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From traditional to distance practice-oriented university course in professional training for pre-service biology teachers

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ABSTRACT

The current study investigated student's perception and experience on the distance practice-oriented university courses and virtual laboratory in particular. The virtual laboratories (virtual labs) concept is one of the challenges in higher education especially in the engineering education. Being more interactive they allow the students to acquire practical knowledge remotely. The university course is designed in different by function and content modules. Every module is built as a connection between scientific knowledge, embedded in biological disciplines, and its transformation into educational knowledge in school subjects in biology through system of knowledge and skills to actually convert the subject of learning. The purpose of this article is to discuss the results of a study of the quality of education in online practically oriented training course for pre-service biology teachers at the Sofia University "St. Kliment Ohridski", Sofia, Bulgaria.

Keywords: Professional development, online learning, e-course, virtual lab, biology, teacher.

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INTRODUCTION

Practical work is an important and distinctive feature of science education. Undoubtedly essential element of good teaching in science is practical work done by the students themselves. More and more nowadays universities rely on information technology and communications, which provide new patterns and new challenges and requirements regarding the education of their members. Increasing volume of information needs to be processed for conversion into actionable knowledge. There is great need of constant improvement of curriculum and also need constant updating of teachers at the rate of exchange of science and technology. The traditional classroom teaching is, at present, unable to meet the training requirements of the knowledge society, making increasing use most to ICTs (Mellado et al., 2013).

Discipline Methods and Techniques of School Experiment in Biology (MTSEB) is practice-oriented and provides the basic knowledge, skills and competencies in the professional field "Pedagogy of Biology." MTSEB generally provides the knowledge and skills required for the position of teacher in biology in all types of secondary schools in Bulgaria in the following aspects: planning, organization and implementation of object-practical activity within different forms of educational organization and in particular - forming of knowledge and skills in methods and techniques of conducting and monitoring of an experiment in biology in schools; organizing and conducting an experiment in biology in middle school, including the main types of experimental work; preparation of the necessary facilities for carrying out biological experiments.

The necessary knowledge and skills in the discipline MTSEB have been grouped as follows:

A) Intellectual skills:

i) Project management skills (time management, recourse management, task management, task assignment

among the members of the group);
ii) Research skills (identification of problem, organization of research or study; formulation of questions, related to the topic; search for information in various sources, analyzing and interpreting information);
iii) Analyzing skills;
iv) Presentation skills.

B) Basic computer skills:

i) Text editing; directories; file processing; search for information; ability to work with various applications; excel tables; presentations, graphics; email and Moodle learning platform.

C) Professional knowledge and skills:

i) To interpret and apply categories of biology teaching methods in planning, organization and management of the teaching process, control and evaluation of the results in secondary schools;
ii) To coordinate the requirements of normative documents on education in biology in secondary school with theoretical requirements for its effective management;
iii) To transfer, coordinate and interpret biological scientific knowledge in analyzing and modeling the content of biology subject;
iv) Specifically biological, related to biological knowledge.

The most commonly employed pedagogical uses of information technology and communications fall into two distinct categories which may be classified, respectively, as “virtual laboratory” and “real laboratory” applications. In a “virtual laboratory” computers are used, for example, to simulate or animate specific scientific phenomena; pupils normally engage in hands-on activities which are directed towards increasing their understanding and insight of the principles involved (Kocijancic and O’Sullivan, 2004).

Virtual laboratory is an alternative of physical laboratory which is possible through virtual reality where one can perform experimental work just like in a physical laboratory as virtual reality provides users a complete interactive environment (Arjamand and Khattak, 2013; Slavov et al., 2014).

Millar says: “If we are interested in the effectiveness of practical work, we really have to consider specific practical activities that we use, or plan to use” (Millar, 2009).

The lab is an environment for data getting that can let students have ‘brain space’ to process information and moreover students can follow and interpret the results made during the experiment (Johnstone,1997). In the laboratories, the action is predetermined. The wrong results can be identified by the learners as well as rectified for the learners before they go to the lab work. The laboratory develop experience and skills in conducting experiments, allow chance to use of devices as well and some of the materials used. The experiments in the laboratory encourage students to think, discover and research, which helps to familiarize them with the methodology and design of scientific research (Johnstone, 1997).

All findings in the literature sources above are taken into account by the authors in the design of the course, and virtual laboratories are integrated art of it.

Design of the course

The course was designed differently by function and content modules. Every module is built as a connection between scientific knowledge, embedded in biological disciplines, and its transformation into educational knowledge in school subjects in biology through system of knowledge and skills to actually convert the subject of learning. In every module there are various activities with the objects of learning (Asenova et al., 2014). Every module has 4 elements /sub-modules/ grouped into two cores and corresponding to specific objectives:

1. Informational core:

a) *Sub-module biology,* which aims at updating and/or upgrading of knowledge about basic biological structures and/or processes.
b) *Sub-module methodology,* which aims at updating and/or upgrading of knowledge about basic concepts and/or relations between different concepts of Methodology in Teaching Biology.

2. Practical core:

a) *Practical sub-module,* which aims at putting into practice planning, organizational and management skills of students’ laboratory work in teaching in biology. Its content consist of recorded on video and/or explained experiments, which students can comment on or which can be conducted at home.

Virtual laboratory aims at putting into practice planning, organizational and management skills or students’ laboratory work in teaching in biology in virtual environment. Here, we want to make a remark that all selected by us and used virtual laboratories for the purposes of the course are available online. Work in this module is fully remote. It is important to say that the virtual activity is not a “realistic” simulation of the laboratory, but is composed of the calculations and steps to be made in the laboratory, to ensure that the student

has understood all the aspects of the practice (Arjamand and Khattak, 2013).

Despite of many advantages, the acceptance of virtual laboratory especially in distance learning environment is not an easy task. Many researchers contributed a lot in this respect (Arjamand and Khattak, 2013).

There is considerable additional pedagogical advantage to be gained by the integration of the various ICT tools and concepts available, particularly by integrating “real” and “virtual” laboratory activities. In either context, however, it is important that methodologies adopted be chosen appropriately to the specific learning goals and age of the students involved (Kocijancic and O’Sullivan, 2004).

In relation with the above mentioned, it has been summarized the criteria by which we chose the online virtual laboratories where students can achieve all goals and objectives set in this sub-module:

1. Quality of the educational content in the virtual laboratory (scientific quality of the educational knowledge, availability of educational knowledge, orderliness and consistency of educational knowledge);
2. Quality of the overall performance of biological objects/substantive-material or symbolic-characteristic;
3. Task quality inside the laboratory;
4. Possibility to choose information and tasks;
5. Opportunity to change the parameters of biological objects and systems and full operation with them;
6. Quality feedback for activity results in virtual laboratory;
7. Option for regulating working time.

This criteria system is open and additional criteria can be added in order to optimize the choice of virtual laboratories.

Specific of the tasks in sub-module of virtual laboratory

In sub-module virtual laboratory, we have used the following types of tasks:

a) *Traditional tasks* (Trashliev, 1989), in which all elements of the invariant structure of the task are present - “basic information of the task - something that is given in advance”, “task question or requirements” and “method of achieving”.
b) *Reduced tasks* (Trashliev, 1989), in which one or several elements of this structure are missing. Tasks of this type are various. An important place among them occupy training tasks in which are applied algorithms known to the student. Algorithm in these tasks is the method of achieving of the task question or requirements. To this group, we have formulated logical, computational and experimental tasks (qualitative and/or quantitative). In the sub-module we place emphasis on reduced tasks with problem-cognitive character. Experimental tasks of this type - reduced type in a virtual laboratory are essential in the training of future teachers of biology. In real course for the students it would take much time, effort and materials to implement the various options for solving the tasks, to find the method by themselves and what is given or wanted in the task.

All the above can be overcome successfully in solving accurately and clearly defined tasks in suitable virtual laboratories.

Recourses in the framework of the course are: basic – they are obligatory and cover basic knowledge and skills in the discipline and additional – they are students with deeper interest, who want to add on basic knowledge and skills in this scientific discipline. Some of the modules in the course are adapted and probated for mobile learning in order to provide greater flexibility of training and access to educational resources at any time and place (Asenova et al., 2014).

MATERIALS AND METHODS

Participants of the study

Participants of the study was students - future teachers in biology majors "Biology and Chemistry" and "Geography and Biology", 4th year of studying at Faculty of Biology, Sofia University "St. Kliment Ohridski", Bulgaria. In order to make a comparative analysis of objective, we distinguished two groups - control and experimental. Total number of participants in the experimental group for school years 2012 to 2013 and 2013 to 2014 was 98 students from the two disciplines at Faculty of Biology; 56 students for the first school year and 42 for the second school year. From these participants 4 are with special educational needs (2 for the first and 2 for the second school years), which means that they are not able to be present at lectures regarding this subject.

Instruments and procedures

Training of the two experimental groups of students in MTSEB subject was conducted during the first semester of fourth year of education. It was decided to be electronically organized course in compliance with distance learning strategy of Sofia University “St. Kliement Ohridksi”.

In order to evaluate the quality of the e-course, including the opinion of the students has been used a questionnaire. The questionnaire responses are gathered in a standardised way, so questionnaires are more objective, certainly more so than interviews. Generally, it is relatively quick to collect information using a questionnaire. However, in some situations they can take a long time not only to design but also to apply and analyse. The information can be collected from a large portion of a group. This potential is not often realised, as returns from questionnaires are usually low. However, return rates can be dramatically improved if the questionnaire is delivered and responded to in class time (as our case).

The questionnaire consists of 24 items with both open and close ended questions. The parts of the questions were arranged in five point form of Likert scale ranging from 1= *Strongly Disagree* to 5 = *Strongly Agree*.

The survey was conducted after the training in experimental

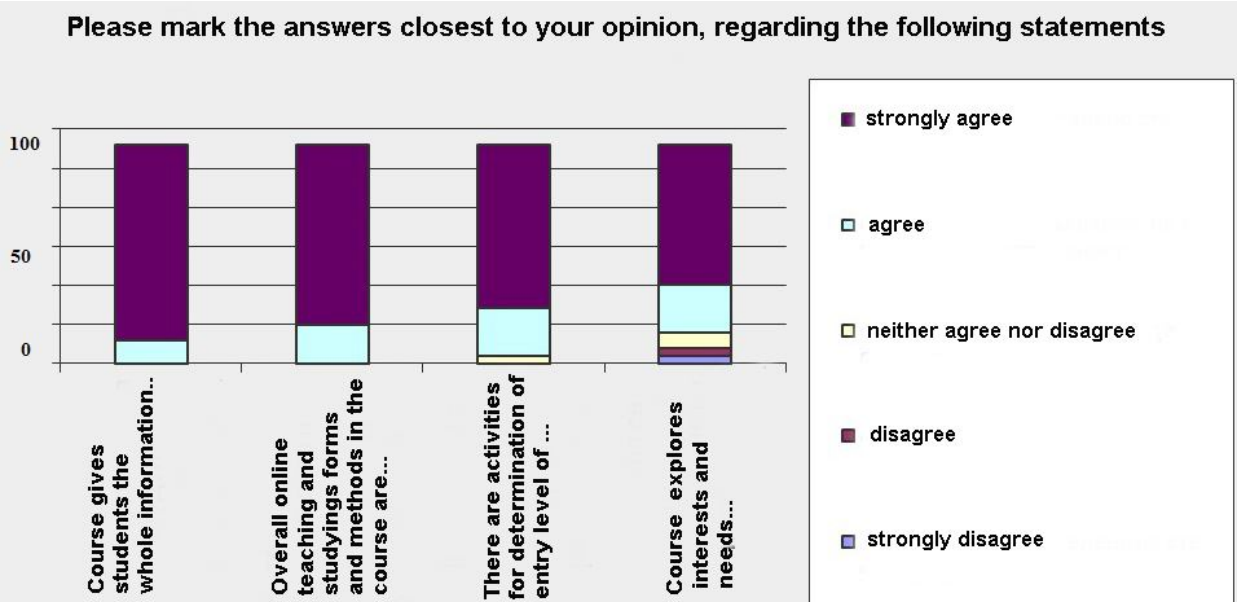

Figure 1. Criteria for assessing the quality of the course by the students.

group was over. The criteria for assessing the overall effectiveness of the e-course MTSEB was the final product that each student had to present by the end of the course.

RESULTS

According to the survey on quality of e-learning MTSEB course, students from the experimental groups tend to give identical answers and certain tendencies can be seen for the two years of the experiment. According to students, MTSEB e-course provides all the information needed for distance learning (89%). Overall, online methods and forms of teaching and learning used in the course are suitable for comprehensive understanding of its educational content say 80% of the students. About 74% of responders indicated that the course provides assessment of students' entry level of knowledge and experience regarding its content, and only 5% say that they neither agree, nor disagree. Asked if the course explores students' interests and needs in this area of teaching, 78% of students indicated that they strongly agree, 17% agree, 4% neither agree, not disagree and only 1% disagree. Figure 1 shows graphically results of the survey about e-learning MTSEB course.

Regarding if students was aware about e-learning course aims and results that are expected to be achieved (what is expected from them to know and to know how) in this subject, the majority said yes (91%) and only 7% said neither agree, nor disagree (2% of students did not respond). Within the survey we also collected students' opinions regarding aspects of the quality of e-learning MTSEB course. This was of great interest for the authors**.** We will discuss the results below. Regarding use of educational strategies effectively assisting students in meeting pre-planned educational objectives in the course - 95% of respondents strongly agreed and 4% agreed (1% of students did not respond). Authors of the article were also interested in whether educational strategies used in the course meet the needs of the students and are consistent with the profile of each student (level of knowledge, age, specific limitations) – 82% of responders answer that they strongly agree, 4% neither agree, not disagree, and only 4% answer that they disagree. Asked if learning activities and content allow individualization of the learning process and support the autonomy of students 92% strongly agreed and 8% agree. This is especially true about student with special educational needs. When asked 92% of responders strongly agreed and another 6% agreed that educational/learning tasks and instructions are clearly formulated (2% of students did not respond). This proves effective organization of cognitive activity of the students in the virtual environment and hence optimality to develop skills in object-practical activities in biology. Students tended to give similar answers also regarding clarity of learning tasks and instructions as well as encouraging of active studying in virtual forms of training. This is very important for the effectiveness of MTSEB e-course**.**

Another important criteria for assessing the quality of the course is if individual and group online interactions between learners and teachers have been applied in appropriate manner. 87% of participants in the survey have given positive answer, 10% neither agreed nor disagreed and 3% disagreed. Regarding is there balance between individual and group educational activities 95% of participants strongly agree, 3% agree and 2% neither agree, nor disagree. This data obtained having in mind already discussed criteria is shown in Figure 2.

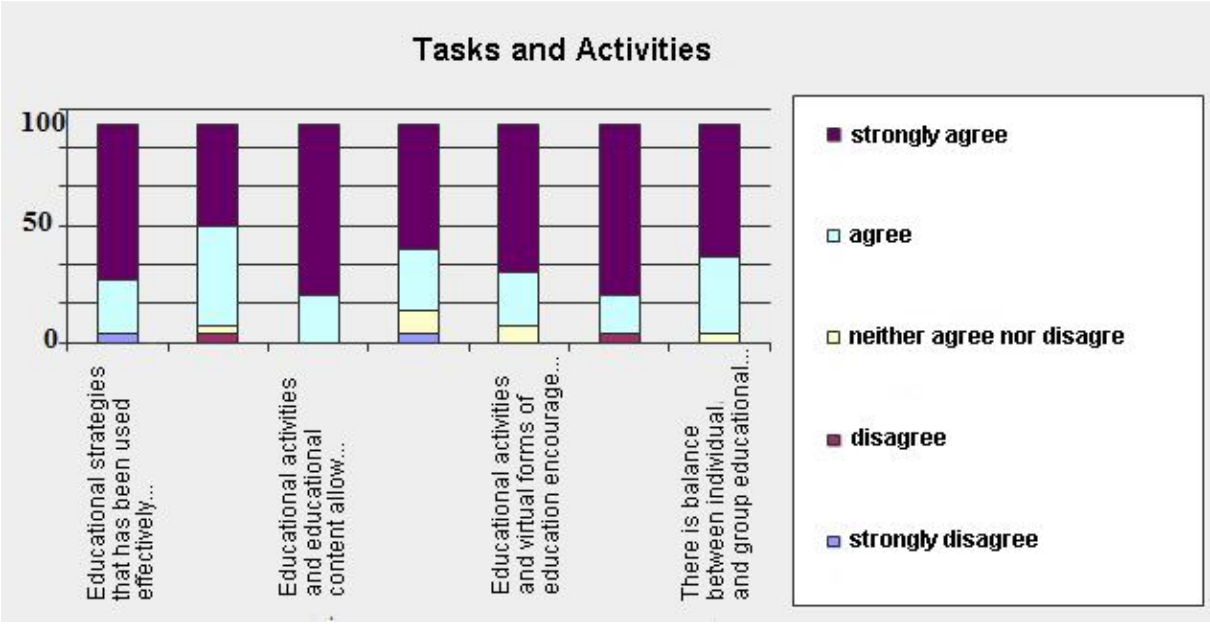

Figure 2. Criteria for tasks and activities design.

DISCUSSION

As a result having in mind the feedback received from respondents on the design of learning tasks and activities included in the e-course MTSEB, we can conclude that we have largely achieved optimality and efficiency of the educational activiy with specific virtual environment that allows students to develop skills in conducting objective and practical activities in biology.

One of the important criteria for e-course quality, having in mind its specifics, is supporting students during their online training (Yotovska et al., 2013). Generally, within the electronic learning environment of the MTSEB course students receive administrative, technical (ability to work with technological features of e-learning environment); social (integration of students into the school community); academic (related to e-course content) and pedagogical (related to ways of learning, teaching, assessment) in all stages of their training (Asenova et al., 2014).

To make sure whether we provided efficiency in terms of the survey criteria, we included the following sequence of statements to which students responded as stated in Table 1.

For the design of media students indicate that the interface of the course (in terms of navigation and web design) is easy to use by the user (93%). The course uses a variety of media - individually and collectively - to carry out online activities and presentation of the educational content (95%). Learning resources are esthetically looking and its design helps in assimilation of the information (91%).

When asked about the advantages of education in the framework of the e-course Methods and Techniques of School Biology Experiment (MTSBE) students identify the following advantages/answers are quoted with ought being edited and are representative excerpt:

i) Appropriate training from the perspective of the student, as they alone decide when to visit the online environment;
ii) I gain time; I study when I like to; I have unlimited access and can read the materials as many times as I want;
iii) I am not obliged to be present at lectures every Friday, when sometimes it is not the best time for me; it is funnier and useful;
iv) Save time, work can be done at a convenient time for us etc.; materials and resources are available at any time;
v) Able to work part-time at a convenient time for us;
vi) There is unlimited access to all necessary recourses and the fact that they are available in virtual environment is a plus, because we can work at a convenient time for us;
vii) It is an advantage because the necessary information for the further realization is satisfied. So the work becomes easy and enjoyable;
viii) It is an advantage, because we can work with these recourses at any time;
ix) The greatest advantages is for disabled people, who cannot be present at lectures; it is advantage, because every time I need a specific course I can find it in the environment, furthermore as a future teacher I can use the materials in my work;
x) I can work, whenever I want to;

Table 1. Support of online students.

Answer options	Definitely agree	Overly agree	Not sure	Overly disagree	Definitely disagree	Response count
1. The course contains instructions supporting students access to virtual resources and use them.	94	4	0	0	0	98
2. The course contains instructions and support system supporting the conduct of online activities.	87	9	1	1	0	98
3. There is pre-technological preparation of students to work with e-learning environments and tools in it.	91	7	0	0	0	98
4. Are provided individual consultations with teachers.	84	12	1	0	1	98
5. Student inquiries are answered promptly and thoroughly.	83	13	1	0	1	98
6. Are provided opportunities for counseling and guidance to students in accordance with their individual differences (origin, incoming level of knowledge, previous achievements, employment, etc.).	86	12	0	0	0	98
7. Support is provided to students who do not achieve satisfactory progress in learning.*	84	10	1	1	0	96
8. Resources are provided for students with special educational needs. *	90	4	1	1	0	96

*Two students did not respond to 7 and 8 items.

Table 2. Student's opinion: Comparison between e-learning and traditional environment.

Which of the following learning activities do you think is better to be carried out in electronic and which in a traditional environment for the success of your learning?			
Answer options	**E-learning environment**	**Traditional environment**	**Response count**
Access to lectures	87	11	98
Access to diverse literature in the context of this course	90	8	98
Communication with the teacher	45	53	98
Communication with colleagues in performance of group tasks	42	56	98
Individual performance with colleagues	37	61	98
Access to students' work (essays, reports, presentations)	86	12	98
Individual consultation from teachers	54	44	98
Project development	60	38	98
Read study materials	72	26	98
Development of essays, reports, references and more	70	28	98
Receive information about the organization of the course	88	10	98
Group discussions	78	20	98
Evaluation of students' achievements	48	50	98

xi) Students save time and money;
xii) Contribute to better get to know my colleagues, with whom I don't have the time and the appropriate place to communicate;
xiii) Allows each student to enter the discussion at convenient time for them;
xiv) More opportunities to reflect on the position of others;
xiv) Gives me a chance to read additional materials before sharing my opinion;

Regarding the comparison between the traditional

and the electronic environment in which the training happens, students indicate as stated in Table 2.

CONCLUSION

Introduction of new information technologies put university in even more competitive environment. It opens new opportunities and challenges for universities, allowing them to seek alternatives for distribution of their educational product. Development of quality educational products will undoubtedly be a great advantage. The authors of the article believe, and study confirms it, that in given optimal pedagogical designs it is possible to have quality distance learning within a practice-orientated university course.

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