Model2Learn: An educational web-based tool to explore ideas about modelling and the environment

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Abstract. *This paper describes an approach to introduce simulation modelling into educational environments, showing how it can be applied to illustrate and communicate ideas about environmental issues. The project takes advantage of a number of Web 2.0 tools to deliver interactive sessions where students are encouraged to engage in increasingly complex and creative tasks. This will facilitate learning on two fronts: increasing knowledge about environmental sustainability as well as in terms of modelling skills and literacy.*

Keywords: environmental education, modelling in education, agent-based modelling

1. Introduction

Concepts in environmental education that involve the interaction of social, ecological and physical processes are often so complex as to make them difficult to communicate solely through narrative forms and visualisation techniques. In light of this, the availability of modern personal computers offers some opportunity to enhance the dialogue among teachers and students using simulation models to provoke questions and explore ideas - including 'what if' questions - interactively.

Researchers have used system dynamics models, micro-simulations and, more recently, agent-based models increasingly for the last fifty years. Their use in education also has a background [Resnick,1994]. Briefly, an agent is an autonomous piece of program code representing an actor in a social system, which can be used to model many or multiple types of agency at different levels of action. The simulation is used to explore consequences of the model's rules by observing the aggregate (macro) outputs of the model, paying attention to the influence of different assumptions, different parameter choices, different initial conditions and scenarios etc.

Simulation models can have a range of different purposes - indeed many can have multiple objectives – and can have appeal to a range of different audiences. Modelling in research is usually combined with other research methods; but it is important to note that the purpose is not limited only to research. Models that typify a particular problem in a relatively abstract way, i.e. stylized models that are more about exploring possible social systems, are often used in an educative fashion. This would fall under the category of 'using models for the purpose of communication of ideas' that is largely not about addressing research questions. Work on 'artificial societies' [Epstein and Axtell, 1996] is more akin to using simulation as a form of play, and if this is structured appropriately it can have a strong pedagogic aspect – starting a process of awareness raising and education.

Environmental education can be seen as a process where individuals and society construct knowledge and social awareness about the sustainability of the environment. In this process schools

and other educational institutions have an important role in order to promote changes in the way we regard our planet. This process is now seen as based on a two-way communication rather than the old paradigm of a one-way flow of information, from teachers to pupils. It has gained importance in the last years since the United Nations Conference in 1972 (Stockholm - Sweden) when an International Program on environmental education was established.

In Brazil during the Rio - Eco 92 Summit the Ministry of Education established a National Program to introduce environmental studies in the curriculum [PRONEA, 2005]. Since then some different approaches have been developed by different research groups and school teachers [Effting, 2007].

Our proposal is to create an exploratory web environment using some social tools to engage students and teachers in the process of thinking further about some environmental problems through the processes of modelling and collaboration.

In the next section we discuss the main ideas of the Model2Learn project, showing how this approach relates modelling to environmental education, describing the pedagogical methods and how we anticipate this to benefit learning in schools. Section 3 presents the final remarks followed by the references.

2.The approach of the Model2Learn project

Web2.0 describes the set of new generation technologies which make web publishing more interactive and accessible to non-experts – all web users and not only IT specialists/ Webmasters. The development of Rich Internet Applications - those that have the features and functionality of desktop applications, is increasingly making the Internet an all-important tool of knowledge work, and it facilitates the sharing of datasets and online collaboration. Whereas these webapps often make use of older technologies like JavaScript on the client side and Java/Ruby and database software on the server side, increasingly, the required coding can be generated automatically.

The Model2Learn Project departs from those ideas to implement an exploratory web based environment where students and teachers can use social tools, modelling and simulation to discuss, test and learn about environmental ideas.

The pedagogical approach of the Project is based on a three level of interaction among learners, teachers and models. Following these three levels we envisage our audience going further in developing their knowledge about the problem being discussed and modelling skills (see Fig. 1).

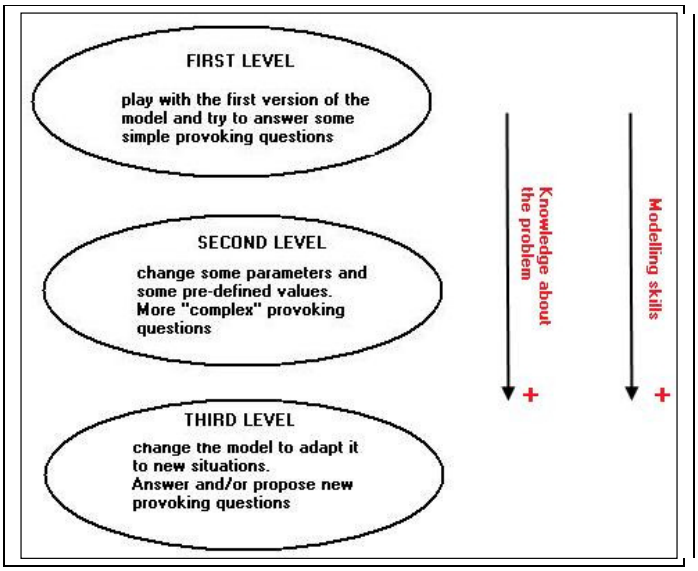

Figure 1 – Model2Learn: Pedagogical Approach

At each stage users are presented with a number of questions regarding the problem being studied. These questions are carefully constructed in order to involve the user in the process of playing with the model by setting parameters, simulating, asking new questions and/or reprogramming it.

At least in the first presentation of the model (level 1) it must not be too complex for users to quickly feel they are gaining an understanding of the model (ie. they are learning something about the idea behind the model - and typically here the model may provoke a feeling of suprise)[1]. Further interaction may allow the teacher to introduce more parameters as well as access to model rules to explore more fully the model, but far more important (in our view) is that the basic concepts should be relatively easily comprehended.

The model should address a topic that is relevant to the national curriculum in education. This criterion aims to ensure that the model may be applicable to such issues deemed important by the authorities. Of course, from country to country the concerns will be different. Our hope is that this acceptance – by the authorities and by the teachers – may make the tool more 'legitimate' and therefore more useable in schools as an activity that can facilitate raising awareness about environmental responsibility. It also suggests that, outside of school, the model is teaching principles that are widely understood and are useful.

Table 1 below presents a list of candidate models that were suggested by members of the team as well as by reviewers of the project. These models are being used as a starting point for the portal. However the idea is that the community suggests and implement new projects to be added to the Project.

Table 1 - Some Initial Candidate Models

Short Name	**Overview and Reference**
Forest-savanna dynamics	A model to explore the influences upon forest-savanna dynamics in the presence of seasonal forest fire events (Hochberg et al. 1994).
DaisyWorld	A demonstrator of self-regulation, to explore James Lovelock's “Gaia hypothesis”. The NetLogo version is available at: ccl.northwestern.edu/netlogo/models/Daisyworld
Chalmers Climate Calculator	An easy-to-use tool meant for anyone who wants to learn more about the climate problem. The publically available model can be found at: www.chalmers.se/ee/ccc.

All models developed to the Project have to be implemented either using NETLOGO [Wilensky, 1999] or BehaviourComposer [Kahn and Noble, 2009]. They also have to be described using the Overview, Design, Details (ODD) protocol [Grimm et al., 2006] intended to improve the readability and completeness of simulation models.

3. Final Remarks

The Model2Learn project aims to create an exploratory web-based environment where teachers and students can use social tools, modelling and simulation to discuss, test and learn about environmental ideas.

A first model about forest-savanna dynamics is already implemented and ready to be used in order to provide a test of how much students can learn from this approach. The model is a reimplementation of the one presented in Hochberg et al. (1994) showing the dynamics of forest and savanna areas in the presence of seasonal fire events (Figure 2).

1 Perhaps, there is a particular danger of confusing the novice user, as most technology is based on a paradigm of 'control' rather than 'exploration'.

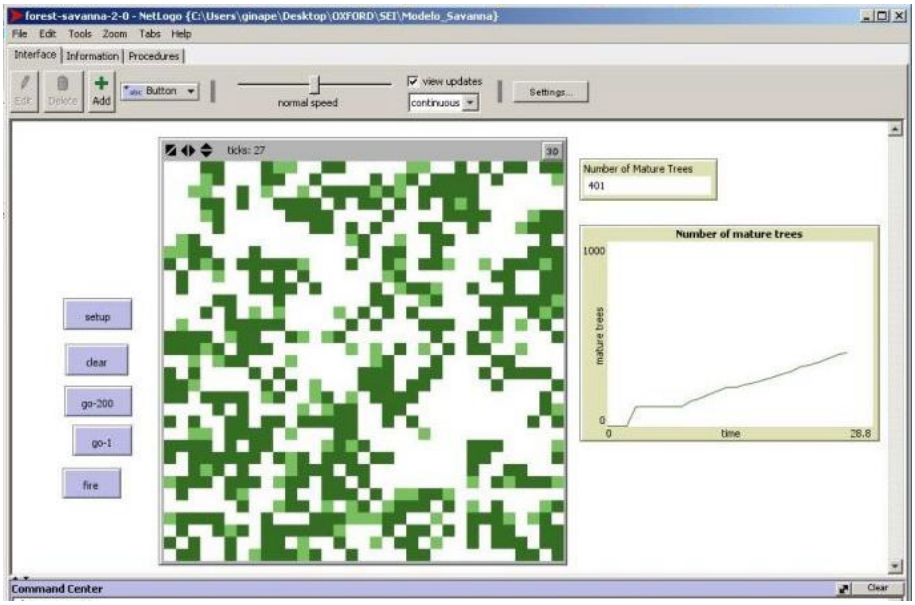

Figure 2 – Forest-savanna model – NetLOGO version

The teaching materials are being developed as a progression through a set of learning exercises with the model. At each level a number of questions are asked:

Level 1 - Why the model does not show the same numbers (results) after simulations ? Is it wrong ? Is there any pattern ? If we increment the number of total mature trees in the beginning does it make any difference (% increase/decrease) in the total number of mature trees after a certain number of years ? Why ?; Level 2 - If we change the period when fire occurs does it make any difference in the evolution of the model ?; Level 3 - Is it possible to think about problems such as degradation of coral reefs X tourism (diving) as a similar one ?

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