

Learning objects in a multimedia interactive environment. The Codewitz project

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Abstract: *Student success in mastering basic programming skills is not as successful as would be expected and at the same time number of students enrolling in Computer Science is decreasing almost worldwide. The Codewitz project is developing and producing interactive web-based learning objects in order to help students and teachers in entry level programming courses. The learning objects are made available via an online material bank (data base) on the Internet at www.codewitz.net. To prepare the projects a need analysis was conducted using an online questionnaire for data collection. The results from the survey will be used to guide Codewitz/Minerva partners in their work to develop the most needed learning objects. Teachers or their respective educational institutions can become partners in Codewitz and download learning objects. All partners can develop their own learning objects and place them in the database and thereby becoming part of the development process of Codewitz.*

Key words: *Computer science, learning programming, teaching programming, learning objects, z, interactive multimedia, Codewitz, Minerva.*

INTRODUCTION

Over the last few years applications to computer science programs in universities has decreased both in America and Western Europe. Not only is the number of students applying and finally enrolling decreasing but also the percentage of females has decreased in many universities. At Reykjavik University in Iceland the applications for computer science has dropped from 293 in 2000 to 94 in 2003 (68% decrease) and at the same time the percentage of female applicants has gone from 31% down to 11% during the same period [1]. One of the reasons can be the influence of the DOT.COM bubble at the end of last century when many of the internet companies were not as successful as expected with many of them going under, this may have given young students the idea that computer science is not an attractive choice as a profession. Another reason could be that universities are not offering computer science programs that interest young people as much as before. Negative stereotypes in movies, where fat and sweaty programmers working alone in a small dark rooms, is not helping and does not depict a positive picture of what computer scientists do in real life.

Universities are using different methods to boost student interests in studying computer science and related subjects and to help them to learn programming. Some have changed their curricula to meet a more diverse student group and are offering online learning environments [2] or are offering degree programs that are combinations of traditional computer science courses and social science or humanity courses [3]. The names of CS programs have changed and new programs are being offered with names like informatics, informational technology and computer science and liberal arts in order to attract more students into the field. Never the less one of the main courses in first year study in most CS programs and related disciplines is still programming and learning programming seems to be a very difficult task for many students [4]. Different aspects of the problem have been discussed, it has been pointed out that new programming languages are more complicated to learn and teachers should consider carefully what programming language to choose for novice programmers [5] [6]. Universities also have to consider how to assist students in their learning, because we need more young people in the field, both male and female students.

The student group has become more diverse, some are just aiming for a degree while others are learning for their own sake and their learning skills are different. Some like to work in groups while others like to work on their own, some like to listen to the teachers' lectures and take part in discussions while others like to read and work on their own.

Teaching methods may affect students' motivation and success and some teachers have emphasized new or different methods of teaching like Problem Based Learning [7] [8] and have reduced lecture hours while putting a greater emphasis on project work. Learning material is also important and new opportunities in information and communication technology (ICT), with the use of multimedia and the Internet, have given rise to new possibilities in preparing and delivering learning material to students.

Learning material has an effect on students' performance and progress and is one of the things that are of interest to develop and consider in computer science study. To use multimedia learning material can be motivating for the students and may be more suitable for those who are brought up playing computer games. More than one project has been implemented in order to develop learning objects for programming students [2] [9] [10]. One of them is the Codewitz project, which is intended to help in learning and teaching of programming languages and was invented at Tampere Polytechnic (TAMK) in Finland.

CODEWITZ LEARNING OBJECTS

The main idea of the Codewitz project is to develop and produce interactive web-based learning objects for programming students and teachers and collect them in an online material bank (data base) on the Internet. Sub-project of the Codewitz project is called Codewitz/Minerva and is funded by the *European Union Socrates program Minerva, ODL and ICT in education*, under the coordination of the Tampere Polytechnic Finland. The participating universities in the Codewitz/Minerva project are the University of Applied Sciences in Furtwangen in Germany (FHF), the Tampere University of Technology (TUT) in Finland, the Ventspils University Collage (VENTA) in Latvia, the Technical University of Civil Engineering (UTCB) in Bucharest, Romania and Reykjavik University (RU), Iceland.

The main goals in the Codewitz-project are:

- “1. Developing and producing interactive learning objects for basic programming courses.
2. Providing a growing repository for string and sharing the resource with the project partners.
3. Creating a network of teaching experts who deal with this problem every day.”

[11]

The Codewitz objects are standalone interactive exercises or assignments for the students to use in their study but also for the teachers to use in their teaching. The students can use the learning objects by themselves in the class room or at home and the teachers can use them as part of their teaching methodology and can show them in lectures or at workshops.

There is hardly a limit for what kind of subject or concepts can be explained in the learning objects, e.g. loops, variables, parameters, arrays, input/output functions, file handling, abstract data types, structured data types, selection structures, recursion, language libraries, error handling, pointers and references. These are all subjects from first year courses in programming but subjects from more advanced courses could also be used for making learning objects, e.g. linked lists, stacks and heaps, searching algorithm, multimedia and streaming database and discrete mathematics. The objects are designed to make the student active, he/she follows the process of the object step by step, enters his/her responses and receives feedback by text, animation and/or graphic. Each object can have up to five areas or windows, Input/Output area, program execution area, memory area, condition area and explanations area as Figure 1 indicates.

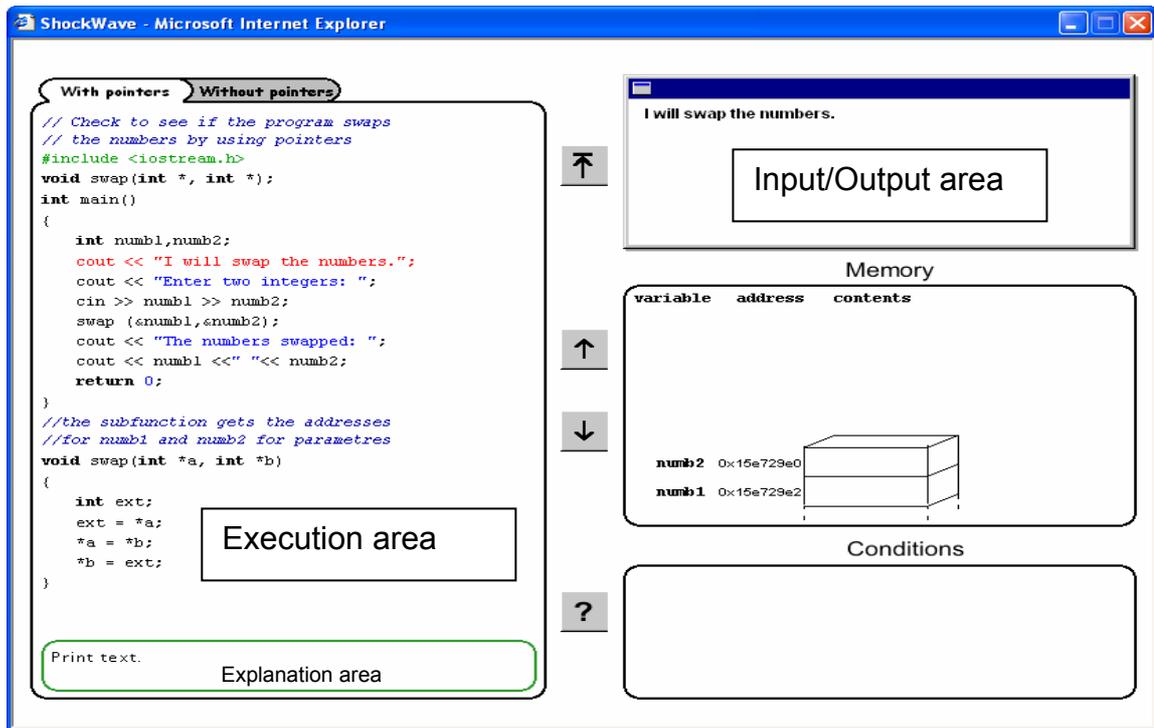


Figure 1

In the programming execution area the programming code for the object is shown and different colours are used to emphasize different parts of the code. In the execution area the student enters his input that can be a number, programming code or any other text. Then the object starts to work and shows what happens both in the memory area and in the programming execution area. If some conditions are needed, or an explanation, they will appear in the respective area. If a partner in the project wants his object to look different from Figure 1, does not need all the area or wants another area he/she can design the object differently. The design must always follow the main ideas of Codewitz, which is to make the students active and to use visual explanations with multimedia.

The objects can be made in different programs but so far the Codewitz partners have used Java applets, Flash and Macromedia Director. The main emphasis has been on making objects for the C++ programming but the partners are also making objects for Java and are considering making objects for other programming language.

PREPARATION FOR THE CODEWITZ/MINERVA PROJECT – NEED ANALYSIS

In order to determine which objects to develop in the Codewitz projects it was necessary to conduct a survey and try to determine what students and teachers find most difficult in learning programming. A website for questionnaires was designed, one for the students and one for the teachers, and made available for Codewitz/Minerva partners in November 2003 by e-mail. A total of 565 students and 35 teachers participated and here the results will be briefly discussed.

If we look at average student response to the question: “What kind of issues you feel difficult in learning programming?” They stated that the most difficult tasks are to find bugs in their programming, dividing functionality into procedures, functions and/or classes and understanding how to design a program to solve a certain task as shown in Figure 2.

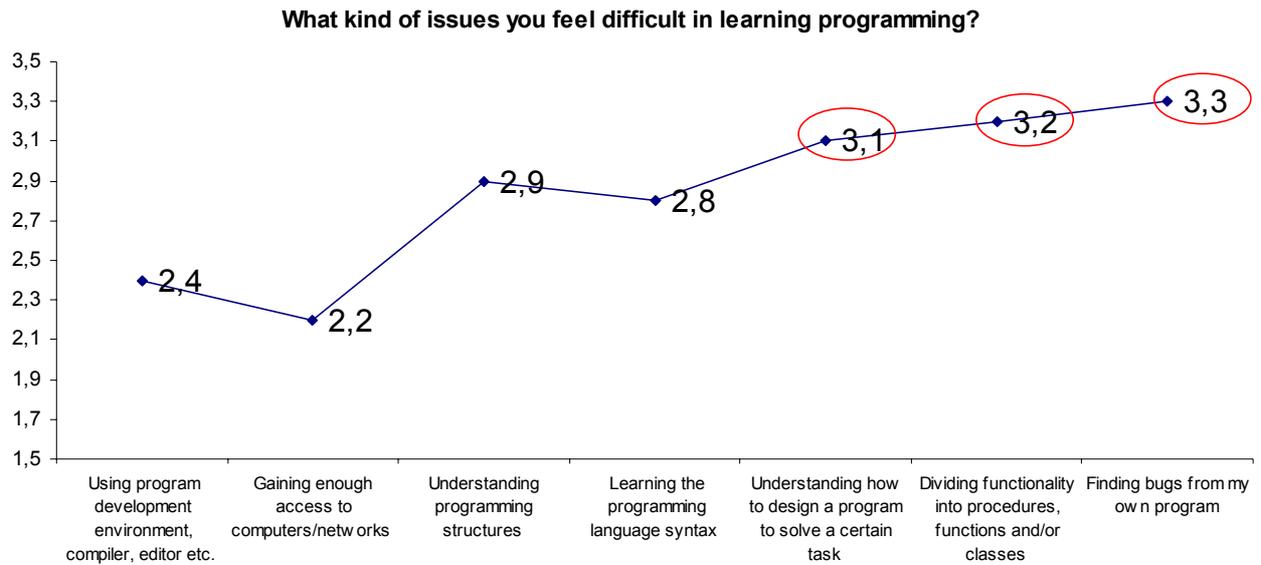


Figure 2

When asked what structures or concepts the students found difficult to learn? They stated that pointers, references, error handling and using language libraries were the most difficult to learn, but recursion, abstract data types and structures data types were also considered rather difficult among others concepts as Figure 3 shows.

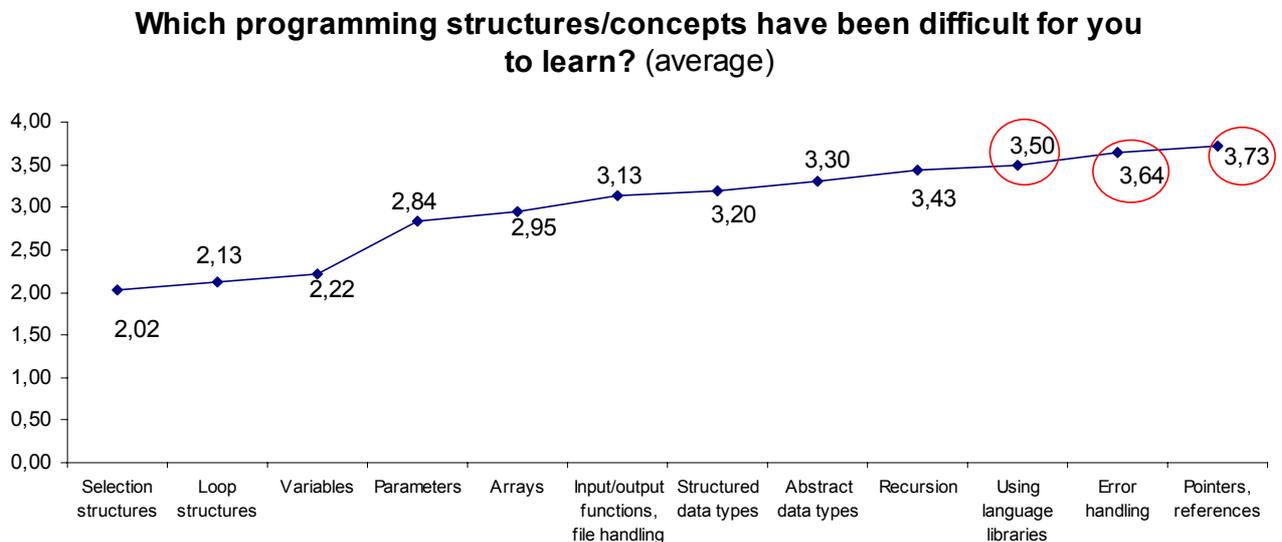


Figure 3

It is important to look at when students consider they learn best and in the survey they stated that they learn best while working by themselves on programming coursework, in practical sessions (in the computer room) and by themselves with teaching material as Figure 4 shows. Lectures are rated lowest in this survey as a good way to learn programming issues.

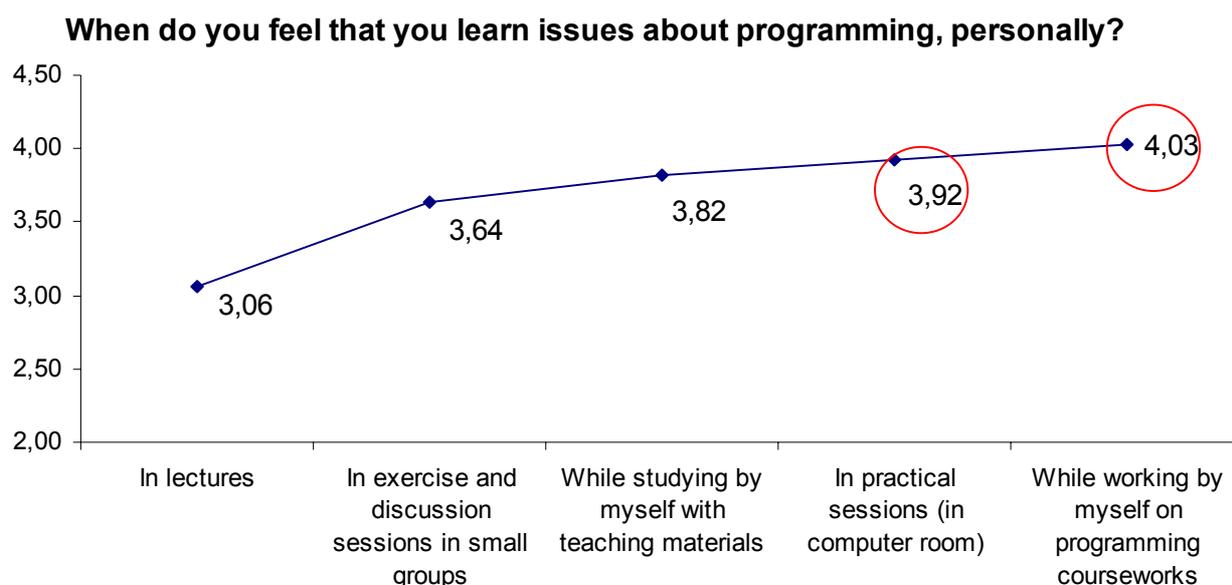


Figure 4

The results indicate that students like to work by themselves on programming, in practical sessions and with the teaching material. These results give a reason to believe that teaching material like the interactive web-based learning objects in the Codewitz projects could be useful and suitable for students learning styles as they give the students opportunity to get explanations and assistance while they are working by themselves on programming assignments.

Partners in the Codewitz/Minerva will use the results from the survey and other information from the survey as guidance for what kind of objects to develop for the students. Results from the survey can be found in the needs analysis conducted by the partners in the project [12].

MATERIAL BANK

To make the Codewitz learning objects accessible for teachers a material bank has been developed. Teachers or their institutions can apply for access to the material bank and download learning objects but also put their own learning objects in the material bank to share with others. Two types of partnership are offered, called partner of level 1 and level 2. Partner of level 1 is both a tester and a developer and is primarily for high school institutions but at level 2 the partner is also a Learning Object producer. To become a partner it is best to go to www.codewitz.net choose *How to join* and get more information about the partnership before sending e-mail to tarja@codewitz.net or esa@codewitz.net. The material bank is open to all who want to use, develop and produce learning objects. Further information and a demo can be found at the Codewitz web-site.

CONCLUSIONS AND FUTURE WORK

The idea of online interactive learning objects is one of many that universities are working on in order to make computer science and learning programming more attractive and interesting for students. The Codewitz projects are based on the idea that teachers can make learning objects built on students and teachers experience and the idea to share with others can make the product of the project widely used. In the three years sub-project of the Codewitz project, Codewitz/Minerva, the requirement analysis shows what subjects should be emphasised to start with, e.g. recursion, language libraries, error handling, pointers and references. The need analysis also indicated that online interactive learning

objects could be useful for students as they like to work on their own when learning programming.

All teachers can become partners in Codewitz, get access to the material bank and take part in developing more interactive learning objects in order to support programming students in their struggle with different programming languages (see www.codewitz.net).

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