Computer Science E-Courses for Students with Different Learning Styles

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***Abstract*—E-learning is a contemporary teaching tool that has become popular and widely used in engineering education in recent years. This article presents the outcomes of a study on considering students` different learning styles in teaching information and communication technology using e-learning. Students were divided into two study groups. The reference group studied according to a provided learning model which including both theoretical educational material and practical assignments. Students of the test group were divided according to their learning styles using the Felder-Silverman model. Different relevant learning models, which included the same theoretical material and practical assignments, were designed for students of the test group based on the learning styles. The results of the study proved that the learning materials which were designed taking into account students` different learning styles considerably improved the achievement of the learning outcomes. A detailed description and analysis of the study is presented in the article.**

I. Introduction

Engineering education is a large system and it is almost impossible to predict its behaviour over far too distant future since the system parameters show a high rate of change. All knowledge is changing so fast that we cannot give students what they will need to know tomorrow. Instead, we should be helping them develop their learning skills so that they will be able to learn whatever they need to. If we can achieve that, we will have world-class engineers, people who are innovative and resourceful.

Learning styles are characteristic cognitive, affective, and psychological behaviours that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. Students learn best when instruction and learning context match their learning style.

Understanding students' different learning styles is one of the midpoints of effective education. The aim of the research described in the article was to abolish mismatches between students' common learning styles and teaching styles in e-learning and make teaching in engineering more effective.

According to Felder and Brent [1], students learn in many ways – by seeing and hearing; reflecting and acting; reasoning logically and intuitively; memorising and visualising; drawing analogies and building mathematical models.

Classroom activities of teachers and students take place in mutual communication. Therefore, the guidance and the formative role of the teacher should be realized in the creation and review of theoretical material and the material in practical classes. However, most of the learning processes are individual learning activities and here self-regulation of the student is realised. The task of the teacher in this case is to provide students with a supportive learning environment: motivate, guide and support. It should be noted that learning should be based on individual personality traits. This ensures successful acquisition of knowledge.

II. Methodology

Since 2010, we have applied a flexible, adaptive approach to teaching computer science in Tallinn University of Technology. The main idea of this method was students division into groups according to their prior subject knowledge. The tasks were also of different level and it has given visible results – the level of knowledge has increased [6]. In teaching we have been focused our attention on activating an individual student's learning.

Students learn in different ways: some like to listen to and talk, while the others prefer to read texts or study by investigating the charts, diagrams and drawings. Any learning style can give good results if it is timely identified and a right approach is chosen and applied.

Teaching must transfer knowledge and support learning, but it must also be cooperative and directed toward students' reflection and development. Helping students in finding and forming their own style of learning – should customize the learning process aimed at creating the conditions for each student for the maximum development of his/her abilities, aptitudes, satisfaction of cognitive needs and interests.

Since the beginning of the fall semester 2012, we have conducted experiments in which we have tried to identify the most suitable learning activities for students, based on an individual test on learning styles. 300 students of economics, social and technical disciplines have been involved in the experiment. In the e-environment Moodle (https://moodle.e-ope.ee/) students were divided into two equal groups of 150 participants: a reference group and a test group.

Students of both groups were taught the informatics courses depending on their prior knowledge: a test was carried out dividing them into beginners, advanced, and experts users. For beginners – the test result was 0% – 60%; for advanced – the test result was 61% – 80%, for experts – it was 81% – 100%. The test contained a different number of computer science related tasks with different difficulty levels.

The system and its effectiveness have been described in the article about a flexible approach to learning [6].

In addition, for the students of the test group all course materials and the whole learning process was designed to match their learning style preferences identified in the test [7].

Felder divides students based on their perception of the material and work with it into the following groups [2]:

active (ACT) and reflective (REF)

sensing (SEN) and intuitive (INT)

visual (VIS) and verbal (VRB)

sequential (SEQ) and global (GLO)

Active learners acquire new knowledge best by doing, discussing and explaining it to others in a group. At the same time reflective learners first think about it alone.

Sensing learners like learning facts and solving problems by well-known methods. Intuitive learners prefer discovering new possibilities and relationships and they are more innovative.

Visual learners remember pictures, diagrams, charts and video best. Verbal learners prefer written and spoken explanations.

Sequential learners like step by step studying, where each step follows logically from the previous one. Global learners prefer to get information by large portions and randomly.

The preferences of students, based on tests carried out among the students of the test group, are shown in Table I. The total for each student is 400% as each student could account for four different forms of information acquisition.

Data from Table I is shown in the following diagrams.

Tests carried out have shown that the majority of students do not have any preferences in the selection of learning materials and that they use a combination of different learning styles– they are well balanced (Fig. 1).

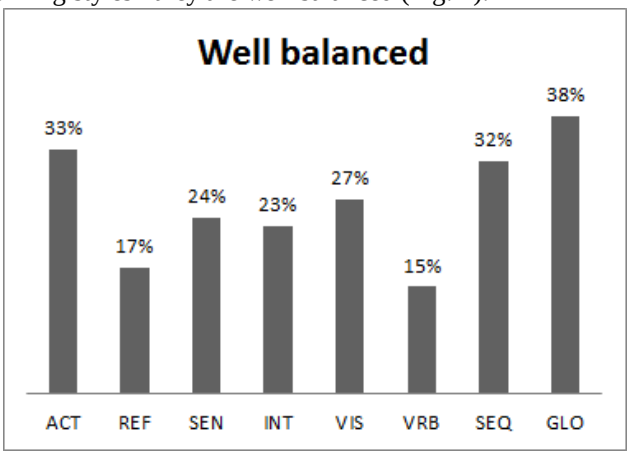

Fig. 1. Well balanced students

Figure 2 shows the types of students who acquire material better if their learning style has been taken into account. So, this group of students learns better if they are given possibilities to participate in group work, discuss, solve real tasks based on facts, etc.

TABLE I.
THE PREFERENCES OF STUDENTS, OF THE TEST GROUP

	ACT	REF	SEN	INT	VIS	VRB
Well balanced	33%	17%	24%	23%	27%	15%
Moderate preference	33%	3%	32%	9%	34%	2%
Strong preference	13%	1%	10%	2%	22%	0%

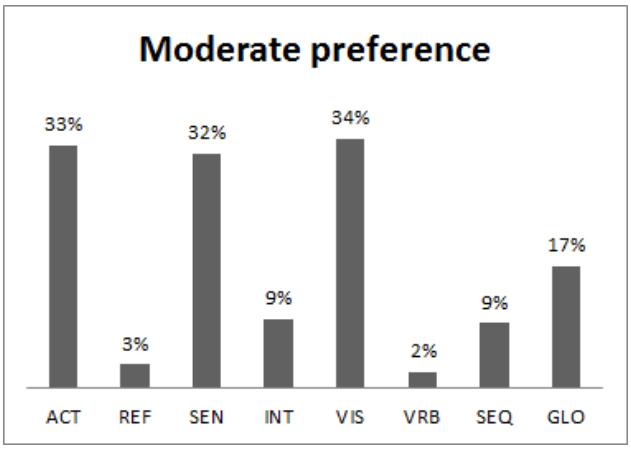

Fig. 2. Moderate preference

However, some students have very strong preferences in learning. As presented in Figure 3, according to the tests active learners, sensing learners and visual learners fall into this group [4].

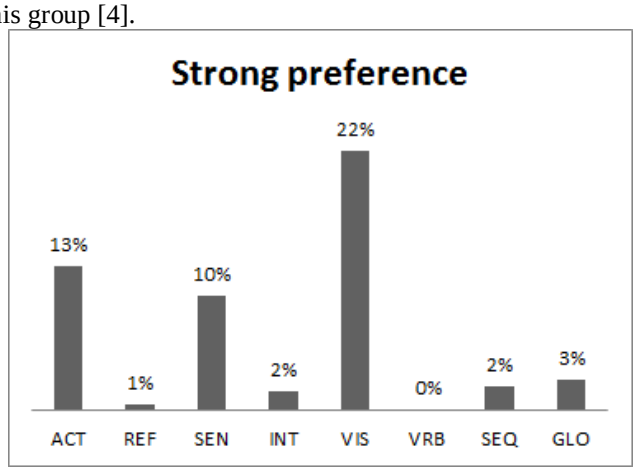

Fig. 3. Strong preference

This way it was possible to find out the main preferences of students in the test group.

Based on the recommendations for the selection of educational material [3], [2], we designed and offered students assignments and theoretical materials according to their learning styles in the Moodle e-environment.

For example, to active learners we proposed group work assignments, to sensing learners – exercises, which were connected with solving real problems, and to visual learners – visual representation of course material, the same principles as have been used in the Khan Academy [5].

All things considered, we managed to make the learning process more flexible by using e-environment opportunities: the students themselves chose the learning tempo, types of educational materials, and direction of individual and group work.

III. Results of the Experiment

The first results of our work showed a positive trend in the acquisition of knowledge. To divide students into groups by prior knowledge all of them were tested at the beginning of fall semester 2012. The same test was held at the end of fall semester. The test results confirm that students of the test group had mastered the learning material better than the students of the reference group (Fig 4 and 5).

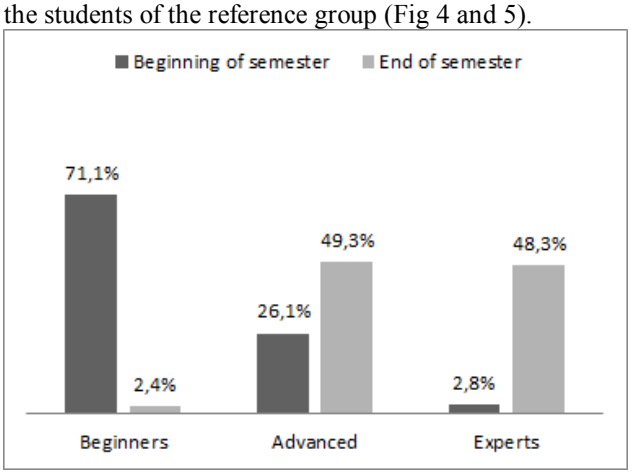

Fig. 4. Division of students into groups by test results in the reference group

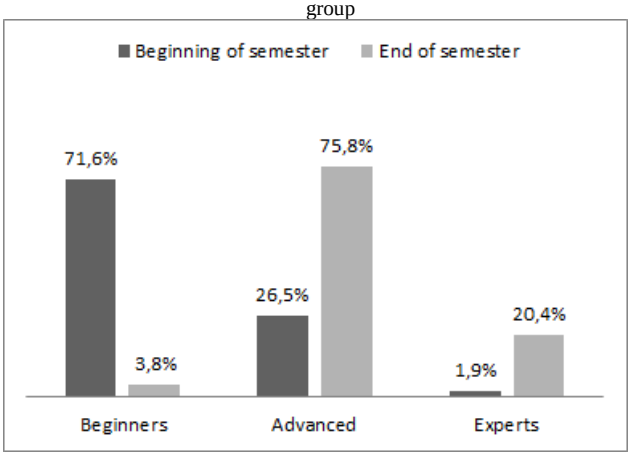

Fig. 5. Division of students into groups by test results in the test group

Students of the test group coped better with their final exam due to the adopted learning material. Growth of knowledge has had a positive effect on their academic achievement (Fig 6).

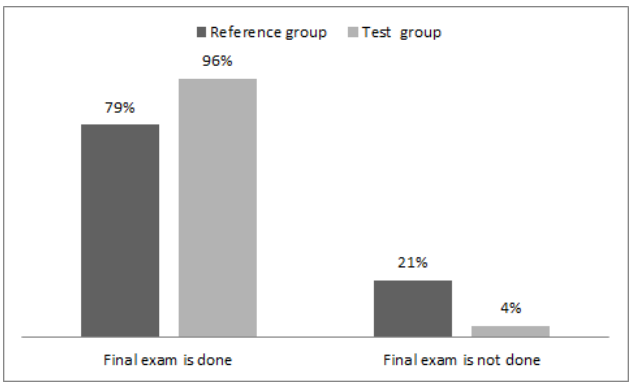

Fig. 6. Academic achievements. End of fall semester 2012

Students' feedback in the test group also indicated that the material selected according to their learning styles motivated and helped them to learn.

IV. Conclusions and Further Development

Students have different levels of motivation, different attitudes about teaching and learning, and different responses to specific classroom environments and e-learning. The more thoroughly teachers understand the differences, the better chance they have of meeting the diverse learning needs of all of their students. Teachers should attempt to improve the quality and efficiency of their teaching, which in turn requires understanding of the learning styles of students and designing instruction to meet these preferences.

Our selected flexible adaptive learning approach improved the quality of educational material and enhanced the educational effect of the use of innovative methods. The approach also provided us with additional opportunities to build individual educational paths for students, and in addition, apply the approach on students with different levels of readiness to learn.

Thus, we gave students the opportunity to choose their own way of learning the course. Students themselves felt the need for further studies, and did not feel the pressure from the teacher. They had the opportunity to work with educational materials in the manner and volume that was appropriate for them directly.

In conclusion, we would like to emphasize again that the content of the material adapted for each learning style should also cater for individualization of learning. It is important to remember that any learning style works well with the right approach.

Our chosen direction is a deeper study and analysis of students' data which could give us a better overview of why and how students learn. Additionally, there is the need for the curricula adaptation and teaching materials composition in accordance.

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