

Authoring and sharing word problems with AWE

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Abstract. We have created the Animalwatch Web-based Environment (AWE), an on-line environment to support a community of teachers, potential users of the Animalwatch Intelligent Tutoring System (ITS). AWE encourages teachers to author content for the ITS, share their creations, discuss about its use, and in general collaborate with each other to make a better use of the Animalwatch ITS. AWE brings teachers into the tutoring system development loop as a way to give them a chance to adopt ITS technology, and to reduce development costs at the same time.

1. Introduction

Tutoring systems are expensive to build, and this fact limits their use in real world settings. Authoring tools have been introduced as an interesting way to reduce costs in intelligent tutoring system development [Murray, 99]. One other hurdle that ITS have to overcome to become widely used is their acceptance by teachers in the classrooms. Because computer tutoring involves mainly the student and the computer, teachers tend to be out of the loop in this tutoring process. It is important that teachers feel comfortable with ITS and appreciate them as powerful tools that can help them teach their curricula. Otherwise, teachers will not feel like using them in the classroom.

This paper introduces an on-line environment called **Animalwatch Web-based Environment** (AWE), whose goal is to solve the issues discussed above. AWE is an on-line specific authoring environment that supports the creation of a community of teachers that use a particular mathematics ITS, Animalwatch [Hart, 99; Beal, 00]. AWE lets those teachers author new material for the ITS, share their creations, discuss about its use, and in general collaborate with each other to take greater advantage of the Animalwatch ITS. Bringing teachers into the tutoring system development loop is a way to give them a chance to adopt ITS technology, and to reduce development costs at the same time.

2. Animalwatch and the Animalwatch Web-based Environment

Animalwatch is a mathematics Intelligent Tutoring System (ITS) for 8-11 year olds. Animalwatch tutors math with word problems about endangered species. Thus, it integrates mathematics, narrative and biology. Animalwatch has a large database of word problems. The ITS takes the student through a series of word problems that it dynamically chooses from this database based on the student's knowledge of the topics. In order to do that, the ITS maintains a *student model* and makes inferences about the student's knowledge as he solves problems. Animalwatch increases the difficulty of the problems it gives depending on the student's progress, going from simple whole number addition problems to problems that involve fractions with different denominators. Animalwatch also customizes the help it presents when students make mistakes. After the user logs in, he chooses one out of three stories about different endangered species (also known as an

adventure), and then goes through a sequence of stages in the story. Animalwatch shows the student a word problem that fits the narrative situation of the *episode* in the story. The problem needs to be pedagogically appropriate, in the sense that it must have an appropriate mathematical difficulty given the system's estimation of the student's mathematical knowledge. Once the student provides the correct answer to the problem, the system gives another problem, which has to be one previously unseen by the student. Animalwatch looks for a suitable problem, and if it doesn't find any then it has to make a radical decision: switch to the next stage of the story, where an acceptable problem for this student will be available. These requirements generate a combinatorial explosion in the number of problems needed in the ITS: the system needs to have at least one word problem for every possible combination of skill and episode (700 word problems for 3 hours of instruction). The task of creating this content was one of the most tedious and expensive ones. However, if the student finishes all stories it is unlikely he would like to go through a story again.

The new model we propose is to open the ITS to the public. It is possible to reduce development costs by letting teachers create word problems and share them with an on-line community around Animalwatch. People can freely download the system, contribute new problems and share them through the web site, give comments and feedback about the system and the problems. We hope this will help teachers see the ITS as a customizable tool which can enhance their curriculum across multiple areas. AWE provides the following capabilities in order to allow the community to emerge:

Creation of word problems. The web site home page is linked to an authoring environment. However, we think that the first main attraction for the teacher will be that there is free mathematics software to download. A week after a person has downloaded the system, she receives an e-mail with an invitation to contribute a word problem to enhance Animalwatch. The teacher will be referred to a web page where she will be able to enter a word problem for an existing episode. The authoring tool is very simple, so that the cost of authoring is minimal. The author should select what image will go with the word problem and what operands and operation would solve the problem. After submitting the problem, the user is told that an administrator will review the problem and either accept it for inclusion in the adventure, or send an e-mail with suggestions for its improvement. The author is the owner of this word problem, and only the owner will be able to alter it. The user can access a personal space where she can administer her own word problems: check if they are approved, modify them, etc. Users may also decide to upload their own images to enhance the adventures.

Browsing word problems and giving comments. Users can give feedback on Animalwatch by posting a comment. Even better, the user can browse through the adventures, the episodes and their word problems. After downloading Animalwatch and checking it out, the user can go back to the web site, post a comment about the Giant Panda adventure, and give a rating from one to five stars. Furthermore, users may decide to download specific adventures for Animalwatch to run, and not others, after checking user ratings and user comments on each adventure. In the future, we want to allow people to restrict the quality of the problems they choose for download, by letting them download problems rated above a certain level. This will give some guarantee that the word problems are good.

Participating in polls and discussion groups. The administrator can create polls to be answered by the users. These polls serve as a way to analyze the general interest for themes of new adventures, for improvements in the ITS behavior, or even for improvements in the web site. Users can also post inquiries and answers in discussion groups, and a list of frequently asked questions is maintained.

As mentioned before, Animalwatch runs as an offline application. Animalwatch can be downloaded from AWE in two steps: first, the user downloads the Animalwatch program; then, the user downloads individual adventures. In this way, Animalwatch's content is independent from the core ITS. Each adventure consists of a zip file where the images and word problems are packed together. Animalwatch reads in all the adventure zip files at runtime, retrieving word problems and

images for the user to see. Internally, AWE is a relational database-backed web site, running the MySQL RDBMS on the server side. AWE dynamically generates web pages using the PHP3 scripting language and querying the MySQL database. This way, the system can keep track of users, approved and non-approved word problems, poll results, ratings, etc. The zip files for each adventure that Animalwatch understands are periodically re-built from this database of word problems and images. It is interesting from the technological perspective that the Animalwatch's database is fed online when actually the program runs offline.

4. Discussion and conclusions: new issues that arise from this participation model

[Ritter, 98] introduced some principles of design for this kind of authoring systems for content creation. Our web-based collaborative model introduces other new interesting design principles:

Make participation as easy as possible. We cannot guarantee that a visiting user will be patient in the web site. Users are very volatile in the Internet: if they don't understand something, they may never come back. Moreover, it is known that while many teachers profess a desire to author curriculum, only a small percentage follow through on this desire [Roschelle, 98]. Any user contribution is very valuable, so we allow users to give any amount of contributions that they want. We also allow for anonymous contributions with no registration requirements, anonymous downloads, image contributions but not word problems, word problem contributions but not images, etc.

Establish an arbitration process: who decides the contribution is good enough? Something important to decide is the level of control that we want on the quality of the user-contributed word problems. When a user contributes a word problem in AWE, it isn't immediately merged with the rest of the word problems. It first needs the approval of an administrator (is it mathematically correct? does the word problem fit the adventure-episode it was authored for?). If the administrator accepts it the word problem is included for download. Some policy is needed to handle bad contributions. If rejected, AWE sends administrator comments back to the author, so that it can be corrected. We plan to implement another level of control where the community decides how good or bad word problems are, by giving ratings to the word problems. We then want to include the possibility of having people download adventures whose word problems are above a certain rating level.

Bring teachers along: what do we have to offer to them? We also have to show them there is something we are giving in return in exchange for user contributions. The web site informs how the contribution of new adventures can help to the integration of mathematics with other topics that teachers are also interested in, and to the general interest of the community. In addition, AWE keeps the word problem authors informed of how many people have seen the word problems they created, depending on the number of adventure downloads. AWE and Animalwatch are both available from <http://ccbit.cs.umass.edu/Animalwatch>

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