Design of Electronic Learning Courses for IT Students Considering the Dominant Learning Style

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Abstract. Methods of using e-learning courses to support learning activities of students at higher educational institutions are the subject of a large number of scientific and educational studies. In particular, much attention is paid to the structure, content, and format of educational resources of e-learning courses. However, the problem of dependency of their efficiency on the learning styles of students still needs to be further researched. This paper deals with the learning styles characteristic for IT students on the basis of determining their leading modality, designs the structure of e-learning courses for IT students considering the dominating learning styles, and provides the results of pedagogical experiment by measuring the performance and satisfaction in learning activity.

Keywords: Learning style · Leading modality · E-learning course · MOOC

1 Introduction

Modern universities are developing in accordance with the concept of Smart-education, one of the main trends of which is openness of learning systems - placing educational content openly available to students around the world, the development of the open source system, development of knowledge sharing according to the following patterns: "student – student", "teacher – teacher", "students - teacher" and "students - teachers" [1, 2]. One of the most illustrative examples of open learning systems for mass advancement and training of students are MOOCs (mass open online courses). An important step in the development of the idea of using the MOOC was the adoption of the UNESCO Declaration on global public policy on the issue of open electronic courses, which aims to develop standards for electronic courses, provide synergy access, conduct educational seminars on the design and the use of e-courses, develop collaboration of scientists and teachers, educational quality assurance [3]. Furthermore, for the last decade, there has been a significant demand for online learning from students as well as all population strata, which proves the need for lifelong learning on the basis of non-formal and informal rather than formal learning. In this respect we can identify a number of economic factors and observe real competition among commercial

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institutions [4]. Paying attention to the quality of e-learning, we focus more on the quality of developing educational resources, tasks for independent work, organization of knowledge control. However, the effectiveness of perception of educational resources also depends on learning styles and needs of students. Therefore, it is essential to develop resources for the curriculum in the most appropriate form for students, considering their main channel of information acquisition or personality. A teacher or curriculum designer develops the material in order to fit the students with different learning styles. This directly affects the level of learning new information. Methods of teaching certain subjects are often based on specific learning styles. Sometimes it is best to learn the information by using a combination of both. Justin Ferryman recommends considering different styles since it is useful not only for a better acquisition of the material, but to preserve residual knowledge as well [5].

2 Problem

The problem of taking into consideration the styles has been well studied in traditional teaching. However, in order to organize online learning, the problem requires additional analysis. In other words, there is a need to define learning styles when determining the content and structure of a distance course, forms of presenting material, a set of training activities to study the discipline, etc. In addition, it is essential to research into the dominant learning styles of students of different specialties, including IT students, and the level of their assessment of e-learning courses of a specific format.

3 Related Work

A learning style describes individual factors that may remain relatively stable over time. Scientists define a learning style as “a biological and mental set of personal characteristics that make the same teaching method effective for some students and ineffective for others” [6].

Different people apply different approaches to solving problem of similar content and complexity or performing the same operations. In this case, a person carries out different activities applying their own peculiar method and performance efficiency (e.g. a type of work similar in content and complexity can be performed by different people with different efficiency – they obtain results of different quality, spend different time to do the task of equal complexity etc.). Conversely, if a person possesses several different methods of activity and is able to adequately use either of them to solve a particular set of problems (tasks) or their stages, a range of effective operation can be greatly extended and complicated problems (including sub problems of different content and complexity or their stages), on the whole, can be solved quite effectively, or at least, more successfully than when a complex problem is solved by a person able to apply only one method. [7]. It should be noted that there is a direct correlation between the style a person uses to solve almost all range of problems he faces in life and the style he applies when learning, and vice versa [8].

A Kolb experiential learning model [9] measures a student's strengths and weaknesses according to the four learning abilities: concrete experience, reflective observation, abstract conceptualization and active experimentation. Based on the combination of these four learning abilities the Kolb model identifies four dominant learning styles: divergence, assimilation, convergence and accommodation (Fig. 1). People of conveying style are strong in abstract conceptualization and active experimentation. In divergence style concrete experience and reflective observation prevail. Assimilators are strong in abstract conceptualization and reflective observation, while the accommodators are strong in concrete experience and active experimentation.

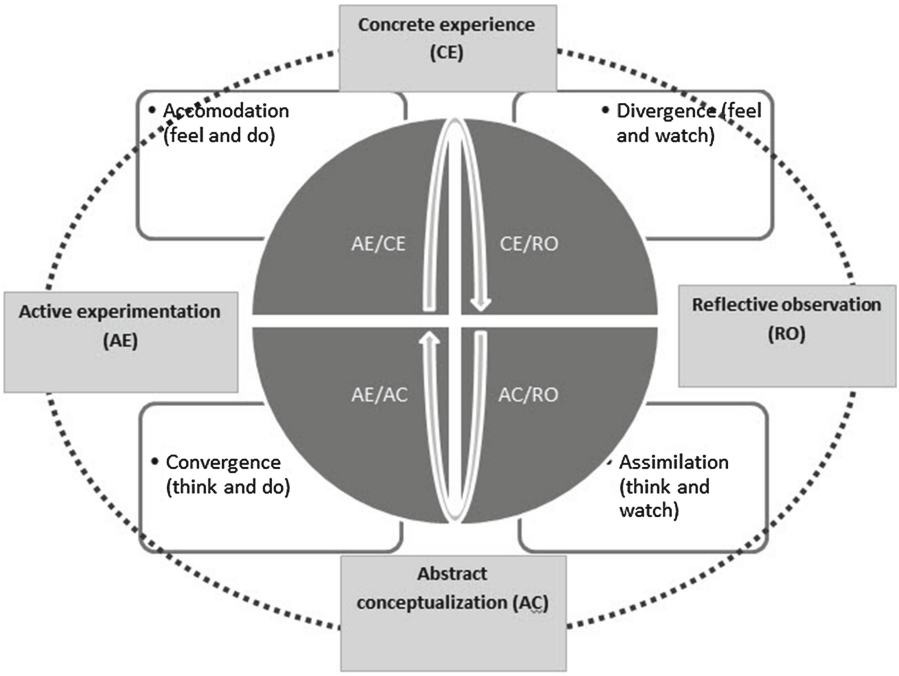

Fig. 1. Kolb experiential learning styles model

Another classification of learning styles is VARK (visual, audial, reading/writing, kinesthetic) developed by Fleming and Mills in 1992 [10]. Psychology categorizes learners with leading learning modality: sensor – visual learners, with prevailing audial modality – auditory learners, with muscular activity – kinesthetic learners, with reading-writing preference – reading/writing learners (Fig. 2). And, accordingly, the highest percentage of material has been acquired on the basis of leading modality. Visual learners prefer graphical and symbolic form of gaining data information. Auditory learners prefer attending lectures, training programs and participating in discussions. The reading/writing learners prefer text-based materials. Kinesthetic students prefer hands-on experience and learn best by touching and doing.

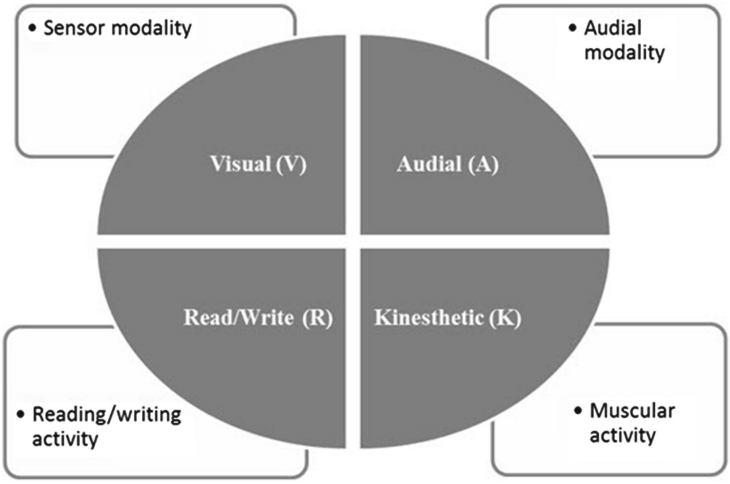

Fig. 2. VARK learning styles model

The first research into the comparison of learning styles and format of distance learning course was conducted in 1999 [11]. Researchers Diaz and Kartnel divided groups of students to study according to a traditional system and on-line, depending on whether students choose to study in social interaction mode or independently in a confined space. As a result of the research the strategy for online learning based on the needs of students and their peculiarities was developed.

Downing and Chim (2002) conducted a study on student satisfaction with online training by categorizing students into active, reflexive, theorists and pragmatists [12]. Activists prefer direct experience, reflexive students prefer just observing. Theorists are keen on analyzing and synthesizing course materials, whereas pragmatists prefer acting quickly to try out new ideas. These studies have shown that reflexive students were more satisfied with online learning, whereas groups with other styles of learning showed no significant relationship between learning styles and satisfaction.

In 1988 Richard M. Felder and Linda K. Silverman [13] investigated the models of learning and teaching. They proposed to define a student's learning style to the 5 questions:

1. Which type of information does a student preferentially perceive: *sensory* (external) – sights, sounds, physical sensations, or *intuitive* (internal) – possibilities, insights, hunches?
2. Through which sensory channel is external information most effectively perceived: *visual* – pictures, diagrams, graphs, demonstrations, or *auditory* – words, sounds? (Other sensory channels–touch, taste, and smell – are relatively unimportant in most educational environments and will not be considered here.)
3. Which organization of information is a student most comfortable with: *inductive*–facts and observations are given, underlying principles are inferred or *deductive*–principles are given, consequences and applications are deduced?

4. How does a student prefer to process information: *actively* – through engagement in physical activity or discussion, or *reflectively* – through introspection?
5. How does a student progress toward understanding: *sequentially* –in continual steps, or *globally* – in large jumps, holistically?

Gardner's theory of multiple intelligences differentiates from specific (primarily sensory) "modalities", rather than seeing intelligence as dominated by a single general ability. In 1983 Howard Gardner has proposed The Theory of Multiple Intelligences in which he suggested that people possess at least seven different forms of intelligence: musical, visual–spatial, logical–mathematical, bodial–kinesthetic, interpersonal, intrapersonal [14]. In 1997 he added the naturalistic intelligence. Although the distinction between intelligences has been set out in great detail, Gardner opposes the idea of labeling learners to a specific intelligence. Each individual possesses a unique blend of all the intelligences. Gardner firmly maintains that his theory of multiple intelligences should "empower learners", not restrict them to one modality of learning.

Several researchers have attempted to determine the relationship between VARK learning styles and on-line course efficiency. In particular, Drago and Wagner [15] in their experimental studies claimed that the efficiency of online learning for students with leading "reading-writing" modality was significantly lower than for students with other leading modalities. However, the students combining auditory and "reading-writing" styles showed better results in online courses in comparison with others.

However, not all researchers have observed a relationship between style and learning outcomes. Kratzig and Arbuthnott's research [16] show no significant correlation between learning style and objective memory performance. Participant's learning styles were identified using self-report, questionnaire and after that they have passed standardized memory tests. According to the self-report questionnaire and the self-assessment guest 40 % and 60 % of participants were identified as visual learners through the questionnaire, but only 23 % performed best on the visual test. The percentages were 16 % and 8 % for kinesthetic-learning preferences. When the participants completed the standardized memory test 52 % performed best with the tactile test. These results Kratzig and Arbuthnott conclude that "such styles may indicate preferences and motivations rather than inherent efficiency at taking in and recalling information through specific sensory modalities".

In 2010 an experiment was conducted on the impact of learning style on student performance and satisfaction using the online environment according to Kolb model [17]. Students were split into groups who studied two types of Web modules - textual and multimedia information. The study found that the learning style in this case did not affect the satisfaction and the progress of students.

Also, Christopher Pappas debunked The Myth of Learning Styles [18]. He says that "there is no convincing evidence to prove that when an instructor changes the presentation mode of his course to match the learning style of his students actually helps them learn". He also recommend to create a course based on the motivational characteristics of the students and not their learning styles, and always be ready to adjust the learning methods and techniques and engage multiple senses rather than just one.

Despite the considerable amount of research in this area, the problem of presenting educational information in a distance course for students with different leading

modality still needs to be studied. First of all, it is caused by the rapid development of information and communication technologies, particularly Web 2.0 technologies that provide brand new possibilities in a wide choice of presenting educational materials, videos and audio materials and their structuring. The aim of our study is to analyze the leading modality dominating in IT students of higher educational institutions, and on the basis of the results obtained to offer the structure, format of e-learning courses content and the assessment system of learning outcomes of IT students.

4 Experimental Setting and Research Methods

Students of the Faculty of Computer Sciences and Economic Cybernetics at the National University of Life and Environmental Sciences of Ukraine participated in the pedagogical experiment. The first experimental group of students was trained using blended learning technologies which combine traditional educational technologies and the elements of distance learning, the second group of students was trained using traditional technologies and printed textbooks. The leading modality or a combination thereof has been determined for each participant of the experiment. The results of the experiment were presented in the guidelines to the methods of teaching students with different learning styles through the use of e-learning courses. In addition, the impact of the structure and format of presenting training material on the progress and the level of satisfaction of students and organization of training activities was investigated. During the study we used the following methods: theoretical analysis of the methods of determining the sources of learning styles of students, studying and summarizing best practices of the use of e-learning courses to support the learning process, analysis, assessment, comparison, pedagogical experiment.

5 Learning Styles of IT Students

Consideration of a learning style is an important issue for both teachers and students using e-learning technologies. Teachers need to know the learning styles of students to further adapt teaching methods apply appropriate resources and determine the types of student activities when using e-learning courses and to better understand the differences between the needs and peculiarities of students. Students who are aware of their learning style learn better as they choose to study those resources, the perception of which has the largest educational effect. If a teacher's style is different from the style of the majority of his students, it is necessary to change the method of teaching and the organization of training activities. Within the framework of the research a survey of IT students was conducted according to the questionnaire by VARK model [19], so that the teachers of professionally-oriented courses had an idea of the student's learning styles. The purpose of this survey was to determine the leading modality of students who have chosen to obtain IT profession. Characteristics of each style are listed in Table 1.

Table 1. The characteristics of learning styles according to the VARK model.

Name of the style	Characteristics
Visual	Information is predominantly presented in the form of pictures, diagrams, flow charts and all those symbolic lines, circles, trees and other elements that are used instead of teacher's words to represent teaching materials. Visual learners prefer receiving information in a holistic rather than simplistic way. As a rule, the appearance of an object, color matching, information placing and spatial design are of critical significance
Auditory	The mode of perception describing the advantage of obtaining information materials aurally. Students with such modality are better taught through lectures, seminars, listening to recorded lessons, group discussions, web chats or talks about the object. Auditory learners most value words spoken verbally rather than written, listening to expert's explanations rather than reading a textbook paragraph
Verbal	It is preferable to present information materials in the form of words. It is no secret that many academic methods are exclusively designed for this style. The style perception tends toward textual introduction and reproduction, reading and writing of teaching materials in different forms. Unlike others, verbal learners believe in the power of words. They like to have information systematized in written form
Kinesthetic	Refers to perceptional benefit of using experience and practice (simulation or reality). Since this description may also fit the other modalities, the key is that the student is always "connected to" reality through experiments, examples, practice or simulation. Kinesthetic learners need to experience the situation in order to understand it. Practical importance and feasibility are valued. As a rule, such learners remember only those things that took place in reality

In order to offer IT students the e-learning courses, the structure of which will be most effective for perception according to their learning styles, we carried out the social and psychological diagnosis of students in specialty "Computer Sciences". We used surveys and questionnaires, proposed in the sources [20, 21] by VARK model. Students are encouraged to fill in a form with 16 (49) questions. The questionnaire helps to determine the students' leading modality and, correspondingly, their main learning style.

The survey results allowed us to identify 15 groups of students with different modality of information perception. The results of the survey (Fig. 3) indicate that the IT students possess the learning styles that combine auditory and kinesthetic modality (AK) – 18 %, visual and kinesthetic modalities (VK) – 17 %, auditory, visual and kinesthetic modalities (VAK) – 16 %. This statistics concludes that the future IT professionals learn best with the help of practical experience, verbal and visual explanation of learning material.

6 Structure of E-Learning Courses Based on Learning Styles

One of the objectives of the experimental study was to determine the optimal structure of e-learning courses and the ways of presenting learning resources for IT students

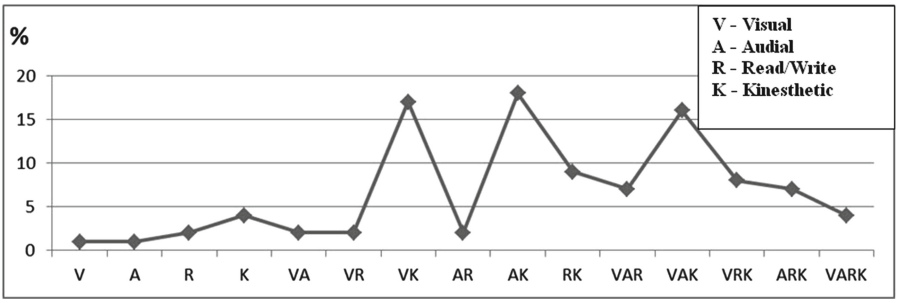

Fig. 3. Correlation of leading modalities of students in specialty "Computer Sciences"

according to their learning style. An e-learning course (ELC), which is used to support the learning process in studying a specific discipline when training future IT professionals, is a set of learning resources and types of activity to provide the study of theory, carrying out practical tasks, independent work, student/teacher cooperation, monitoring academic performance etc. The general approach to the structure of ELC, presented in [22] is to determine different types of e-learning resources appropriate at different stages of the learning process, though it does not consider the individual characteristics of student's perception of learning material. In particular, when studying theoretical material the students are encouraged to use the following resources: an electronic textbook, an electronic copy of the printed textbook, video lectures, video lesson, presentation, virtual excursion, links to external resources etc. In order to develop practical skills in e-learning course teachers can use laboratory workshops, tasks for laboratory (practical) work, individual work, virtual seminars, webinars, group research projects, forums, chats etc. Besides, the e-learning course should include the activities to monitor academic performance and reflection, as well as such resources as: tests, assignments, surveys, questionnaires, checklists etc.

Taking into consideration the dominant learning style of the student group it is vital to choose a different format of learning resources and activities in an electronic course. For visual students the resources of ELC should provide an opportunity to view the lecture material in a structured way in which the information is classified according to various criteria, key points are underlined or highlighted, there are images, video clips, posters, slides, flowcharts, graphs and charts. The tasks for independent work should have the materials where a student will be able to convert visual images into verbal ones thus creating vivid memory of events and actualizing corresponding visual sequence in memory. As an example, students may be given the task to design classification tables (charts, graphs, charts) on the basis on the review of learning material in textual, tabular, graphical and video formats. These students appreciate the form of presentation of learning material, design, color gamma. Everything is supposed to be harmonious and attractive. All types of activities designed for students when organizing the training on the basis of e-learning course, suggest that the learning material and the tasks should be structured. This course should include the presentation of learning content, video lessons, memory cards, electronic textbooks, tasks with a clear structure and procedure, examples of task performance. The e-learning technologies may include video conferences using the interactive white board to visualize material.

The resources for students with a dominant auditory modality should provide the theoretical material in the form of video and audio recordings of lectures. To acquire practical skills it is recommended to use webinars recorded in the video format and placed in the course resources. Group work tasks can be effective, since through discussion, brainstorming and talk's auditory learners expand the amount of the material by receiving verbal information from others. Besides, quite effective can be the task to create audio recordings in which the learning material is analyzed and synthesized through spoken language.

For students whose dominating style is "reading-writing" the resources of the training course should be built on the principle of compulsory working up of the material with the help of a pen or keyboard. Theoretical resources can be presented in the form of video lectures, full-text document, definitions, alphabetically built glossary, the list of concepts etc. Practical tasks should include guidelines for assignments and be based on the conversion of the forms of presentation, such as diagrams, flowcharts and graphs into words and statements. When carrying out the tasks students are expected to use references, supporting materials, theses, reports, guidelines, instructions. While studying for the seminars students can use the following tasks: to make a plan of presenting material, its structure, indicating paragraphs and subparagraphs. Among the e-learning technologies it is preferable to use task with written answers, essay tests to monitor learning outcomes.

Students with kinesthetic modality percept educational materials more effectively if e-learning courses include resources in the form of virtual workshops, virtual tours and exhibitions with further analysis. E-course tasks should be based on the examples of solutions performed in previous years for similar tasks. Practical tasks should apply approaches that allow mastering knowledge in practice, use the trial-and-error method. To explain abstract concepts in electronic sources it is recommended to provide lots of examples from real life.

In our research we suggested another structure of electronic course: the resources that take into consideration the dominant leading modality best suited to successful learning of IT students. When designing a new e-course pattern we used such elements that are best suited for people who combine visual, auditory and kinesthetic modalities. To highlight the theoretical material it is proposed to use video format, electronic textbooks as well as additional links to external resources and virtual tours (Fig. 4). To acquire practical skills in electronic courses there should be virtual laboratory workshops with methodological recommendations, individual assignments with clear assessment criteria and the examples of solutions to these assignments. These examples of solutions are advisable to file in screen cast format, which illustrate the process of solution as well as have a soundtrack explaining. To organize independent work it is recommended to provide resources with practical video lessons and assignments for individual study, research group projects, which make it possible to develop teamwork skills in students through the use of information and communication technology. The resources that contribute to the formation of practical skills should include video conferences to discuss issues related to the solution of practical problems. Methods of control should contain tests to assess the level of theoretical knowledge, control tasks to assess practical skills, questionnaires, checklists and other tools for self-assessment and reflection.

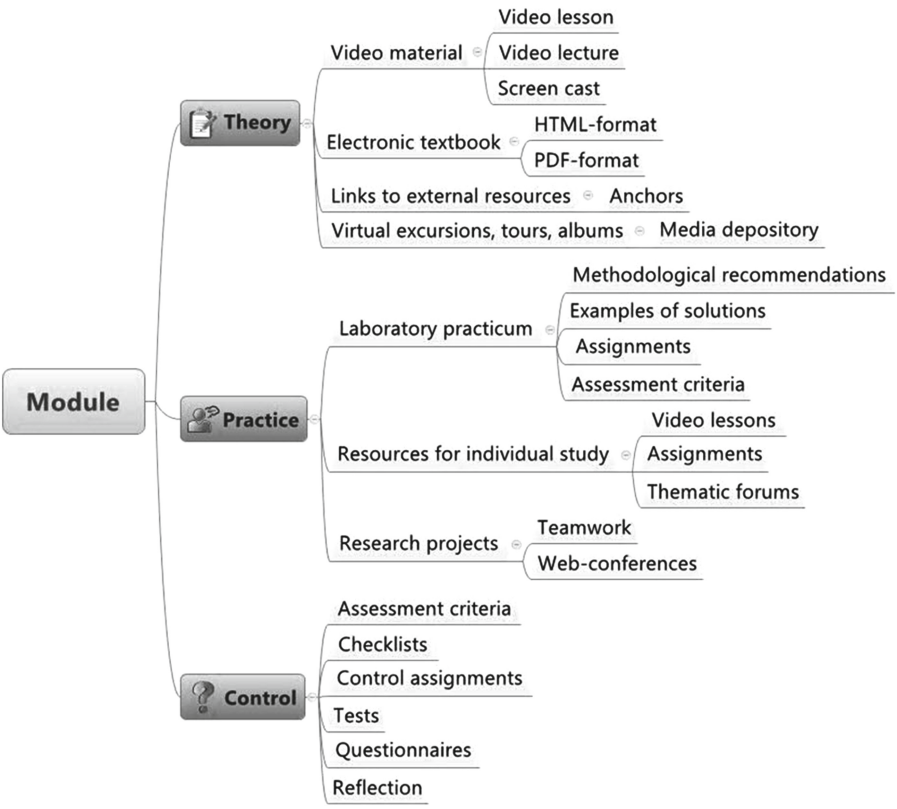

Fig. 4. The structure of a module in the experimental course

In pedagogical theory and practice, there are different approaches to the definition of criteria and indicators of the effectiveness of learning activity. As a measure of the effectiveness of any human activity one can specify two universal criteria - productivity of work and satisfaction of its participants. [23]. As a rule, the participants of the learning process are interested not only in the result of training, but in their satisfaction or dissatisfaction with the process of learning and their relationships. It is not always possible to assess satisfaction by observation. Thus it is necessary to develop diagnostic methods in order to determine the level of satisfaction in the relevant activity.

In the pedagogical experiment, the students studied the first module using blended learning technology and a new model of e-learning course. In the second module, the traditional learning technology was applied, though electronic textbooks were used to study the theoretical material. To determine whether the use of e- learning course influences the efficiency of the learning process, we used the rate of learning progress, namely the results of modular control assessed by 100 grades scale. The results of the modular control included the following activities: laboratory work - 40 points, independent work - 20 points, modular test - 20 points, control task - 20 points. To measure the level of satisfaction with learning activity, we compiled assessment questionnaires

according to the criteria of the organization of the process of learning when studying the module. Each criterion of satisfaction questionnaire was assessed by students using a 5- point scale of assessment: completely satisfied, generally satisfied, satisfied but with some comments, generally dissatisfied, strongly dissatisfied. Comparison of progress and satisfaction are shown in Table 2.

Table 2. The results of progress and satisfaction.

Courses	Module 1 (using ELC)		Module 2 (without ELC)	
	Average grade	Assessment level	Average grade	Assessment level
System Analysis	72	4,6	66	3,5
Information Systems Design	84	4,7	63	3,2
Information Technology	78	4,5	67	3,4

While analyzing the results of the study, we have come to the following conclusions: the progress of students in learning outcomes for module 1 on the basis of ELC was significantly higher than for module 2 – on average by 12 %. The level of student assessment of learning material quality when using ELC was also higher by 24 % on the whole. Similar studies were conducted among the students of distance learning. The results of the progress of students who were trained in the intersession period on the basis of ELC increased even further – by 21%, compared with those who were trained according to the traditional techniques of distance learning.

7 Conclusions

When developing learning materials and designing the whole process of training, it is important for teachers to take into account the learning styles of their students to ensure the quality of their learning outcomes and increase their motivation to study. According to the results of the research, the awareness of learning styles can yield benefits for students today. Questionnaires by VARK tool is easy and fast and can provide the important information which can be successfully used in the creation of effective learning environment for students. The information about the learning styles of students and their impact on the learning environment can contribute to a vitally important understanding of the students and create an effective learning environment, in particular, to make decisions on the design and content solutions of e-learning courses at all stages of the course. The obtained results need further confirmation and study. In particular, the promising areas of research, we believe, is to study the relationship between the dominant modality and presentation e-course of theoretical resources, methods and forms of independent work of students using e-learning courses.

In addition, it is useful to conduct a study and compare the results of using e-learning courses for other models of learning styles.

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