PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 57, 2013
102

PEDAGOGY 1:1 IN HIGHER EDUCATION: A CASE STUDY

Mateja Ploj Virtič, Uroš Župerl, Marija Javornik Krečič
University of Maribor, Slovenia
E-mail: mateja.ploj-virtic@uni-mb.si

Abstract

The use of ICT in education has changed substantially over the last two decades. The development of new technologies has enabled us, the users, to mature and gain experience. The introduction of ICT in the educational process at the same time means a change of the teachers' role. The teacher appears in the role of a mentor who directs the activities of the learner. There has been a change in the teacher preparation to teach. He should provide both the content as well as technical support and to create a suitable learning environment. The way of teaching in the natural science and engineering education is specific due to the need of transfer knowledge into the practice. The nature of work in this kind of education requires more experimental work, based on individual learning process. There are many different implementation options of laboratory exercises that advantageously incorporate ICT into the nature of their work. The most popular in engineering education are two different types of laboratories: Simulation (virtual) and Remote controlled (online) labs, defined by Balamuralithara and Woods (2009). A remote controlled laboratory for conducting remote experiments at the University of Maribor, Faculty of Mechanical Engineering was developed. Development of the remote lab was carried out as an exploratory work of the group of students and professors. The lab was developed in the following three phases: development of the construction with corresponding technical documentation, development of the control system and development of the system for remote control of a lift. The successful student project is evident through the applicability of the developed laboratory that serves as a great tool for studying and offers all the benefits of ICT.
Key words: *experimental work, higher education, learning environment, pedagogy 1:1.*

Introduction

A lot has been written about the use of information and communication technologies in teaching and learning in the last few decades. With the emergence of modern technologies, the latter started to be more or less successfully included in the educational process.

A large number of professors saw the introduction of ICT in classes as a threat, similar to the time of the industrial revolution, worrying that technology would replace their role in the classroom. But however, experts all agree that ICT can only serve as a teaching and learning aid, and certainly cannot and should not replace professors (Cox, 1999; Postholm, 2006; Condie, 2007; Dolenc, 2012).

At the moment, a significant change in the mental concept is being observed; as opposed to the initial frequent use of ICT at all costs, this phenomenon has now settled down. Educators have started including ICT in teaching in a more planned manner and on the basis of scientific research and findings. verc et al. (2013) point out that efficient use of modern technologies in teaching the net generation requires particular emphasis on changing the professors' work and their role (verc et al., 2013).

Ananiadou and Claro (2009) reported the overall objectives of the OECD/CERI project "New Millennium Learners" (NML) which are, on the one hand, to conceptualise and analyse

ISSN 1822-7864

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 57, 2013

from a comparative perspective the effects of new digital technologies on young people's cognitive development, values, lifestyles and educational expectations; and, on the other hand, to examine the responses to the emergence of this new phenomenon in terms of educational policy and practice. These objectives are recognized as the 21st century skills and competencies which needs to be developed.

The message for professors in the last OECD publication (OECD, 2013) refers particularly to the preparation of suitable learning environments which enable efficient learning. Emphasis is placed on establishing the right balance between the teaching strategies used, and special attention is given to the development of 21st Century competences. Instance and Dumont (2013) summarise the research findings presented in the OECD publication (2013), which define an efficient learning environment as one:

- That places learning at its heart, encourages commitment to learning and enables students to see themselves as students;
- Where learning is social and often collaborative;
- That is as harmonised as possible with student motivation and the importance of emotions;
- That is highly sensitive to individual differences, including prior knowledge;
- That is demanding for every student, but does not over overburden them;
- That uses evaluation, coordinated with objectives, with a strong emphasis on formative feedback;
- That promotes horizontal interaction between curricular and extra-curricular activities and subjects.

The characteristics of an efficient learning environment and development of the 21st century competencies mentioned above are pursued as the main objective in projects that have consecutively appeared recently, and which uniformly use the term *"pedagogy 1-to-1"* or *"1:1 environments"*. The successful implementation of the 1 to 1 programme *"Smart Classrooms"* in schools in Queensland was an excellent reference for the preparation of the *"Innovative pedagogy 1:1 in light of 21st Century competences"* project which is currently taking place in Slovenia, and is financially supported by the Ministry of Education, Science and Sport of the RS and the European Social Fund.

Innovative Pedagogy 1:1 in the Higher Education

The educational process of the engineering education is usually carried out in two different forms: lectures (theory) and lab work (experimental learning), where students upgrade the theoretical knowledge and connect it with practice and independent learning.

Experimental learning focuses on the individual learning process, as Kolb (1984) defined, and it traditionally plays a central role in the science and technology curriculum, at all levels of education.

Šverc et al. (2012) believe that *"information technology by itself does not change the method of teaching and learning. The technology must become part of the culture and pedagogy that enables a shift toward student-orientated teaching, wherever and whenever" (verc et al., 2012).*

The "Innovative pedagogy 1:1 in light of 21st Century competences" project (Flogie et al., 2013) is based on increasing the individualisation of teaching and the personalisation of learning. It is important to support the introduction of new work forms and methods through reasonable and systematic use of modern information communication technologies, modern e-services, multimedia and interactive e-content.

Using information communication technologies in pedagogy 1:1 does not just mean their use in teaching, but also their inclusion in all the main components of the educational process, i.e. andragogy/pedagogy, organisation, technology and content.

The goal of the "Innovative pedagogy 1:1 in light of 21st Century competences" project

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 57, 2013

is therefore to set the foundation for the introduction of innovative pedagogy in the Slovenian educational area. In order to achieve this objective the following phases are planned: development, implementation (testing in pilot classes) and evaluation. Due to their extensiveness, these phases will take place within all expert groups along the entire educational vertical, and will include 13 consortium partners.

Remotely Controlled Laboratory

The only way for students to connect the theoretical knowledge with practice and to assimilate necessary practical knowledge and experiences is laboratory work. There are many different implementation options of laboratory exercises that advantageously incorporate ICT into the nature of their work:

Lamanauskas et al. (2007) report on the "ARISE" project, where they evaluated the use of augmented reality in the learning environment. The introduced environment can be created augmenting real objects found in the environment and usual material visuals with virtual information in the real space. In Siauliai University, a pedagogical experiment was done, and it aims at establishing effective teaching/learning platform based on augmented reality technology influence upon the learning results.

The next step into the future of e-learning represents placement of "real" labs, as learning environments, on the Internet. It offers a lot of new possibilities for performing lab exercises, including simulation environment lab, automated data acquisition and remote control of instruments online. Balamuralithara and Woods (2009) defined two approaches to conduct labs online: Simulation (virtual) and Remote controlled (online) labs.

The main difference between them is experimental plant, which is virtual in simulation lab and real in remote lab.

Each of these laboratories has its advantages and disadvantages. The major advantage of the remote laboratory, which will be described later in this article is that it allows experiments on the real machine tools and not only the mock-ups. This advantage is essential for future engineers.

The research is presenting an example of the implementation of 1:1 pedagogy in the education of mechanical engineers through the development of a remote lab built on real plants.

Case Study: The Modern Laboratory for Mechanical Engineers

Defining of Research Problem

The curriculum in the engineering education was comprised of theoretical knowledge that needed to be upgraded and deepened with experimental learning and practical exercises. Here we raise the question of whether e-education is appropriate for engineering education. The fast-moving world of information technology enables different kinds of applications for attaining demanding goals. Both lack of financial support as well as demands for the implementation of a study process that is separated by space and time are the main reason for the intense implementation of e-education in higher education.

The introduction of e-learning in the higher education system is also an opportunity to raise the quality of the study process. It is necessary to consider the adequate preparation of human resources for the technological development. Quality improvement requires a change in attitude, and development of a new philosophy and new concepts. These concepts are simple, but the practice of quality improvement is far from easy (Aberšek, 2004).

ISSN 1822-7864

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 57, 2013

Methodology of a Case Study

The group of postgraduate students performed an exploratory research. The development of remote experiment was conducted in several phases, carried out in a form of student project work and problem based learning. Students prepared each phase and planned it as a project task under the tutorship of the professor who was assigned the task to help them and who was responsible for the project of the remote experiment to be concluded successfully.

The criteria for the exploratory research were defined in accordance with the criteria for the preparation of a remote controlled laboratory:

- availability 24 hours a day;
- remote access to the experiment;
- security system (switches off the laboratory's operation to protect the drives);
- monitoring the performance of the experiment via webcams;

and the most important criteria:

- provides users the opportunity to learn programmable logic controller (PLC) programming and its control from remote sites.

Development of a Remote Laboratory

A main problem in the student task was the connection of an external measurement system and a numerically controlled machine tool. A goal was development of an adaptive control system which allows a remote experimentation.

Students have developed a general adaptive control system which enables the implementation of a variety of experiments which are conducted on the basis of the LabVIEW software that is integrated in the Moodle open source virtual learning environment. The article presents the Experiment for Control of a personal lift.

The lab was developed in the following three phases: development of the construction (Figure 1) with corresponding technical documentation, development of the control system and development of the system for remote control of a lift.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 57, 2013

Figure 1: Profile construction of the personal lift.

Students reported that working on this project, they acquired theoretical and practical knowledge, manual skills and learned about teamwork, thus acquiring extensive experience that they will need while working for a company.

Experiment for Control of a Personal Lift

The adaptive control system for the experiment for remote control of a personal lift consists of three components (Figure 2): the mechanic construction of a personal lift which operates on three floors (with drives, control unit and sensors), personal computer with appropriate software for remote control and webcam for control the experiment.

ISSN 1822-7864

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 57, 2013

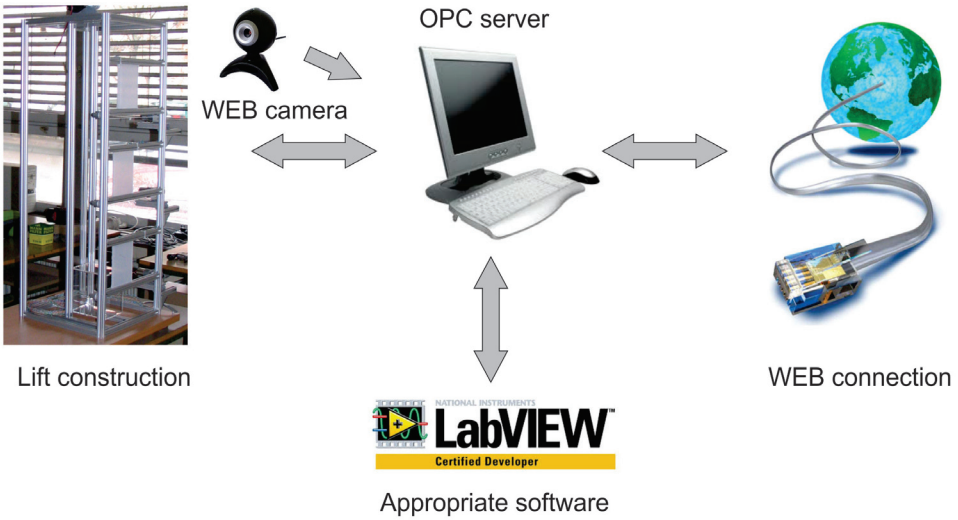

Figure 2: System for remote control of the lift.

The figure 3 shows the outlook of an experiment website, which provides access to the experiment, the life webcam and remote control the lift.

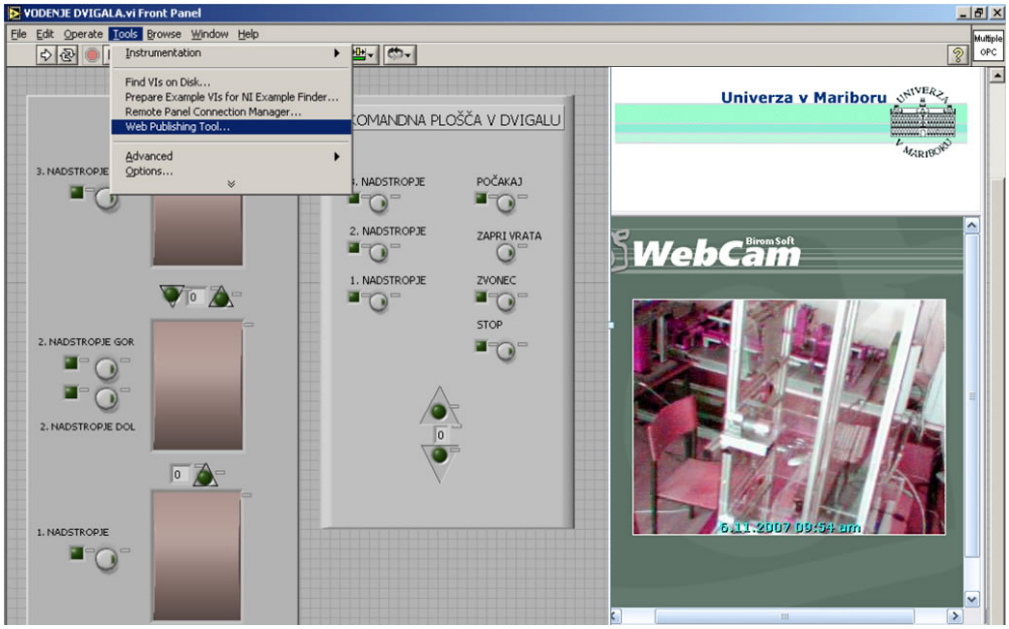

Figure 3: Web window for remote control of the lift.

To avoid any congestion, the students must book in advance for the conduct of the experiment. They can access the server only on the reserved dates. When the student logs on, he takes over the management of the experiment. The program window to manage experiment transfers (Figure 3) the live stream from the plant, as well as virtual animation operation of the lift with opening and closing doors, lights and sound, and buttons to operate the lift. The program window also shows the lift control panel with different buttons having various functions.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 57, 2013

Before starting, the student tests the operation of the system and downloads the required programmable logic controller (PLC) for the implementation of the experiment.

The objective of the experiment is to teach the students to program and use the controller to remotely control a specific device. During programming, the student can simultaneously test the functioning and improves the program to the desired operation of the device. After the completion of the experiment required, the student logs off from the system and leaves the device in the initial state for the next user. He submits the final report of the completed experiment to the assistant.

Discussion

The specifics of the study program automation require a lot of practical knowledge and skills that students have acquired with different methods of work, in particular, the emphasis on laboratory work. In addition, we try to take into account the OECD guidelines that promote collaborative learning, the integration of digital technologies and the cognitive development of the individual.

By following these guidelines the strategies of higher didactics are changing and distance learning acquires new dimensions. Compared with the traditional higher education didactics is contemporary much more flexible, as the online labs available 24/7, thus providing work for larger number of students. We can count many other advantages of the described distance learning. After depreciation the initial cost the maintenance and management of online laboratory is financially more favourable. Furthermore, the work of an assistant is much relieved, such e-learning enable more personalization to individual capabilities and, consequently, the achievement of higher goals of those who are capable of.

Reservation system enables students to use the facility at a time when the faculty was closed and thus increases the utilization of the experiment, and energy savings. Remote control experiments provide 100% security to the student, as he is located in a different location.

Various authors highlight the benefits of the introduction of remote laboratories in mechanical education: Calvo et al. (2009), and Dormido (2004) described advantages of the single form of education allows different ways to use a variety of methods and strategies for using information technologies:

- *"Flexibility: Laboratories can remain "open" 24/7, every day of the year. Moreover, as students may connect from anywhere in the Internet the laboratories are accessible when physical access is not possible (e.g., working students, or students with disabilities);*
- *Maximal use: In most cases laboratory equipment is expensive. By providing remote access, laboratories may be available to more students, being even possible to share laboratories between different universities and research centers;*
- *Real experimentation: Even though virtual laboratories based on computer simulations and virtual reality techniques provide very valuable experience, nothing can be compared to the interaction with real plants, although performed in a remote way. This is especially true when students must be trained to cope with real world situations;*
- *Active learning: The learning process requires students being active by doing things that instruct them."* (Calvo et al., 2009; Dormido, 2004).

Aziz et al. (2009) described online learning environments, which have been used at Stevens Institute of Technology (SIT) for a number of years to provide undergraduate engineering students with a comprehensive laboratory experience based on content-rich and flexible remote and virtual laboratory experiments.

Anyway, the eternal pessimist will also find some disadvantages of remote laboratories, as well as modern ways of working with students.

ISSN 1822-7864

Conclusions

The introduction of innovative pedagogy 1:1 in higher education area, more specifically at the University of Maribor, Faculty of Mechanical Engineering is presented.

Remote lab is based on an increase the individualisation of teaching and introduced new forms of working. The lab is supported by reasonable and systematic use of modern information and communication technologies, which is giving him an added advantage.

Case study presents the development of the remote lab which was carried out as a successful student project and its utility is a reflection of the remarkable work done. Postgraduate students, who participated in the project "development of a remote laboratory", achieved higher cognitive goals and developed many skills. The laboratory was tested in the past year to carry out lab work and students' satisfaction has encouraged us to the fact that in the coming academic year, we're planning to evaluate which skills and competencies of the 21st century the students develop conducting the experiment.

The case study is an excellent presentation of inclusion of the ICT into the higher education process and complexity of the integration of all components, which in modern methods of teaching, consider the following: pedagogy/andragogy, organization, technology, and content.

Acknowledgments

The authors greatly acknowledge the support of the Ministry of Education, Science and Sport of Republic of Slovenia and European Social Fund in the frame of Project: "Innovative pedagogy 1: 1 in the light of competences of the 21st century" on Faculty of Natural Sciences of University of Maribor.

References

Aberšek, B. (2004). Vocational education system in Slovenia between the past and the future. *International Journal of Educational Development*, *24*, 547-558.

Ananiadou, K., & Claro, M. (2009). 21st Century Skills and Competences for New Millennium Learners in OECD Countries. *OECD Education Working Papers*, No. 41, OECD Publishing. http://dx.doi.org/10.1787/218525261154.

Aziz, E. S., Esche, S. K., & Chassapis, C. (2009). Content-rich interactive online laboratory systems. *Computer Applications in Engineering Education*, *17*, 61-79.

Balamuralithara, B., & Woods, P. C. (2009). Virtual laboratories in engineering education: The simulation lab and remote lab. *Computer Applications in Engineering Education*, *17*, 108-118.

Calvo, I., Marcos, M., Orive, D., & Sarachaga, I. (2009). Building complex remote learning laboratories. *Computer Applications in Engineering Education*, *18* (1), 53-66.

Condie, R., & Livingston, K. (2007). Blending online learning with traditional approaches: changing practices. *British Journal of Educational Technology*, *38* (2), 337 – 348.

Cox, M., Preston, C., & Cox, K. (1999). What Factors Support or Prevent Teachers from Using ICT in their Classrooms? *Proceedings of British Educational Research Association Annual Conference*. University of Sussex in Brighton, September.

Dolenc, K., & Aberšek, B. (2012). E-learning and teaching – methodological or technological problem. In.: *Distance learning in applied informatics: conference proceedings*. Constantine the Philosopher university, Faculty of natural sciences, Nitra, pp. 73-81.

Dormido, S. (2004). Control learning: Present and future. *Annual Reviews in Control*, *8* (1), 115 - 136.

Flogie, A., Šverc, M., Kovačič, D., Perčič, K., & Vičič-Krabonja, M. (2013). *Inovativna pedagogika 1:1 v luči kompetenc 21. stoletja*. Prijavna dokumentacija projekta – interna dokumentacija, Zavod Antona Martina Slomška, Maribor.

Instance, D., & Dumont, H. (2013). Smernice za učna okolja v 21. Stoletju. *O naravi učenja, uporaba raziskav za navdih prakse (orig.: The Nature of Learning, Using Research to Inspire Practice)*, OECD, Paris & University of Tübingen, Germany.

Kolb, D. A. (1984). *Experiential Learning: Experience as The Source of Learning and Development*. Prentice – Hall, Inc., Englewood Cliffs, New Jersey.

Lamanauskas, V., Pribeanu, C., Vilkonis, R., et al. (2007). Evaluating the educational value and usability of an augmented reality platform for school environments: Some preliminary results. In: *Proceedings of the 4th IA SME/W SEA S International Conference on Engineering Education*, Greece, pp. 86-91.

OECD (2013). *O naravi učenja, uporaba raziskav za navdih prakse (orig.: The Nature of Learning, Using Research to Inspire Practice)*. Ed. Dumont H., Instance D., & Benavides F., Zavod RS za šolstvo.

Postholm, M. B. (2006). The teacher's role when pupils work on task using ICT in project work. *Educational Research*, *45* (2), 155-175.

Šverc, A., Flogie, A., Perčič, K., Kovačič, D., & Vičič Krabonja, M. (2012). Uvajanje učenja 1 na 1 na Zavodu Antona Martina Slomška Maribor (Introducing of one-to-one learning at the Anton Martin Slomšek Institute). In: *Zbornik prispevkov mednarodne conference InfoKomTeh*, Ljubljana.

Šverc, A., Flogie, A., & Vičič Krabonja, M. (2013). Cilji inovativne pedagogike 1:1 in uvajanje le-te na zavodu A.M.S (Goals of innovative one-to one learning on Institute A.M.S.). In: *Zbornik prispevkov mednarodne conference SIRikt*, Kranjska Gora.

Advised by Laima Railienė, University of Siauliai, Lithuania

Received: *October 03, 2013* Accepted: *December 02, 2013*

Mateja Ploj Virtič	PhD., Assistant Professor at the Department of Technical Education, Faculty of Natural Sciences and Mathematics, University of Maribor, 160 Koro ka Street, 2000 Maribor, Slovenia. E-mail: mateja.ploj-virtic@uni-mb.si Website: http://tehnika.fnm.uni-mb.si/index.php?option=com_content&view=article&id=27&Itemid=56&lang=en
Uroš Župerl	PhD., Assistant professor at the Faculty of Mechanical Engineering, University of Maribor, 160 Koroška Street, 2000 Maribor, Slovenia. E-mail: uros.zuperl@um.si Website: http://fs-server.uni-mb.si/si/inst/ips/labod/ANGUro%9A.htm
Marija Javornik Krečič	PhD., Associate Professor at Faculty of Arts, University of Maribor, 160 Koroška Street, 2000 Maribor, Slovenia. E-mail: marija.javornik@um.si Website: http://www.ff.uni-mb.si/zaposleni/osebna.dot?inode=10039&crumbTitle=Marija%20Javornik%20Kre%C4%8Di%C4%8D&pageTitle=Marija%20Javornik%20Kre%C4%8Di%C4%8D