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USING LEARNING OBJECTS TO TEACH PROGRAMMING LANGUAGES

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ABSTRACT

The idea of using "Learning Objects" in teaching has become very popular in the last few years. Although the concept of using objects in teaching is not new, the power of the computer technology and the Internet gives educators large opportunities and endless combination of possibilities in applying new theories to web-based education. This paper describes the use of learning objects to teach programming languages to undergraduate students at the Near East University.

Keywords: Learning object, teaching, programming, web-based education, design of educational software.

1. INTRODUCTION

Throughout the history the educators have always been looking for new methods of teaching. One of the aims has been to teach in such a way that the learner can retain the knowledge and can apply this knowledge to more complex situations.

For many centuries the classical method of teaching has been used throughout the world. In this method it is assumed that two entities are in existence: the teacher (or the *educator*), and the student (or the *learner*). Here, the teacher is the active part which supplies the knowledge, usually in a class-room environment, and the student is the passive part whose task is to receive the knowledge and to prove his or her knowledge by means of examinations. This method of teaching is still in use in many parts of the world, especially in the under-developed and in most of the developing countries.

Today, the power of the computer technology and the wide availability of the Internet have changed the methods of teaching. Personal computers are now within the reach of most people. Nearly every household in developed countries has a personal computer. Most of these computers are equipped with multi-media tools such as microphones, speakers, scanners etc. The wide scale availability of the computer technology has given the educators many opportunities than has ever been possible. The first application of computers as educational tools was in the area of *Computer Based Education*, or sometimes known as the *Computer Based Training* (CBT). The concept and the use of CBT have resulted in a shift in the way teaching was carried out. In a way, the meaning of the term "*teaching*" changed into "*learning*". Students could sit down infront of their computers and they could learn by themselves by following the instructions given to them. This new approach was also called the "*learner-centered*" approach. With this approach, the learners have greater control of their own learning speeds, the learning time, and the environment where the learning takes place. The role of the educators in this new method has been to develop effective and efficient computer programs and computer based learning tools, such as multi-media based learning aids. One of the problems with the CBT has been the fact that the educators have not followed any well-known and well-established techniques when developing the learning tools. As a result of this, different educators have used different tools and it has been considerably difficult to measure the efficiency of any given tool.

The second major change in using the computer technology as a teaching aid has been in distant education, or distant learning. The idea of distant learning is not new and many universities and colleges have been providing distant education for many centuries in the form of correspondence courses, even well before the invention of the personal computers. Here, the basic idea was such that the student had to register to a course without having to attend to the college. The college then used to send the student course notes, usually in the form of books or other paper-based course material. After the student studied and learned the course material he or she had to take external examinations to prove the understanding of the course material.

The techniques used in distant education has changed considerably over the last decade as a result of the wide availability of computers and the Internet. Students can now learn over the Internet without having to attend any formal lectures at the colleges. In this new method, most of the course material is presented on the Internet, usually in the form of multi-media. The students study the course material and they can provide feedback to the educators by using the electronic mail, by attending virtual conferences over the Internet, or by establishing study groups over the Internet. Although the student and the teacher can

be remote from each other, they can establish very close links over the Internet. Some technical colleges even provide laboratory facilities over the Internet where the students can perform various experiments remotely in their own places of study.

Learning Objects is now a new methodology which has been gaining popularity over the last few years. This methodology applies to learning with the aid of a computer, and is not necessarily for distant learning. Students can use the learning objects in their full-time courses in order to gain knowledge. The concept of learning objects is described in the next section in detail.

2. LEARNING OBJECTS

There are very many definitions of learning objects. The IEEE LTSC (IEEE Learning Standards Committee) is the principle group responsible for the standardization of learning objects. The IEEE (2000) committee define the learning objects as:

"Any entity, digital or non-digital, which can be used, re-used or referenced dusing technology-supported learning".

The definition given by the IEEE committee is very broad and is not very useful in that form. Wiley (2000) has simplified the definition of learning objects by saying "*Any digital resource that can be re-used to support learning*". There are many other different definitions of learning objects. The important point about learning objects is that they are digital in nature. The other important point is that they are re-usable. Thus, a learning object created for a particular learning environment can be used in other learning environments as well. In essence, a learning object can be a piece of computer program, a small video clip, a sound track, an image and so on.

One problem facing the developers of learning objects is the granularity of an object (Clark,1998). When we say that a small video clip can be classified as a learning object, the important question is, how small is *small* ? What will be the duration of the video clip ? five minutes ? two hours ?. The important point here is that the learning object selected needs to support an educational objective or learning goal. It is important to have enough granularity to have meaning and establish context, but not so large that the learning object needs to be restricted to one context. i.e. it should be possible to combine the learning objects for various teaching environments. For example, if the requirement is to teach the programming language then an animation showing the basic structure of the programming language could be accepted as a learning object.

Another example of a learning object can be a mini-tutorial on a subject, or the computer simulation of the behaviour of a particular machine.

In order to simplify the task of developing learning objects, the *University of Wisconsin Online Resource Center (Wisc-online, pp.220-221, 2001)* offers the following guidelines to be followed before creating or using a learning object. Accordingly, a learning object:

- Shows clear purpose
- Reflects a specified learning preference
- Supports the competency at the appropriate level
- Helps learners understand the concept
- Can be applied to courses in different subject areas
- Can be applied to different programs of study
- Can be grouped into larger collections of content
- Requires interaction on the part of the learner
- Can stand alone
- Contains all information and materials needed by learners to complete the activity
- Is easy to use for the learner
- Applies appropriate principles of good practice
- Applies appropriate learning object principles

The *Australian Flexible Learning Framework Online Product Development Review and Evaluation* project identified some critical factors associated with the design and development of flexible online learning resources. Here, the focus was on environments that support customisation, and rely on re-usable learning objects. One of the major problems they found was the issue of granularity. They identified the following factors:

- Interoperability
- Organisation
- Scalable use
- Customisation
- Learning designs

Many researchers established a link between the children's LEGO sets and the learning objects. LEGO sets are small and they can be placed in any form in order to build the model of an object, e.g. a house. The same set can then be re-used to build a different object, e.g. a car. Once the user of a LEGO set learns how to put the places together to build small models, he or she can learn to build more complex models. Learning objects have some similarities here. They are small, and just like the LEGO sets they can be re-

used for different learning environments. But the comparison of the learning objects to LEGO sets have some potential errors. The LEGO sets are extremely easy to use and any formal training is not required. A child of any age can use the LEGO sets to build some kind of a model. This is not true for learning objects since the student needs a basic understanding and training before he or she could use a learning object.

It is the authors' opinion that the learning objects should have a hierarchy. Thus, a collection of learning objects should be developed for a particular teaching topic, and these objects should start from a simple approach and then become more complex and more advanced as the learner completes the study of simple learning objects. For example, the teaching of a one semester chemistry course can require a few hundred learning objects at different levels of complexity, and comprising of video clips, images, short-tutorials, and interactive quizzes.

One of the benefits of the learning objects is that the learners can be given positive feedback if they have achieved the required outcome, i.e. if they have learned the required topics. In general, this is achieved by post-tests after each piece of learning. The feedback can then be used as the basis for the learner to move on to the next learning object. They would move on if they have got all the answers correctly, or if a pre-defined threshold number of correct answers have been obtained. On the other hand, the learners will be asked to either repeat the same learning object exercise or to move to another learning exercise which could provide more training to the learner before attempting to the main object again. This process of repetition is very useful during the learning phase.

3. USING LEARNING OBJECTS TO TEACH A PROGRAMMING LANGUAGE

Learning objects have been used in the teaching of subjects with practical elements, such as physics, chemistry, mechanics, and so on. In this paper we shall be discussing the development of learning objects for the teaching of a programming language.

Using learning objects in teaching a programming language is not a new topic. Learning objects were used by over 1,000 students at the *London Metropolitan University* and the *Bolton Institute* on four modular courses in teaching introductory programming. Structured evaluation was carried out to measure the success of the approach. It is reported that the overall pass rate was increased considerably with the introduction of the learning objects based teaching. Two types of learning objects were used in this research study: text-based (html), and Flash-based multimedia animations. Whilst both types have been reported to be useful, the students rate the visual and interactive animations more highly.

One of the difficulties of teaching a programming language is how to provide the right information in the right context at the right time, and to the right student. Students attending programming courses usually come from a variety of disciplines and some have no programming experiences at all, while some others have taken introductory programming courses. There are also some students with experience of advanced programming languages such as C++. One of the major problems of bringing students to the same level of understanding in a short period of time is the lack of an effective communication mechanism between instructor-student and student-student to share crucial knowledge at the right time. Students often misunderstand concepts and apply them incorrectly which leads to wasted time. By the time students get help it is usually too late.

Adamchik and Gunawardena (2002) have created learning objects for the teaching of the Java programming language. Their approach is based on the concept of creating a large repository of learning objects, each of which consists of the core material, code examples, supplementary notes, and review questions. They have defined a learning object by a XML document where it presents an interface for future research, retrieval and updating, as well as for potential connection to and assessment tools. Furthermore, Adamchik and Gunawardena describe a new teaching, learning, and authoring tool, called the *Adaptive Book*, that allows the educators to add new learning objects, modify current ones, and discuss concepts using a variety of representation models. The adaptive book serves as an interactive, continuously up to date learning environment for students. Adamchik and Gunawardena believe that in the near future, the concept of adaptive book will have the potential to replace or enhance traditional paper textbooks. They also believe that the learning objects based teaching method will significantly increase the pedagogical effectiveness and the context-based communication effectiveness over traditional methods such as email and discussion forums.

In this paper, the teaching of the PASCAL language to *Computer Information systems* (CIS) students at the *Near East University* will be considered as an example. PASCAL has traditionally been taught to the first year CIS students at the Near East University. The course has traditionally been both classroom and laboratory based. Students learn the basic programming principles of the PASCAL language in the class-room. Practical programming examples are then solved using personal computers in the laboratories. Students are given programming home-works and assignments where they spend time writing

and testing their programs using either their own home computers, or the computers at the University laboratories. Laboratory assistants provide help to the students should they need it.

4. METHOD USED AT THE NEAR EAST UNIVERSITY

This section describes the method developed by the author to teach PASCAL programming to undergraduate students using learning objects.

A library of learning objects are being created, each describing the various parts of the PASCAL programming, including the theory and the laboratory experiments. Granularity is one of the important features of learning objects and the size of each object was chosen carefully such that each object describes a self-contained piece of work, not exceeding an hours of students time in total. The objects are chosen carefully so that they can be used to build bigger objects for more detailed studies. For example, the PASCAL program development cycle could be a learning object. Here, the student is thought in general terms using text, graphics, and possibly animation on how to specify a program, how to code the program on the computer using a suitable editor, and finally how to compile and test the code for any errors. All of this work could be packaged into a small module with questions at the end, and this module can then constitute one of the learning objects At the end of this exercise the students can move to the next learning object, which in this case could be the teaching of the Data Types of the PASCAL language.

In our model, the instructor can create a customized learning object and share it with an individual student, a group of students, or the entire class.

The second aspect of the communication model is to provide students with a flexible learning environment to quickly transfer their code into a communication platform and allow them to highlight and annotate and share that with instructor or fellow students.

The project described in this paper started in September last year and although the project is still in the development stage, it is anticipated that the programming tools such as DHTML, XML, JAVA, SQL and Macromedia products (e.g. Flash, Dreamweaver, and Authorware) will be used during the development of the learning objects.

After the development of the learning objects a booklet will be prepared to guide the students to the use of the learning objects. Since new learning objects are to be continually added to the library of the existing objects, it is anticipated that the booklet will be in such a form that can be upgraded easily.

Although the existing learning objects will be used in the University Laboratories, they can also be used for distant learning applications where the students can be given a CDROM of the appropriate learning objects, or they access the learning objects through the Internet.

5. CONCLUSIONS

There are many opportunities and advantages to be gained by using learning objects for taeching purposes. Perhaps one of the biggest advantages of learning objects is the fact that they can be shared and re-used as many times as required.

The paper has described the use of learning objects in teaching a programming language to undergraduate students at the Near East University. A small library of learning objects are being created for different parts of the programming language. The objects are chosen to be small, but at the same time, each object is just big enough to describe the theory and the laboratory experiments to be carried out by the students. The students select different learning objects once they are happy with the current one. The students have to use all the learning objects in order to attain a satisfactory level of understanding at the course. Although it seems difficult to meet the individual learning needs of every student, we will be able to use the interactive tools to create and maintain a large library of individualized LO's. We strongly believe that over time we will be able to achieve the goal of creating an individualized library of LO's for teaching and learning programming languages at the Near East University. The learning objects are being used by a small group of Undergraduate students at the University and the results will be compared to the classical methods of teaching, and the results will be published as soon as they become available.

The development of a learning object could be an expensive task, but it should be possible to share the learning objects between universities. This will give rise to huge cost savings. The student number is increasing all the time at the University and it is becoming more and more difficult for the instructors to pay attention to the needs of individual students. The author hopes that the new learning object based teaching methodology will enable the instructors to assess the performance of the individual students more closely and more efficiently.

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