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Review

Innovative contributions for improvement educational system adapted to the specificity of the Carpathian mountain areas

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We proposed in this study to use the latest technological advantages in order to improve the teaching methods for the microbiology discipline, within the ”Mountain Academic School”, Center of Mountain Economy (CE-MONT), Vatra Dornei, Romania. Our research team will capitalize the professional experience by actively participating in the creation of the ”Mountain Academic School” in order to increase the quality and usefulness of researchers in mountain areas, as well as to provide a research and education environment with high technical and scientific level, attractive for young researchers in Romania and from abroad. CE-MONT is the only research center for the mountain economy in the South East Europe. Its aim is to strengthen research capacity in fields like the economy of mountain areas, agriculture, food safety and education. The center is located in the Romanian mountain area, in a region renowned for the quality of milk products and spa tourism. The overall investment of seven million euros was funded by ERDF funds and the Romanian Government. The center has 12 research laboratories, a conference hall with 200 seats, a library, a small printing press, and 2 mobile laboratories for field work. The CE-MONT goal is to foster regional cooperation and become “a pole of excellence” for the Carpathian-Balkan mountain area. In the discipline of microbiology, of Faculty of Veterinary Medicine, University of Agronomical Science and Veterinary Medicine of Bucharest our team used a system that was tested on a group of 25 students over three years using innovative teaching technologies based on the combined uses of communications and information technologies for educational purposes by creating "informational and educational products". The development of communication and information technologies allows the learning of laboratory systems in a virtual learning environment. In this paper is described an innovative teaching and learning system that was developed to teach microbiological techniques. The purpose of the interactive system was not to teach the students manual skills, but to acquire other skills, such as interpreting microscope images, biochemical tests, etc. The system is fully autonomous and it has been used as a teaching support in the form of a microbial avatar that has been made based on morphological and metabolic characteristics of microorganisms. The microbial avatar has the advantage of learning by playing, thus rendering microbiology much more attractive for the students.

Keywords: EHEA areas, interactive system, microbial avatar, biosensor, voltammetry

INTRODUCTION

The Bologna Process initiated by 29 Ministers Responsible for Higher Education (1999) has brought unprecedented reform across the European Continent to make higher education programs more transparent and comparable and to make higher education students and staff more mobile across the European Higher Education Area (EHEA).

Education ensures the development of a human being, as an independent, free, responsible and creative person. Perceptions were set about the student’s role within the learning environment which had many implications,

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Table 1 Participants' characteristics

Age	Number of participants
18-19	10
19-20	10
20-21	5

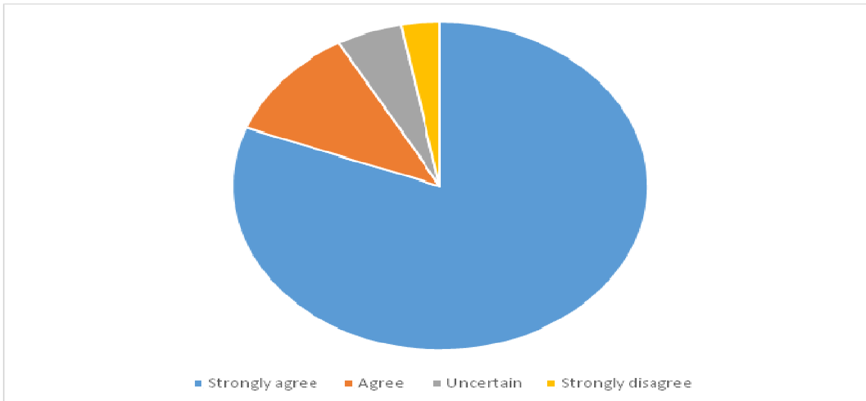

Figure 1 Student responses evaluating their perceptions on how helpful is the system

including the way that innovative teaching methods were received (Daft RL 1978; Lubienski, 2003).

This model states that, in order to learn, students must do more than just listen, students must be engaged in doing things and thinking about the things that they are doing (Fabry at all, 1977).

The continuous improvement of the quality of teaching has led to the modern, student-centered teaching characteristics, which are based on one of the most recent paradigms of teaching, the constructivist one (Brush T., et all, 2001; Ertmer, 2005).

We believe that learning is an active process, and the information learned in a course is directly proportional to the effort of the teacher, more precisely with his/her teaching methods. These methods depend on the student and his/her cognitive style (global or analytic), taking also into account the genetic component (with the four learning styles: auditory, visual, tactile and kinesthetic) – (Handelsman et al., 2014). Within the courses in microbiology, creative, heuristic, intuitive, permissive, and holistic methods have been used.

The teaching methods were based on: questioning, heuristic conversation, inductive and deductive methods, teaching materials (plasticine microbiology)- (Simona Ivana, 2015), back-tracking, conservative-type learning, experiential learning, cooperative learning, the demonstration method, case study method, group activity combined with role playing, simulations, learning by doing, ice breaking, buzz groups, dilemma, brainstorming, starburst, trial and error, the principle: "discover what you/I did wrong and try again", etc., according to the learning style of the student (Cuban N. et all, 2001).

In this regard, this study aims to develop the creativity of the students and their interest in deepening the field of microbiology. Food safety and security is a top priority objective of a sustainable development (Ziv A. et all, 2003).

DESIGN

Premises: the population explosion, an increased need for food, industrialization of consumption livestock, excessive widening of the food trade, the import of feed from areas with poor sanitary standard, excessive industrial processing (food factories) – (Lubienski, 2003).

As far as we are concerned we were professionally formed and we actively formed our students according to the principle: "We are different, so we learn differently!" Moreover, the EHEA areas of priority are based on student-centered teaching and focus on the teaching mission in higher education, education, research, and innovation.

Participants: In this study, which was centered on the student, the cognitive style, and on the genetic component, a group of 25 students was selected, to whom this interactive system of teaching and learning in the field of microbiology has been applied (Ivana S. et all, 2013).

Study design and data collection

Evaluation questionnaires were used to determine the effectiveness of the system. Student participation was voluntary and anonymous. We have found the following

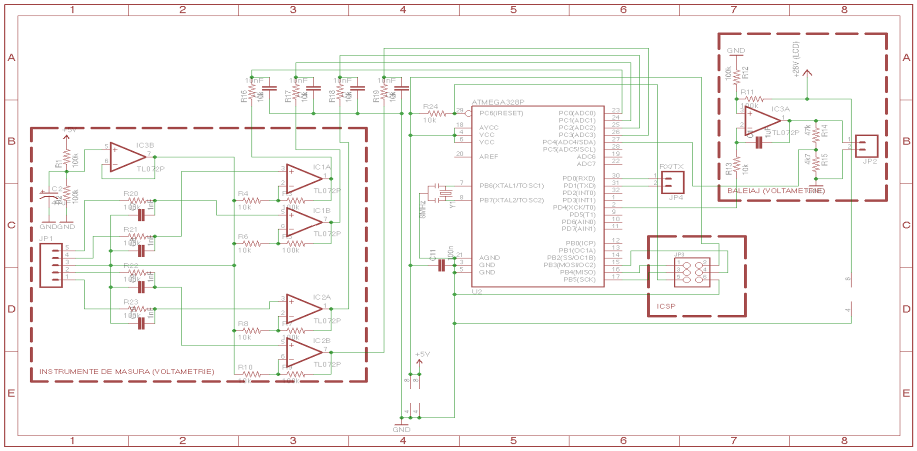

Figure 2 Voltammetric Amplification Module (M1), Scan mode, Analog-to-digital serial interface Module (M3)

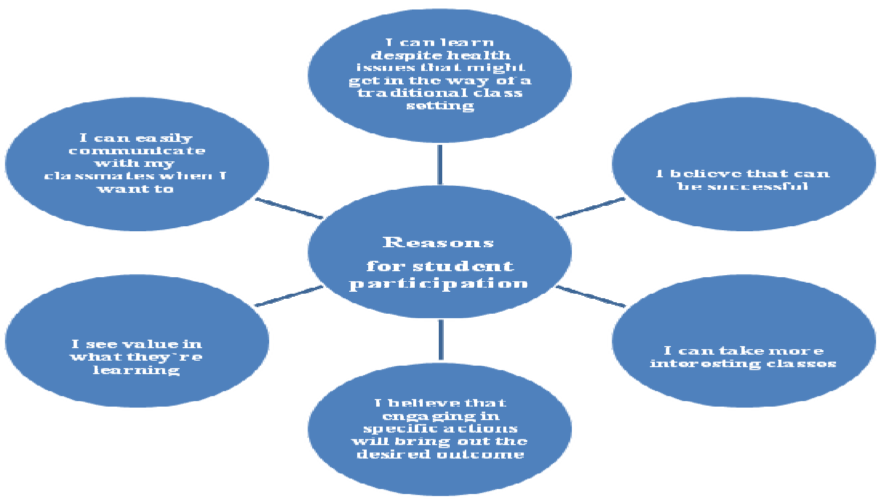

Figure 3 Reasons for student participation

aspects of the innovative system resource helpful (figure 1,3,4,5).

Lately, in order to acquire new knowledge in a practical and real way, analysis of samples by voltammetry and the interpretation of the results according to parameters obtained has been used. In the learning process, the technique of voltammetry has been used only to study the effects of macromolecular substances (Ivana S. et all, 2013).

The study carried out in this paper refers to the possibility of using the voltammetry technique also in the field of microbiology, by obtaining voltage differences specific to microorganisms (Ivana S. et all, 2013).

This interactive system of training and testing the students in microbiology uses the principle of variation of the voltammetric response of some voltammetric probes, depending on the substances between the working electrodes, and consists of a voltammetric amplifier which serves to capture the slow variations of potential from a biological sample located in the changing electric field generated by a scan mode, an analogue-to-digital serial interface, a microcomputer built around an integrated circuit on which runs the software, and a display module showing the interface realized by the software`s running on microcomputer (Ivana S. et all, 2013).

METHOD

The device presented below uses the latest technological advantages for the purpose of improving the training and testing of students in the field of microbiology (Ivana S. et all, 2013).

The system is fully autonomous and can be used as a teaching support; it can also be embedded and presented in various forms: microbial avatar, information point, integrated assistant in the laboratory table, etc (fig. 2). In order to fulfill the teaching functions, the device consists of the following modules: (M1) - Voltammetric Amplifier; (M2) – Sweeping module; (M3) - Analog-to-Digital serial

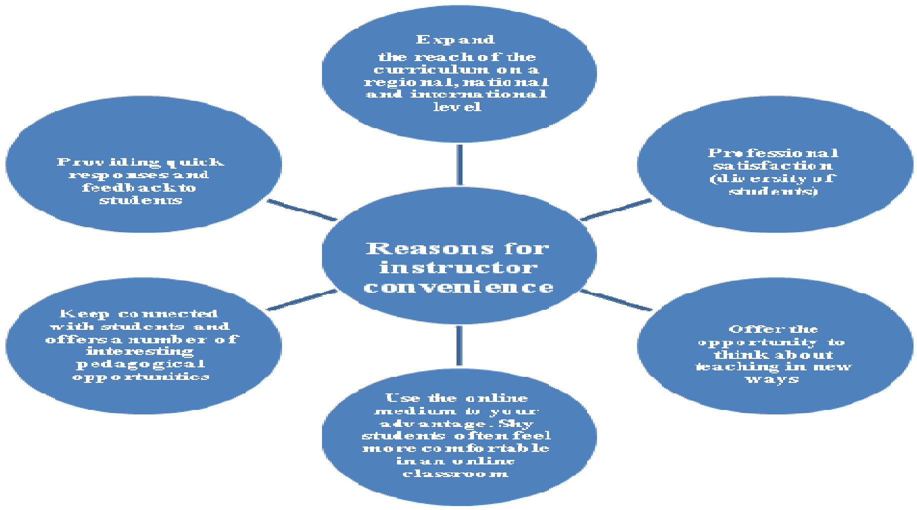

Figure 4 Reasons for instructor convenience

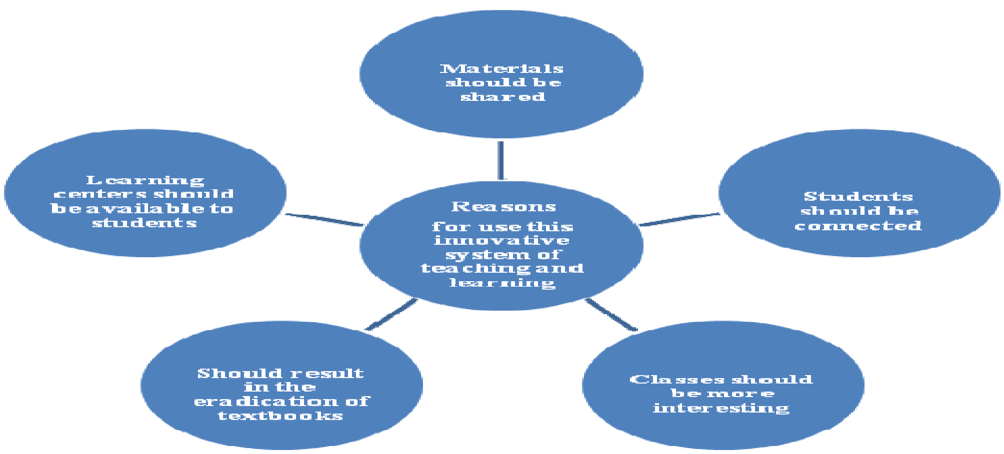

Figure 5 Reasons for use this innovative system of teaching and learning microbiology

interface; (M4) - Microcomputer; (M5) – Display module.

M1 - Voltammetric Amplifier - is realized using low pass mono-cellular filters (R20-C7; R21-C8; R22-C9; R23-C10) which protect the inputs of the analog-to-digital converter (M3) of the possible noise and are used to capture the slow potential variations of a biological sample placed in a variable electric field generated by the scan mode (M2).

The positioning of the electrodes is not relevant because the device is designed to be initially calibrated, and the results of the measurements are passed through a perceptron in order to be classified. The classification software runs on the microcomputer (M4).

The signal from low pass filter is magnified 11 times using the operational amplifiers configured as non-inverting amplifiers IC1A, IC1B, IC2A, IC2B along with the related resistive dividers R3-R4, R5-R6, R7-R8, R9-R10. The reference potential is obtained by dividing through R1-R2 the stabilized 5V voltage used for supplying logistics, filtered by C2 and adapted as impedance through IC3B, thus stabilizing the reference point.

The voltammetric probes are made of platinum on polyethylene, as well as the two electrodes of the scan mode. The principle of the voltammetric response variation depending on the substances between the working electrodes will be used.

M2 – Scan mode - is designed as an operational amplifier integrator R11-R12-R13-C1 and IC3A, supplied from the display module (M5) with +28V, in order to provide a wide range of output voltages.

The output of this module is divided 11 times through R14-R15 to obtain a voltage compatible with the input of analog-to-digital converter (M3), which is used as a feedback intelligent loop to track through the software, the workload of the capacitor C1.

In this way, using the PD4 port (M3) the workload of C1 can be controlled, providing impulses of various durations depending on the desired tension. The role of IC3A is that of an impedance adapter. The (M2) module is used to control the potential of the electric field from the voltammetric sample. 4-channels are used for the intermediary electrodes, in order to remove the possible contact errors. The electrodes from JP2 are made of platinum on polyethylene.

M3 - Module Analog-to-Digital/Serial interface – is made starting from ATMEGA328P microcontroller. It has embedded 6 analog-to-digital converters of 10 bites and programmable input-output ports. The circuit also includes a serial transceiver.

In order to protect the pins of ADC converters, we use R16-C3, R17-C4, R18-C5, R19-C6 low pass cells directly connected between the outputs of the amplifier module (M1) and ADC inputs.

The M3 module operates with specialized software to accomplish the two tasks: a collection of data provided by the voltammetric amplification module (M1) and the functioning of the scan mode (M2). The collected data are wrapped up in a structure with 5 variables of 10 bits each and transmitted using the serial port to (M4).

M4 - Microcomputer – is built around the iMX233 circuit which is a system-on-a-chip containing an ARM926J nucleus running at 454MHz (U1) along with an HY5DU121622 circuit containing 512MB (64Mbytes) of random access memory (U2) together with the support components for power supply (L2-L3-R3-R4-C41 and U3), and those required for the management of lithium-polymer battery of 3.3V and the capacity of 1400mAh through VR1, the interface for micro-sd card which comprises the operating system and the GPIO general programmable interface that exposes the pins of the system-on-a-chip for connecting the display module (M5) and the serial interface with M3 module.

M4 runs a customized version of Linux that includes the following packages: ncurses (for the graphic interface) and nginx, php and sqlite3 to run a web server. The perceptron module is written using C ++ and receives the data via the serial interface, a structure that contains voltammetric information, subsequently stored in a sqlite3 database and processed to obtain information about the environment. Also in the C ++ program, is implemented the logic of the training and testing program. The classes are uploaded using the web interface running on the server which is comprised of nginx and php5, and stores the data in the same sqlite3 database. The module stores the list of students; each student can select his/her name from the aforementioned list each time he/she accesses the application, allowing, at the same time, the track of his/her progress.

Student-device interaction is conducted as follows: the students have access to learning materials; when they feel ready they can start the testing program that consists of multiple choice questions. The operating system chose from a pre-defined set of questions using the web interface, a specified number of questions and after their randomization, they are displayed for students, so that they can see one question at a time.

In the end, the student is noted and stored in the catalog. The data are available through the web interface. In order to access the web interface, an ordinary USB Wi-Fi adapter can be used.

M4 allows the connection of a Bluetooth-compatible device through which it can be connected to a smart mobile terminal.

M5 - The module contains a color display device with liquid crystals, a diagonal of 10.92 cm and a ratio of 4:3 - BT043DC+, of 400 x 320 pixels, over which is superimposed a foil detecting the resistive pressure; the device is powered through a commutation voltage stabilizer of MC4063AD boost-type. Through this module is displayed the interface in ncurses of the included application. Through the menu, we can access both the function of voltammetric detection of the bacterial residues and e-learning function. By using the voltammetric detection, the device recognizes the bacteria and provides the information stored via the web interface. In this way, the information is constantly updated. By choosing the teaching function, the students choose his/her name from the list, enter a password and can access the content of the device: he/she can either can scroll the course or test his/her knowledge.

ASSESSMENT

Innovative educators know that a result of technology, the writing process has changed drastically. Some teachers are stuck in the past, though, with students moving at the same pace, following a very similar process of brainstorming, first draft, second draft, revisions, edits, publishing. Writing in the 21st century no longer looks like this.

A further aim was to help students acquire the intellectual skills necessary for the competencies by means of the interactive system (Ivana S. et all, 2013).

The purpose of the interactive was not to teach the students manual skills but is acquiring other skills such as interpreting microscope images, biochemical tests, etc. (Ivana S. et all, 2013; Judson, 2006).

The development of communication and information technologies allows the learning of laboratory systems in a virtual learning environment. Teaching with technology is a tool with a high potential for supporting student learning in creative and innovative ways when properly aligned with the instructor`s learning objectives and course content. "Innovation is the introduction of new products and services that add value to the organization" (Kevin Mc Farthing, 2016).

Innovative educators need to get students off of the paper and allow them to get to the thinking and producing faster by composing digitally. They know that a result of technology, the writing process was changed drastically

(Kozma R.B., 2003).

The term "technology" refers to advancements in the methods and tools we use to solve problems or achieve a goal. "Innovation is introduction of new products and services that add value to the organization" (Kevin Mc Farthing, 2016).

Teaching with technology can deepen student learning by supporting instructional objectives; offer the opportunity to think about teaching in new ways; provide ideas and techniques to implement in traditional courses; offer professional satisfaction (diversity of students); encourages contact between students and faculty; communicates high expectations and encourages students to have high self-expectations; respects diverse talents and ways of learning and engenders respect of intellectual diversity; includes a well-organized course, the structure of which is clearly communicated to students (Sandholtz et all, 1977).

This type of teaching offering the opportunity to think about teaching in new ways; provide ideas and techniques to implement in traditional courses; assure professional satisfaction by the diversity of students (Page T. et all, 2008). More than 60% of students surveyed said that they were “very interested” or “somewhat interested” in this study.

CONCLUSIONS

In order to learn microbiology and to understand its importance to all educational levels must simulate the best they can the activity they will perform as future specialists in real microbiology laboratories.

In order to improve teaching activity, we have implemented, since 2013, an innovative system that has the following advantages: it provides the possibility of studying a multitude of microorganisms (a biosensor enabling the students to detect, by direct microscopy methods, the bacteria or the toxic substances existing on the surfaces, in the air, on the skin, in the food, etc.); it uses hardware and software resources that are currently found in any educational institution; it helps the student to learn easier and faster, based on the analysis; it is completely autonomous and can be used as teaching support; it offers the students the opportunity to rapidly verify their knowledge; the training and testing program implemented by the microcomputer (M4) comprises courses that are uploaded using a web interface and a list of students (who can select their name each time they access the application in order to verify themselves and to track their progress in learning the material); the microcomputer (M4) allows the connection with a Bluetooth-compatible device, through which it can be connected to a smart mobile terminal; the interactive system recognizes the batteries and provides the information stored through the web interface, information which is constantly reviewed and updated.

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