Designing a Procedure for Analysing and Evaluating New Learning Objects.

Application: Physics Applets

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Introduction
An emerging field of research is the formulation of criteria that enable the users of online materials to evaluate the quality of web pages in general and online educational web accessible environments in particular. The criteria very often refer to the quality of the content (see bibliography, 2004 and Cornell, 2004) or the usability of the multimedia material and the web-based environment (Mallon and Webb, 2000 and De Marisco and Levialdi, 2004). When the materials that are to be evaluated or classified have been designed for educational purposes, items that refer to whether or not they are suitable for use as learning resources are added to the main criteria. This is the case of MERLOT (Multimedia Educational Resource for Learning and Online Teaching), which offers an ever-expanding catalogue of free online learning materials (MERLOT, 2005), and IMSEnet (Instructional Materials for Science Educators), whose website contains many annotated links to science teaching materials (IMSet, 2001). In both cases, the authors suggest a similar procedure for the evaluation of web-based materials, in which three sets of evaluation criteria are considered: reliability, ease of use and potential effectiveness as a teaching/learning tool. Most of the items relate to technical and design aspects, and a few of them refer to educational aspects, such as how easy it is to identify the learning goals, whether it is possible to use the material in different educational situations and whether the target learners are well defined or not.

Applets are a good example of the free learning materials that are available on the Internet. These simple applications are designed using the Java language, contained in an html file and only require an Internet browser (Bohigas et al., 2003). In general, most of these applets agree with the definition of simulation given by various authors working in the field of science education: to simulate Physics phenomena in an invented environment that allows the users to interact with and to modify parameters, variables, rules and so on, and in some cases also to measure different magnitudes (De Jong et al. 1998 and Kornis et al. 2000).

The literature on applets first dealt with their technical features, although since 2001 several published papers analyse the suitability of applets as learning resources for specific contents (Christian and Belloni, 2001, Davies, 2002 and Junglas, 2003). It would be very useful for teachers to have a tool that allowed them to assess applets' effectiveness as learning resources before using them with their students.

The problem that we were confronted with was how to evaluate new learning objects, i.e. applets, when there is no tradition of evaluating them in a specific application context for science learning?

Methods and Sample
The methodology that we propose for finding the answer to the question stated above, consists in an iteration process (Denzin and Lincoln, 1994) involving successive approximations. This methodology can be used to design an evaluation tool that improves as the iterative process goes on.
In order to elicit features related to technical aspects as well as educational ones, the applets were assessed by a group of seven experts with different but complementary profiles: six university lecturers specialised in physics and a physics graduate. Their expertise in the use of information technologies for educational purposes covers a range of topics, including applet design for the purposes of physics education.

The following diagram shows the methodology proposed for the evaluation of learning objects (LOs):

![Methodology Diagram]

GUR: group of users for compilation of LOs. GUE: group of users for evaluation of LOs. ExX: experts. ET: evaluation tool.

The first iteration (I1) that was carried out focused on the evaluation of secondary education physics applets. In this case the GUR comprised just one of the experts, who selected ten applets related to different physics topics. There were only two initial requirements: not all of the applets selected had to be qualified as ‘good’ (we were of course aware that the meaning of ‘good’ is subjective) and the applets had to be selected in under three hours. The constraints on the selection process were as follows:

- Applets hosted on websites that cause navigation problems had to be discarded.
- The applets selected might not be well known by the GUR.
- The applets selected had to be of different types, e.g. applets that describe physical phenomena or enable relationships between physical magnitudes to be established, or applets that enable relationships between the phenomena and their graphic representation to be established.

For I1, the GUE was made up of the seven experts mentioned above. A web page was designed that allowed the GUE to access the ten applets that had been selected, which they could explore on their own. The evaluation (Step 2) took place in a group session lasting three hours, during which each expert expressed her or his opinion of each applet. In this first iteration no evaluation tool was available, so the evaluation was carried out in a free way. All the experts looked at the applet projected on a screen by means of a video, which all of the experts watched at the same time. Each of them then analysed the applet in a free way. This was repeated ten times, once for each applet. Their contributions highlighted different aspects that they considered relevant: presentation, functionality, possibilities, limitations, qualities and faults.

**Data Analysis and Results**

During the group session, one of the members of the group collected the experts’ contributions and was responsible for transcribing them. This document was analysed by another expert, who categorised and classified the contributions following an iterative process. Another expert revised and refined the categorisation of the GUE members’ contributions. At the end of the first iteration it was possible to identify a set of relevant parameters that need to be taken into account in evaluating a learning object (LO). In our case
the LOs are physics applets. All the parameters could be considered from five perspectives, which referred to the ease of handling the applet and understanding the messages conveyed. The following is a brief summary:

- A. Technical aspects. Factors related to the applet designer’s technical skills and to the technical features of the website on which the applet is hosted.
- B. Design. This refers to the quality of the visual language, from an aesthetic point of view and from the point of view of the visual clarity of the message.
- C. Scientific quality. This includes factors related to the applet designer’s scientific precision. The author is considered reliable when the contents agree with those accepted by the scientific community.
- D. Suitability for use on a course. This category considers the applet as a simple object constructed in Java that is contained in an html file and refers to its suitability for inclusion in a teaching sequence.
- E. Expected learning conception. An evaluation of the way the images are animated and the opportunities for interaction that the applet offers are closely related to the model of learning that the user implicitly has (Krauss & Ally, 2005).

As a result of this methodology, the set of evaluation items divided into five categories that arose during the I1 iteration enabled us to design the first version of an evaluation tool (ETv.1) used in the next iteration (I2).

At present, the I2 is being carried out. The GUR and GUE comprise secondary education science teachers, who used the ETv.1 to evaluate a set of five previously selected applets. The analysis of teachers’ individual responses using the ETv.1 and their contributions to the group discussion at the end of the evaluation process will enable us to design a new version of the evaluation tool. When the I2 iteration finishes, we will have the ETv.2 evaluation tool that the next iteration (I3) will improve on. After several iterations, we will have an instrument that we hope will help teachers to formulate a diagnostic of any applet that they find on the Internet and want to use effectively as a learning object.

Conclusions and Implications
The work presented here is a methodological proposal for designing, evaluating and analysing new learning objects that have never been evaluated from the point of view of their effectiveness as educational resources.

Five categories emerged as a result of the first iteration. Although several of them (A, B and D) are commonly used to evaluate web pages, another aspect that intervenes implicitly in the assessment process emerged: what the teacher thinks of the scientific quality of the content (C) and of the ways in which her or his students learn (E). The second version of the tool was used by secondary school science teachers and this gave us the opportunity to highlight an issue that becomes particularly important when the tool is being used to evaluate physics applets: the teachers had to reflect on the way they teach as well as the way they believe students learn, which will surely contribute to their professional skills improvement.

Teachers who are not skilled in the use of online environments and multimedia materials but are interested in designing learning activities and wish to take advantage of the free resources that are available on the Internet will find the tool very useful, as it will enable them to offer more attractive, inspiring and useful learning materials to their students.

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