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How to teach programming languages to novice students? Lecturing or not?

Ásrún Matthíasdóttir

Abstract: *How to teach novice programmers is always an interesting discussion and in this paper the author writes about a new structure of teaching programming at the School of Computer Science at Reykjavík University. This is a new programme without formal lectures but with computer lab sessions, recorded lectures and online exams. The aim is to offer exciting and stimulating environment in class which may require more preparation from the students and more contribution on their behalf.*

Key words: *Teaching programming languages, recorded lectures, novice programming,*

INTRODUCTION

In the beginning of the 21st century higher education has become more accessible and a real option for the majority of young people in Western Europe and Northern America. Higher education is for everyone, it is no longer only for the elite as it was up to the end of last century [1]. In the year 1977 the number of students registered in universities in Iceland was 2.249, in 1984 the number had gone up to 4.704 students and in 2004 the number was 16.068 students out of a population of 300.000 [2]. This is in congruity with the increase of university students in Western Europe [3, 4]. The growing group of university students is more heterogeneous than before, having different backgrounds and of a broader age group. In 1997 students over 30 years old were 24% of the student group at the university level in Iceland, but in 2004 this group was 38% of the student population [2, 5]. This has brought a pressure on the universities to offer a variety of learning opportunities and different methods of studying, e.g. distance education.

Computer science is a subject that has not followed this increase of university students as the number of applicants has decreased the last years. As an example the applications of computers science students at Reykjavik University has dropped from 350 in 2000 down to 60 in 2006¹. Somehow computer science does not seem to appeal to young people to day. Universities have looked for explanations; some have changed their course programmes or offered new programmes.

Teaching programming languages is one of the foundations of computer science education and usually one of the first courses novice students take. It is important for the teachers to gain students' attention and strengthen their motivation for learning to programme with the help of a variety of teaching methods. Learning programming is a difficult task for many students and teachers are looking for methods to make it easier for them [7, 8, 10]. Over the years teachers have discussed the best way to teach novice programmers, what to teach and how, learning styles and learning tools, how students can be motivated and supported and what programming languages should be taught [5, 6, 7, 8, 9].

In a survey related to the Codewitz project in 2003 (see www.codewitz.net) the aim was to get more information from students and teachers of what is difficult in learning programming. Among the main results the survey indicated was that the students did not agree on what was difficult to learn and similar percentages of students thought the same things were difficult and easy. In the same survey only about one third of the students claimed they learned issues about programming in lectures and they agreed that the best way to learn programming was working by themselves on programming coursework, in practical sessions

¹ Information from the Reykjavik University Academic Affairs

(in the computer room) and by themselves with learning material [7, 8]. This is consistent with Bellaby, McDonald and Patterson [11], who state that "...lectures are not a useful way of teaching programming".

In this paper the author will give a short overview of the School of Computer Science at Reykjavík University (RU) followed by a discussion of how the School has developed the teaching of programming and a new method of teaching a first year course which started in the autumn 2005.

SCHOOL OF COMPUTER SCIENCE AT REYKJAVIK UNIVERSITY

The School of Computer Science at Reykjavík University (RU) offers a three years BS degree in Computer Science, two years MS Programme and a PhD programme is in preparation. In autumn and spring semesters students take four theoretical courses that are taught for 12 weeks followed by an exam period. After the exam period all the first year students attend a three-week practical project work course [6] but others take 3-week intensive courses. These intensive courses are different every year as the School is aiming to bring in highly qualified professors and/or researchers to teach classes in their speciality.

To be able to respond to the different needs of a heterogeneous student group the School offers three different ways of studying: 1) Traditional school-based education, 2) University Education While Working (EWW) and 3) Distance Education (DE). EWW and DE are offered part time but traditional school-based learning is organized as a full-time study. This has developed in the way that students mix these opportunities together, taking 2-3 courses in the traditional programme and 1-2 in EWW or even DE. The main difference between EWW and DE is that EWW is offered in afternoon classes once a week each course and the students can also take a few courses in the summer semester but DE students are offered to come to the School two weekends each semester.

RECORDED LECTURES

Usually teaching of theoretical courses at the University has been rather traditional, consisting of 2-4 lectures a week and 2-3 practical sessions, often in computer labs. To ensure that all students get access to quality teaching we have recorded most of the lecturers since 1998. At the beginning the recorded lectures were only accessible for the DE students but soon school-based students also got access to recorded lectures and EWW from the start in 2001.

To record the lectures we use a wireless microphone and the program Camtasia (see <http://www.techsmith.com>), which captures all that is on the teacher's computer screen and also his voice. It is not video recording so the students who watch it do not see the teacher but hear his/her voice and are able to follow him/her during the lecture. When the lecture is finished the file is copied into the school learning management system *My School* in less than a minute. The teachers can also record the lectures after class hours at their desk; they can edit their recorded file with the Camtasia program or make supplementary and extra explanations or learning material. The experience is that most teachers just record the lectures and put them straight into the *My School* system.

The students have access to recorded files through *My School* from where they can download them and listen to when ever they want and as often as they want. Students need good Internet connection and the Windows Media Player or some other player on their computer. This has been a very popular among the students and is highly appreciated [5] or as one DE student said: *I would rather skip the weekend session if I could get more recorded material.*

As we know all good things can also have negative side effects and our recorded lectures are no exception. One of the main side effects is low attendance rate to lectures, students tend to skip the lectures and instead plan to listen to the recording later on. In my mind students have an important role in the class room, because they should contribute to the work that goes on in class. At a good lecture there should be something going on that is worth experiencing, something which the student does not experience if he just listens to the recorded lectures. In this respect, communication not only with the teacher, but also with fellow students is important. Another side effect is that when students ask questions in the classroom the teachers must repeat them so they will be recorded before he/she answers. Often teachers forget to do this and only the answer is recorded. It can be rather awkward for the teacher to repeat questions in a small group of students, because he/she may look rather foolish or boring.

Teachers are tired of this situation and want to find another solution. They want more attendance and an interaction in the classroom, a situation that is not well suitable for recording. One solution could be to block access to the recorded files but as DE or EWW students, who are taking the same courses would have access to them, this is not a valid solution. Another solution is to stop recording lectures and make special recorded material for DE and EWW students, which could mean much more work for the teachers. The solution must ensure that DE and EWW students get good service; they must get good study material and be able to follow what is going on in the course. The solution that we are working on at the moment is to change the structure of the courses, not only splitting the teaching into formal lectures and lab hours, but also changing the methods of teaching and keeping the main goal of activating the students in mind.

TEACHING PROGRAMMING IN A NEW WAY

Computer Science students are a heterogeneous group as all other higher education student groups today, some students are looking for a practical degree that might lead to a rather well paid job while others are interested in the subject. They have different educational backgrounds; some have recently finished upper secondary school (High School) while others have been working for some years or have already finished a university degree in a different subject. Also, they have different learning habits and different motivations to study.

All first year students at the school of Computer Science start by taking a 12 week C++ programming course and usually they would get three formal lectures (45 min each) a week that would be recorded, then they split up into smaller groups of 25-29 students each that would get two computer lab lessons a week. The students tend to skip the lectures, which creates a number of problems, but there are also problems with the lab hours. Some of the students have better preparation than the others and want to start programming right away and are not willing to follow the teacher's instructions or wait for other students. They want to work on their own pace and want the teacher to come running to help them when they are stuck.

To change the situation we designed a new system for the whole course in the autumn 2005 with a good cooperation with the dean of the department and the director of Academic Affairs who organises the time table. The plan was to have no formal lectures any more, only working sessions in the lab – workshops. Instead of 3 lectures and 2 lab lessons a week each student gets 5 lab lessons.

We were aiming at more quality time for the students and the main idea was that teachers and students spent their time together in a more productive way, the students working on their programming codes and the teachers assisting them on a one-to-one basis.

Students' cooperation and collaboration could also be stimulated in this kind of situation. The teachers might give short presentations, 5 – 10 minutes, at the beginning of the workshop, or in between, that could be recorded, but mainly the students were working on their tasks.

When the course started in the autumn 2005 the teacher had already prepared recorded material, some of it was from previous year's lectures – some was new. The main difference between the old and the new structure is that previously the recordings were up to 45 minutes long each, but now they have been edited into 5-15 minute each. We use transparent names for the files, e.g. loops, and put them in the My School system to make it easier for the students to find the right file. The students are encouraged to bring their own headphones and listen to the material while practicing programming in the lab sessions. When they see they need more knowledge or help they can look for recorded material and listen to the teacher and do not have to wait for him. Students solve exercises at very different speed and if they can find help in the recorded material to keep on working they do not have to wait for the teacher. The teacher can spend more time on students that need more help than the recorded lectures can give them or want some extra explanations; i.e. the teacher has more time for those who ask for help and really need it.

The teacher also prepared short online exams, quizzes, each week that was a part of the course assessment, but it was also thought of as a support for the students, they could follow their progress over the course and see how well they are doing. An extra online exam, an example of the real exam, was offered to the students the day before the real exam was held for them to use as an exercise. The sample exam turned out to be very stimulating for the students and they used the time between exams to prepare for the real exam and got good results.

The teacher's experiences and feelings for this new method were very positive and stimulating. He felt the students were more active and could go faster over the curriculum and the students who already had some experience with programming could move on and he had more time for the beginners. Class attendance has been much better and apparently the students seem to be very pleased with this new structure of the course and rated it highly at the end of the semester. In 2003 the average rating was 3.58 but was in 2005 3.81.

STUDENTS' ATTITUDES – A SURVEY

To get information about the students' attitudes a short questionnaire was prepared and put online at the end of the programming course in 2005. Students were asked by e-mail to answer the questionnaire. When it was closed two weeks later 36 (40%) of them had responded, 30 males and 6 females. Most (70%) of the students were in the traditional education, eight (24%) were in the DE and two (6%) said they mixed together the different forms of education.

Students attendance in the classroom is an important factor and twenty-three (64%) of the students stated that they attended lab sessions most of the time or always, 5 (14%) said they attended rarely and 8 (22%) never. Those who never attended lab sessions were asked why but no one answered. Usefulness of the lab sessions is also of interest and 87% said they were very useful. Fourteen DE students answered questions about the usefulness of the working weekends and 9 (65%) said they were very useful or relatively useful but 5 said they did not attend.

The recorded lectures are of importance in this course as students do not get any formal lectures. Instead they can listen to recorded lectures from last year and new recordings as well. Students can listen to the recordings where they prefer and almost all listened to them at home (97%), 17 (47%) at school, and 5 (14%) elsewhere. Twelve (33%) of the students said

they listened to all the older recordings or most of them and 13 (36%) said they listened to them when they needed further explanations of special material. This means that 69% of the students are using the recorded lectures frequently, 3 (14%) rarely and only 6 (17%) never. The answers for the last year recorded lectures and new recordings made from the lab lessons was similar as about two thirds (68%) said they liked the recorded lectures (very well or well), 6 (17%) were neutral and 6 (17%) said they did not use them.

The online exams are an important support for the students and most (83%) of them claim to like them, 11% were neutral, 3% did not like them and 3% said they did not use them at all. The attitudes towards the example online exams were similar, most (86%) of the students said they liked them, 11% were neutral, 3% did not like them. No one said they did not use them.

When asked about the usefulness of different study issues everything seems to be useful as Figure 1 shows. The learning objects from the Codewitz project were rated least useful but nevertheless 61% agreed on their usefulness. We do not have information about how frequently they used the Codewitz material but the teacher had used it in the lab session a couple of times and pointed it out for the students as a comprehensive or support material.

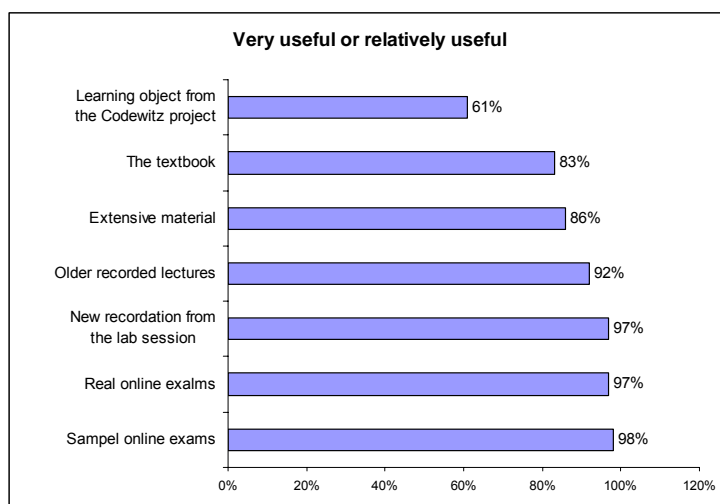


Figure 1

CONCLUSIONS AND FUTURE WORK

The new structure and teaching methods with the emphasis on lab sessions, recorded lectures, online tests and one-to-one teaching, has been very successful. Both the teacher and the students are positive toward these new changes and we will keep on the developing work. One must bear in mind that this is just one course, one experiment, but it encourage teachers to keep on the good work and develop this idea further. One of the ideas for future development is that each student has two screens, one to watch recorded lectures or other comprehensive material and the other to work on their program code.

This experiment has affected other teachers at the School of Computer Science and at least two have reacted directly on the idea. The structure of the courses *Human Computer Interaction* and *System Analysis*, which are both first year courses, have been changed. Now the teachers give only one formal lecture a week in stead of three and have three lab sessions a week in stead of two. Other teachers have put more emphasis on activating the students and reducing long formal presentations.

There is a discussion among the teachers about changing the names of the class hours and no longer call them lectures or lab session, they should just be called class hours and the teacher could organise them in the way that is suitable for the learning situation at each time. There could be a mixture of short presentations from the teachers or from the students, discussions and interactions, programming work and work that emphasises communication and cooperation among the students. This could encourage the students to attend as they would be expecting stimulating environment in every class which in turn might require more preparation from them and more contribution.

This would call for more work for the teachers at the beginning, they would have to record material for the DE and EEW students or edit older recordings, they would have to prepare more activating tasks and projects for the students and be prepared for more discussions and tutoring in stead of formal lecturing. The situation could be different in different courses; some might need more formal presentations than others, some might give more opportunities for discussions and project work.

While discussing this with fellow teachers I have noticed that they are very positive and would like to keep on going in this direction although it might mean more work in the beginning making the recorded material, but most of them will be reusable despite book changes in courses over the years.

Teachers are always looking for new methods and I think we can all agree on that we must keep on searching and scrabble for better ways of teaching programming and to make the subject more interesting and attracting to young people.

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