucalyptus has been taking on a place as a replacement for tropical lumber whose exploration is increasingly more difficult for geographic and environmental reasons. Therefore, this learning object uses a scenario of eucalyptus afforestation as a contextual representation aimed at school debates (e.g. through role playing games) and reflecting on the pertinence of certain economic choices and their impacts on land communities. In the learning object statements by characters who present several versions on the subject can be read, information about soil quality can be gathered, and videos and images that illustrate the theme can be viewed. A help tag elaborated with questions and answers can be accessed if needed. On top of that, there is a questionnaire to be answered after using the learning object”.

In the second stage, data charts related to the different landscape areas are attributed. As another example, if a teacher intends to create a scenario aimed at debating agricultural chemicals in the environment, they can choose a landscape in a transitional micro region between rural and urban, feed the database with the chemical concentration units (e.g., organophosphorates or carbamates) and establish different concentrations for several landscape areas. In this example, while students use the learning objects they can carry out research on the concentration of agricultural chemicals at different landscape locations. This type of activity is similar to the one we developed for the Carbópolis software (www.iq.ufrgs.br/aeq/carbop). In case of the learning object about eucalyptus afforestation we fed data about the acidity level (pH) in the soil and the concentration of saline ions (Na⁺, K⁺ and SO₄²⁻ among others) in different regions of the scenario in the illustrative map.

In the third stage, images and characters are inserted that serve to illustrate different points of view on a subject. In this stage the user may edit a set number of characters (choosing gender, ethnic group, and clothing, for example) to be inserted in different locations in the landscape. In this type of activity, users should suggest the statements by those characters regarding the theme being discussed. For example, if a teacher wishes to create a landscape aimed at debating genetically modified foods, they may choose a landscape in a macro region, then ask the students to build the characters and suggest the statements the characters would make about the theme being debated. The initial assembly of this scenario serves as support for role playing games, as in a similar activity we
developed in the *Cidade do Átomo* software (www.iq.ufrgs.br/aeq/cidatom). In the case of the learning object about eucalyptus afforestation we have used several opinions presented in books and articles from printed and digital magazines.

The third and fourth stages consist in the elaboration of texts to support the use of the learning object, either in the form of questionnaires that point to a conclusion for the activities, or a set of questions and answers that serve to settle user doubts about the use of the planned learning object or content presented.

The use of learning objects created can be done after his publication in the Jigo environment. In this environment, there is a module for the use of learning objects. This module must be downloaded and installed on the user's computer. We decided on this configuration to avoid any problem with the Internet connection in the schools computer labs. The module for the use of learning objects reads the objects in XML format, what must be lowered downloaded from http://www.iq.ufrgs.br/aeq/jigo/?pagina=publicadas.php. Figure 1 illustrates the processes of creation and use of objects, and highlights the differences between the modules.

![Figure 1 - Scheme of the modules for use Jigo.](image)

Lastly, to close this article, it needs to be told that later on, as with *Carbópolis* [20], after a broad disclosure to school systems, we intend to check how this didactic material is effectively used in school contexts, especially in relation to the didactic strategies used by the teacher(s).

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References