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THE ROLE OF INTERNET IN THE DEVELOPMENT OF STUDENTS' COMPETENCIES

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Abstract:
Although there exists a strong possibility for many inventions to be used inappropriately, individuals still need to think of ways how to overcome this setback and use inventions in the best possible manner. The Internet is one such tool, for instance, which offers various types of challenges, both positive and negative. It might be very useful, but also harmful. In this text, we consider how the Internet tools are used to develop certain competencies in students, such as problem solving, critical way of thinking, spatial abilities, as well as soft skills. We present some achievements arrived at by working with students of bachelor, master and doctoral studies levels at the University of Belgrade and the State University of Novi Pazar.

Key words:
competence,
soft skill,
problem solving,
spatial ability,
critical waz of thinking

INTRODUCTION

As we know, a considerable number of inventions have been further used in such a way that even their creators could not have expected. Oftentimes, great scientists are able to foresee the negative consequences of their scientific and technological inventions, but in spite of that, the further development and application of those inventions has not been stopped. The problem of the relation between loss and gain was recognized in the role of art in the spiritual development of the individual by some communities since the development of technology. Among the many artists to delve into the problem, for instance already in the 1930s, let us mention M. Nastasijević (1991, pp 89-91) [12]. We are all witnesses of very intensive development of information technologies nowadays, and the Internet is among those very appealing to many people. Therefore, experts from different fields (psychology, neurology, sociology. etc.) have analyzed good and bad consequences, as well as the achievements, of using the Internet (see for example Carr, 2010) [7]. With that respect, we all need to think about how the Internet and other technologies can be used in the most adequate way, especially for education purposes, especially because we are, as educators, the ones most responsible in this framework.

The main goal of this paper is to present the use of the Internet for the purpose of developing students' competencies such as problem solving, critical way of thinking, spatial abilities, as well as some soft skills: time management, communication culture, team work, etc. We present the results obtained while working with students of bachelor, master and doctoral studies at the University of Belgrade and the State University of Novi Pazar.

COMPETENCIES

Higher education had been characterized by the so-called *ex-cathedra* lecture form for many decades. However, with the intensive development of information technologies the circumstances in the classroom setting have also changed considerably. The knowledge itself "has changed". It has become instantly available, it is broader and less deep, and there are many problems that have already been solved. One can use an extensive range of resources, such as Mathematica, Matlab, Excel, Javaview, Autocad, Geogebra, Google SketchUp, WinG-CLC, etc. to solve various types of mathematical problems, as contrasted to the beginning of 20th century when students had to try to solve problems using their intuition and knowledge gained at lectures or while reading corresponding books and papers (we refer to Bećović, 2013, for more details and references therein) [3]. We recognize that the students "have also changed". They prefer instant access to information; they want to see their knowledge applied immediately. They now like team work. We refer to Bokan, Petrović & Živić, 2012 and Vukmirović, 2012, for more details [5]. For this reason, teachers also have to change and adapt to the new circumstances. The system itself has changed in the past 15-20 years – from a teaching to an educational system. This Education Reform involves:

- a shift from the lecture oriented form to the student-centered approach to learning;
- a shift in the paradigm from measuring educational achievements to measuring competencies [13];
- a change in emphasis from focus on content in curriculum to problem solving in a new situation.

In an interview for "Evropa" Magazine on September 27, 2007 (pp. 26), Branko Kovačević, the then Rector of the University of Belgrade (2006-2009), explained this phenomenon symbolically in the following way: „ We live in capitalism now, which is our 'boorish reality' and hence we have to teach students to swim before we push them in the water. University is not virtual reality and therefore we cannot speak untruthfully and allow ourselves that young people perish at the moment when they leave the university".

Competencies might be divided into two groups:

- Generic competencies (for example: critical way of thinking, spatial abilities, etc.)
- Subject-oriented competencies (for example: problem solving, etc.).

Many experts have considered problem solving competencies to be very important. According to them, problem solving includes the ability to structure a given problem to relate it to the context, to identify and find the appropriate resources for getting further information and to develop strategies for decision-making even under uncertain conditions. Problem solving also refers to a higher-order cognitive process and to goal-oriented thinking and acting in situations where no routines are available for mastering the situation and where the solution path is not immediately obvious (see for example Banmert et al, 1999; Mayer, 1992) [2],[9].

In this context we do not analyze all the possibilities offered by the Internet. We point out just to those ones important for our experience working with students of the University of Belgrade and the State University of Novi Pazar. The Internet offers open access to many types of software very useful for teaching and educational processes (Google SketchUp, WinGCLC, Javaview, etc.). One can find lots of information important for one's own research or teaching (for instance, there are many sites which give access to original scientific papers, furthermore, there are open forums for discussing open problems or clarity of some notions, etc.).

OWN EXPERIENCE IN DEVELOPMENT OF STUDENTS' COMPETENCIES USING INTERNET RESOURCES

When I started to think about using the Internet in the teaching process at the Faculty of Physical Chemistry of the University of Belgrade and at the Mathematics Department of the State University of Novi Pazar, I had already had some experience in this area having thought a bachelor degree course at the Faculty of Mathematics of the University of Belgrade (see Bokan, Ljucović & Vukmirović, 2009; Bokan, Šukilović & Vukmirović, 2012; and Anic et al, 2014, for more details) [6] [1]. This experience said that students answered the question "What aspects of the Internet do you use?" as shown in the following percentages:

a) e-mail 97,92%

b) data mining 72,92%

c) blog 25%

d) chat 37,50%

e) educational content 83,33%

We refer to Bokan, Ljucović & Vukmirović, (2009) [4] for more details. Subsequently, having in mind this data, we may conclude that generally speaking all students think favourably of the Internet and they are familiar with its possibilities. In the text that follows, I present how we create courses at master and PhD level studies involving exploration of the Internet in the best way to stimulate students to develop some competencies and soft skills important for their future perspective.

A. During the 2013/2014 academic year I have given lectures on Mathematical methods in physical-chemistry research for doctoral level students at the Faculty of Physical Chemistry of the University of Belgrade. This course has been created in consultations with several members of the Faculty's academic staff to adapt this course to needs of students' research in future as much as possible. I have made additional effort to explain the corresponding methods more from a mathematical point of view, putting less emphasis on some examples of applications in physical chemistry, physics, chemistry etc, so as to motivate the students to study and understand the course better. But, from the very beginning they learned the content of the course and rules for evaluation of their knowledge in both the pre-exam and the exam part. One of the pre-exam obligations was to write a seminar paper and to present this work in classroom by using IT facilities. Each student could choose a topic from our course freely, but needed to involve the explanation on how one can apply this theory by researching a problem from the field of natural sciences. At the beginning they were confused, but I suggested that they discuss this homework with their professors, thesis advisors, as well as to try to find some information and ideas using the Internet. More than 50% of the students followed this advice and explored the Internet resources to prepare their seminar work, including very interesting applications of mathematics in the field of natural sciences. To illustrate it I would like to emphasize some students' achievements:

- explanation of the role of Fourier transformations, curvilinear coordinate systems and Bessel functions in research of helicoidal structures in biophysical chemistry, especially in DNA analysis;
- interpretation of boundary conditions in dimensions 1, 2, 3 using Descartes' coordinate for wave equations studying music recorded by a violin, a drum with the membrane of a square and a rectangle shape, etc.;
- explanation of binomial distribution of probabilities of existence of isotopes of certain chemical elements in certain chemical solutions.

When we analyze all procedures in preparation of seminar papers we may point out that students use the resources offered by the Internet mainly at the very start, looking for an adequate topic which will lead them towards the goal defined at the beginning. Later on, they use references found in various other ways. Since we have insisted on oral presentation of their work including answering questions, finally we may emphasize that besides

using the Internet, students also involve interactive work with teachers to choose a topic of seminar work, to check their writing style, etc. (all important for the development of communication skills). They were faced with problem solving as they needed to structure a given problem to relate it to the context, to identify and find the appropriate resources for getting further information and to develop strategies for decision-making even under uncertain conditions (caliber of manuscript, choice of details which are important for understanding the connections between mathematics and other sciences, quality of presented results, etc.). Consequently, they have learned how to develop a critical way of thinking at the same time.

As a teacher, I do sometimes allow a number of students to write seminar papers on topics from within the same area of mathematics, but with different applicability. They also have to be able to discuss their own work and listen to the work presented by their classmates, as well as to agree among themselves who would present the chosen topic (if they work in groups). By doing so, we encourage them to develop team-work skills and efficient communication culture.

The students needed to prepare an e-version of the seminar paper as well as a corresponding presentation for a limited time (not longer than 15 minutes). Subsequently, we may conclude that the students also needed to learn time management as an important soft skill to achieve success.

Having presented the previous details we may conclude that students have used very intensively the information technologies available and have enriched their knowledge in this framework. They have understood that, besides their teachers, they themselves also need to contribute to accession of their knowledge. To memorize only the content of a course is not enough to be qualified for research; it is necessary to understand some ideas, notions and results in pure generality. In this way, they are able to understand the significance of lifelong learning approach in education. Finally, they became more motivated to study mathematically theoretical approach, sometimes more abstract than they would like and rather difficult to understand, but in a far-reaching way, very useful, as they recognized various applications of the same mathematical results. Most importantly, they have seen that the Internet can be very useful for many purposes, but only as a resource and is far from being omnipotent!

B. Many students of technology and engineering sciences understand very well the role of geometry, especially descriptive geometry, in their education as they directly apply it in their job. On the other hand, the situation is quite different with other students, although for example descriptive geometry might be very useful in developing spatial abilities which might be helpful in problem solving in the world with enormous amount of information available [1] [4] [6] [8] [11]. It was shown that students of bachelor studies had more interest in descriptive geometry when we presented this topic by using a software for drawing pictures [4].

When we started to give lectures on projective and descriptive geometry to students of master degree of informatics and mathematics as well as physics and mathematics, the first challenge was to create the same course for all of them and motivate them to be interested in this topic; especially having in mind that some students have already had some working experience, some of them have been without working experience and furthermore they finished bachelor degree studies at different university. That implied that their previously acquired knowledge might vary in this respect. After consultations with my colleagues, I chose as my introductory class a presentation of a short historical overview of development of architecture and painting which influenced the development of projective geometry to help them to understand specific ideas in that area. Google SketchUp software for 3D modeling was used to present some of the figures.

Let us therefore analyze some outcomes of the use of Google SketchUp. From a financial point of view, this software is very convenient since it is available on the Internet as an open source. This is user-friendly software and all students can use it without difficulties. Before giving lectures on descriptive geometry, students in teams of three to four individuals needed to make a model of, in the first year, a mosque, a chair and a house; in the second year, a hotel, a bridge and living room sitting furniture. They had two weeks to prepare the homework and after that to present their solutions in the classroom. When I saw their results of 3D modelling of all objects, including explanations of some difficulties threatening to impede them from achieving the final results, we started with the analysis of Google SketchUp abilities, as well as some other tools (Autocad, WinGCLC, Mathematica, Excel, Geogebra, etc.) to conclude:

- 3D modelling involves many combinations of drawing basic elements (points, lines, plane figures) having in mind their mutual relations,
- not one single software exists which offers all possibilities expected by individuals who want to realize their own ideas. Consequently, it is useful to know how one can make a software for one's own purposes. But making new software includes a lot of theoretical knowledge (analytical and synthetical approach to projective geometry, descriptive geometry and many other areas).

With this analysis, students were well-motivated to learn this topic in the frame of an intensive course including the corresponding methodology and approach. This analysis had instigated their critical way of thinking.

To check students' achievements in spatial abilities and problem solving competencies I gave them several problems to construct normal projections of rather complicated figures on three mutually orthogonal planes when they know 3D models of these figures and, vice-versa, to make 3D model of figures if they know their three normal projections. Of course, it is important to point out that we gave lectures only about normal projecting on one plane using the distance method. They solved these problems very successfully. Moreover they succeeded to prepare the exam and pass it in a short period of time, including not more than two exam periods.

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