Individual Learning Approach in the Basic Course of Computer Science

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Abstract. The article presents the results of an experiment with students participating in the basic course of Computer Science. The purpose of the experiment was to find out, how much the beginning students were prepared for the course and what their preferred learning style was. Various tests were carried out to identify students' levels and learning styles. As a result, students were divided into groups according to the test outcomes. Separate groups were formed of students with different levels of knowledge and their learning styles were determined using the Felder-Silverman model. Course materials, assignments and tests were compiled so that they catered for the needs of different groups; parts of the course were made available as an e-course in the Moodle environment. An overview of the course and the analysis of the experiment is presented in the article.

1. Introduction

The basic course of Computer Science is taught by the Institute of Informatics of Tallinn University of Technology to non-IT students from different departments and has the general name Informatics. Current research presents the description and results of an experiment carried out with the students of Civil and Power Engineering and Economics curricula.

The general aim of the Informatics course is to develop logical, analytical and computational thinking by using the computer on the highest level. The course consists of two parts: information processing and programming.

Considering the target audience, several attempts were made to design the course material in the way that it would be simple to understand but would still achieve the goals. Nevertheless, the course seemed to be rather difficult for most of the students. It resulted in low examination grades and lack of motivation.

Moreover, in spring 2010 students' feedback showed that the subject comprehension was 1.63 points out of 5. These results of anonymous feedback were retrieved from the Studies Information System (ÕIS) – an e-environment, where students get information about curricula, declare courses, keep results and give feedback on learning and teaching processes [1].

To improve the situation, the course materials were updated and, most importantly, the whole teaching approach was changed.

2. The course description

The course of Informatics starts with a spreadsheet processing task where MS Excel is used. The aim of the first module is to learn to create applications using standard facilities. Students write formulas, apply built-in functions and create diagrams as well as manage data. The practical tasks vary depending on the students' specialization.

The aim of the other part of the course is to introduce the main principles of building algorithms and programs. Visual Basic for Applications (VBA) has been chosen as the programming language to create programs in Excel.

However, starting with VBA was difficult for most of the students: combining the object-oriented thinking with algorithm structure and the syntax of a programming language was too much all together.

To make the start easier, Scratch – a graphical programming environment created in Massachusetts Institute of Technology – was added to introduce these ideas [2]. Scratch is an intuitive programming language, it enables an easier and quicker way of grasping the main concepts and methods of programming, algorithms and modelling.

Therefore, transition to VBA programming is softer and not that complicated for the students.

3. Methodology

Although students are different in many ways, our aim is to provide them with equal knowledge, as much as possible. So it seems obvious that it is necessary to apply different teaching methods depending on the individuals. However, with current resources it is not possible to organize teaching completely on one-to-one basis, so the students have to be divided into some groups.

In our research we concentrated on two aspects: the level of knowledge about the course subject at the beginning of the course and students´ individual learning styles preferences.

This indicated a great need for using flexible learning approach, the effectiveness of which was proved by Stuart R. Palmer [3].

The experiment was carried out in three main phases:

- transformation of the course materials and main activities into the e-learning environment;
- formation of student groups based on the level of their prior knowledge;
- individualization of the learning process considering students´ preferences for learning styles.

3.1 Applying E-learning Methods

The first step in making the teaching approach more flexible was to convert the Informatics course partly to an e-course.

At the beginning of the current research, e-learning had already developed and was very popular around the world. It had repeatedly proved its potency. At the present time educators are less optimistic about using an e-environment as the only tool in teaching, seeing that personal contacts with students are not less important.

So, we decided to update all course materials and transfer them to the Moodle environment [4]. It gave us a lot of opportunities to make the computer science courses more attractive. Moodle supports a lot of different tools and activities: video lessons, tests and self-tests, demos, possibilities to submit home-work and get immediate feedback. Analysis of student feedback shows that training with the help of a large amount of small tests plays an important role, especially in the first steps of the learning process.

All student work as well as their results with feedback are now stored in one place, which gives a good overview of the learners' progress during the semester. Keeping track of students' learning activities gives a possibility to adapt the teaching process continuously. Adding a portfolio for each student would be the next step in near future, as it will give the learner an overview of his/her work and achievements and the teacher – a picture of the student's progress during the course.

In addition, the e-environment gave students more freedom to choose the learning time. For example, they got an opportunity to fully compensate for any absences from class and cover the material at home.

The students’ community at Tallinn University of Technology is multinational. Some of the basic courses, including the course of Informatics, have to be taught in at least three languages: Estonian, English and Russian. The same course material is now available in all these languages, while the structure remains the same.

As a result of the described updates, students’ feedback showed that their self-rating points increased to 2.54 out of 5. Positive dynamics in learning and teaching is shown in Figure 1.

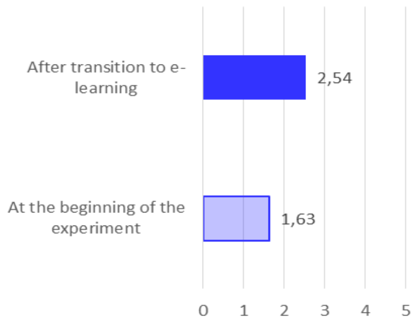

Fig. 1: Subject comprehension after the first step of the experiment.

3.2 Considering the Level of Prior Knowledge

During the experiment period it became clear that we did not have any information about our students, except for their names and curricula. This information was not enough for effective teaching and material compilation. For example, we did not know anything about the learners’ prior preparation (at school) and their readiness to study Computer Science at Tallinn University of Technology.

3.2.1 Computer Science in Secondary Schools

There are no Computer Science courses in some Estonian schools, mainly because there are not enough teachers. At the same time, the level of knowledge, skills and experience is very different among working teachers. In order to get good results in teaching university students, secondary school teachers had to be taught first.

As a result of the initiative of the Institute of Informatics, a non-mandatory course ‘Basics of Application Development and Programming’ has been included in the curriculum of Estonian secondary schools starting from year 2011. The course was created based on our experience in teaching students for many years.

3.2.2 Levels of Knowledge in the University

During the next step of the experiment, students were divided into groups according to their prior knowledge. Three groups, Beginners, Advanced and Experts, were formed based on the results of an initial test. Beginners′ test results were under 60%; the Advanced group had their results between 60 and 80%, Experts finished the test with results between 81% to 100%.

It is assumed that students who opt to study the course of Informatics have the necessary knowledge and skills – the computer user skills certification (ECDL) level [5]. Therefore, the test questions were related to the topics in the ECDL modules: use of computers, file management, creating documents, presentations and spreadsheets.

It turned out that most of the students were Beginners. Their level of knowledge was much lower than we had expected. Another important factor that needs to be highlighted is the fact that every year the percentage of Beginners grows (Figure 2).

What is more, the majority of Beginners got results lower than 40%. As shown in the following diagram (Figure 3), this percentage is permanently increasing.

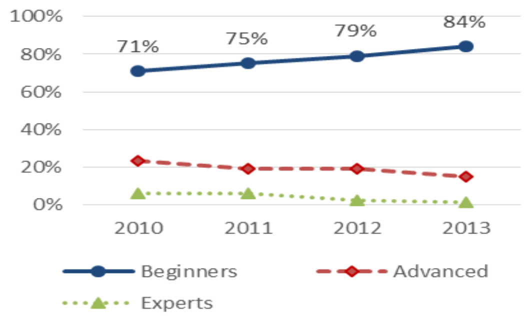

Fig. 2: The Beginners percentage increase over the years.

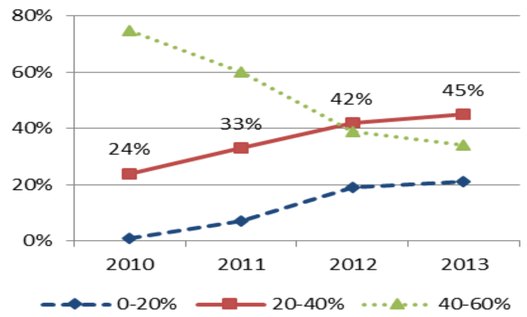

Fig. 3: The decrease of Beginners' test results.

Our teaching goal is to achieve the same level of knowledge and skills at the end of the course for all students despite their initial level.

During the course in the e-environment different sets of tasks were offered to students belonging to various groups. The levels of difficulty of these tasks corresponded to the levels of knowledge in each group. Students with lower knowledge level were offered a larger quantity of simpler tasks. At the same time, students with higher level solved a fewer number of more difficult tasks.

It must be emphasized that Experts' set of tasks was the same as the Basic task in the course before transition to e-learning. So, we found one of the reasons for the poor progress in the course – students could not cope with the material which was offered to them. A new set of tasks was considered and it corresponded to the number of course training hours.

In this way we were able to identify and eliminate lack of prior knowledge. After the described course update students' feedback showed their self-rate of 3.65 points out of 5, as shown in Figure 4.

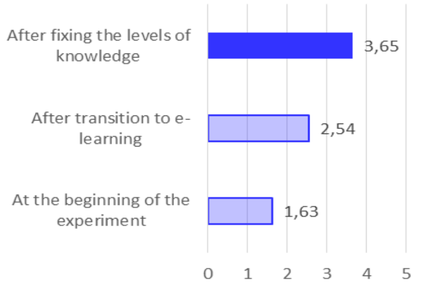

Fig. 4: Subject comprehension after the second step of the experiment

3.3 Individual Approach to Students with Different Learning Styles

To achieve better study results, it was decided to analyze the students' ways of learning and solving problems.

It has been proved by different researchers that people learn in different ways: some like to talk and discuss, others prefer to read texts or study by investigating charts, diagrams and drawings. There are many ways how to study the assimilation of the study material by students, depending on their individuality [6].

Felder-Silverman model, where students are divided into groups according to their learning styles, was adopted as the basis for the current study [7]. Depending on their learning material perception and work with it, Felder distinguishes the following groups [8]:

- active and reflective learners
- sensing and intuitive learners
- visual and verbal learners
- sequential and global learners

More than 600 students of economics, civil and power engineering were involved in the next step of the experiment. All students were divided into two equal groups: a reference group and a test group.

Students of both groups were taught the Informatics course depending on their prior knowledge – the same system that was mentioned earlier. In addition, for the students of the test group course materials and the whole learning process was designed to match their learning preferences identified in the Felder test [9]

The statistics of the last two years show that most of the first year non-IT students are active, sensing and visual learners (Figure 5). This means that they have very strong preferences in their work with educational materials. The students must be provided with appropriate sets of tasks, otherwise they have difficulties in learning.

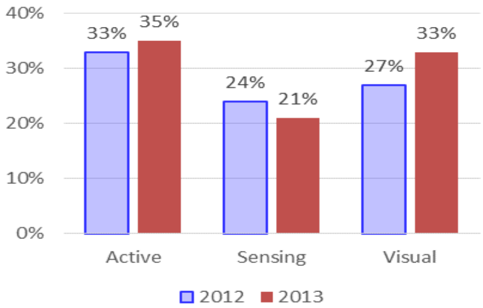

Fig. 5: Preferences of first year students.

According to Felder's instructions [10], we provided:

- active learners with: group work assignments, more independent work and work related to their specialization, opportunities to help others.
- sensing learners with: exercises, which were connected with solving real problems.
- visual learners with: visual representation of the course material: video lessons, screenshots, short video fragments of practical assignments [11].

The results of our work showed a positive trend in the acquisition of knowledge. The students of the test group managed with all practical assignments much better than the students from the reference group. They did it with a great desire and showed more initiative in their work.

As shown in Figure 6, examination results of the test group students were better, too.

Finally, students' feedback showed that subject comprehension was 4.53 points out of 5. (Figure 7).

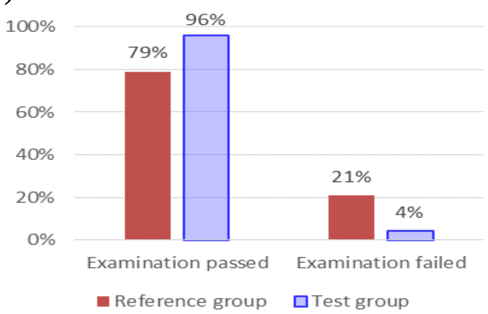

Fig. 6: Academic achievements. Spring semester 2013

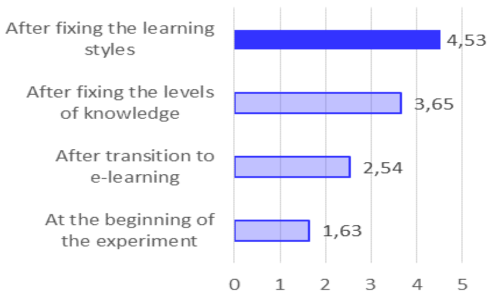

Fig. 7: Subject comprehension after the third step of the experiment.

Figure 7 shows the positive trend in understanding the subject during the experiment. This fact once again proves the importance of our study.

It is necessary to mention that during the course usual practice classes were held as it had been the case before the experiment. However, now they were something more than just ordinary lessons - they became a way to support students in their work with educational materials.

Most of the new information about the subject the students got in the e-environment, at home, in the style appropriate for them. During the classes they asked questions, presented their home-work and shared their experience with others.

The teachers' role changed in our updated course as well. Now we are more than simply information transmitters, we have become advisors and supporters.

4. Conclusions and future work

In our work we could get the answers to the questions raised at the beginning of the experiment. We were able to explore our students, study their personal character traits and preferences. Moreover, according to the results, we could individualize the teaching and learning processes and improve their quality.

In addition, we were able to increase students' motivation, which is a very important aspect.

In conclusion, we would like to emphasize again that the content of the material, which is adapted to students' prior knowledge level and to their learning styles, helps students better deal with the material and is an important factor in individualizing learning.

In the near future, we will conduct a deeper study and analysis of the students' data, which could give us a better overview of our students – who they are and how and why they learn. Additionally, there is the need for the continuous process of curriculum adaptation and material development, taking into account different learners and teaching materials.

Our methodology can be understood as an in-depth examination of the learners' data with the aim of extracting useful information from it to cater for flexible and more effective teaching and learning.

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