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COMPUTER-AIDED INSTRUCTION IN TEACHING BIOMEDICAL ENGINEERING STUDENTS

KOMPUTEROWE WSPOMAGANIE PROJEKTÓW W NAUCZANIU STUDENTÓW KIERUNKU INŻYNIERIA BIOMEDYCZNA

Abstract

The studies of the Biomedical Engineering faculty combine technical and humanistic elements. The biomedical engineering itself is a combination of knowledge located at the intersection of engineering, medical and biological applications. Technical universities which offer training courses on Biomedical Engineering place greater emphasis on engineering education. It is apparent, however, that the majority of students of this course are graduates of high schools with humanistic knowledge and no technical preparation. Initial teaching of technical subjects must therefore be conducted in a language and format accessible to the "non-engineers". Particularly, it is important to demonstrate and teach students the tools that will facilitate their further education.

Keywords: *engineering specialist teaching*

Streszczenie

Studenci kierunku Inżynieria biomedyczna są specyficzną grupą studencką łączącą w sobie pierwiastek techniczny i humanistyczny. Sama inżynieria biomedyczna stanowi połączenie wiedzy zlokalizowane na pograniczu nauk technicznych, medycznych i biologicznych. Uczelnie techniczne, które w ofercie kształcenia posiadają kierunek Inżynieria biomedyczna, kładą większy nacisk na kształcenie inżynierskie. Jak wykazują obserwacje, większość studentów tego kierunku to absolwenci szkół średnich z wiedzą humanistyczną bez technicznego przygotowania. Początkowe nauczanie technicznych przedmiotów musi więc być prowadzone w języku i formie przystępnej dla „nie-inżynierów". Szczególnie istotne jest zaprezentowanie i nauczenie studentów narzędzi, które ułatwią im dalszą edukację.

Słowa kluczowe: *inżynierskie nauczanie specjalistyczne*

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1. Introduction

At the beginning educational programs at technical universities focused mainly on science courses. In the late 60s, and especially in the 70s, technical schools introduced the subjects beyond the science group. Firstly, foreign languages and soon after subjects of sociology, philosophy or economy were added. Broadening the engineer point of view was the main motivation. Graduate engineers should not only design and build new constructions but also find their place in society and coexist with other human beings regardless of their origins, religion or beliefs. Some of the technical universities added to their program courses on applied psychology of work, history of engineering solutions or creativity. When engineers started to take up executive positions the requirement of management and administration skills became indispensable. Thus, technical universities created new faculties of management and MBA courses in their structures. However, in spite of the changes, technical universities originally have always been dedicated to the logical minded people and as a result most of their students graduated from technical high schools.

2. The actual situation of education of engineer management staff

At present, on the labour market the shortage of engineers and technical schools graduates can be observed. According to the forecasts this situation will intensify. Because of this shortage it is easier for engineers to find a job in comparison to humanistic graduates. The media widely publicize the problem and high school graduates are more conscious about the possibility of finding future occupation in a trade profession. As a result for a few years the incline of candidates to technical studies has been noted. The survey data (prepared by the Department of Control and Supervision of Polish Ministry of Science and Education [4]) maintains that during university recruitment high school graduates chose mostly technical universities (Tab. 1). What is more: out of first five most popular universities, four were Polytechnics (Tab. 2).

Table 1

The popularity of higher education institution in 2010/2011 academic year [4]

No.	Type of the higher education institution	Number of candidates on one place
1	technical higher institutions	3.9
2	universities	3.5
3	agricultural higher institutions	3.5
4	economic higher institutions	2.8
5	physical education higher institutions	2.5
6	pedagogic higher institutions	2.5
7	state school of higher professional education	1.3

Table 2

The most popular higher education institution in 2010/2011 academic year [4]

No.	Name of the higher education institution	Number of candidates on one place
1	Warsaw University of Technology	8.6
2	Gdansk University of Technology	7.4
3	Lodz University of Technology	6.3
4	University of Warsaw	6.2
5	Poznan University of Technology	6.1

3. Bio is in vogue

In the academic community it is said that Bio is in vogue, that is Bioengineering, Biotechnology, Biomechanics, Biomaterials, Bioinformatics etc. As an instance on the Bioinformatics 5.3 candidates on one place were present in the recruitment process in 2010/2011 academic year. Similarly on the Biomedical engineering 4.8 candidates, Biotechnology 4.5 and on Bioinformatics and systems biology 3.1 [4].

Nowadays it is thought that these are domains of future. The interdisciplinary science teams are created, a lot of research are conducted and this is one of the main science major granted by European Union. As a result, in higher education the Bio-specialties ordered by the Polish government are founded. The information attracts attention of students. In Krakow Biomedical engineering can by studied at the Cracow University of Technology or at the newly created Faculty of Electrotechnics, Automatics, Informatics and Biomedical engineering at the AGH University of Science and Technology (former known as the Inter-faculty School of Biomedical Engineering founded in 2006).

In 2010 at AGH 4.8 candidates on one place were present with only four other majors with higher number (the highest – 8.4 candidates on civil engineering) [7]. The data available on the Internet page of Cracow University of Technology also indicate the popularity of the Biomedical Engineering – with 5.92 candidates on one place. It came in third place after Informatics (6.82) and Architecture (6.63) [7].

4. Student profile of the Biomedical Engineering

The candidates to the Biomedical Engineering are mainly non-technical high school graduates. At AGH they constitute almost 100% with 42% graduated from school of biological and chemical sciences and 9% from humanities (data obtain from students surveys). Similarly the situation occurs at the Cracow University of Technology. First year students have no or a little technical and science background while the standards of the Biomedical Engineering focused mainly on them [6]. The subjects of mathematics (with mathematical analysis, linear algebra and numerical methods) statistic, probability theory calculus or electrotechnics are

obligatory (Tab. 3). With most of them a student meet during the first year. It is a heavy load for humanities high school graduates.

Table 3

Basic course requirements: subjects and minimum hours course [6]

No.	Subjects	Minimum hours
1	Mathematics, statistic, probability theory calculus	120
2	Physics	60
3	Chemistry	60
4	Mechanics and strength of materials	60
5	Materials science	60
6	Electrotechnics and electronics	60

In the Internet forum a lot of interesting comments can be found:

At present I study Biomedical Engineering. How does it look like? Well, I have no life at all. I have finished humanities high school, always was very good pupil. I hoped I would manage my study somehow. After one term I am thinking about leaving it..., my psyche is no go. The biggest nightmare is informatics... [8].

...physics must be known because it is a technical major, mathematics is lectured at very high level. Additionally... mechanics... I don't recommend it for people who are interested in anatomy and biology... It is an IT-mechanical major [8].

5. Science courses for humanities

Technical universities attach importance to mathematical and informatics skills development. In their syllabuses traditional science courses were always essential. However, the methodology should be adjust to the needs of a new type of humanities high school graduates. The same student training effects should be achieved by applying the other methods e.g. simple exercises, projects, working in groups with often repeating a newly acquired knowledge.

Within the framework of informatics classes the Biomedical Engineering students have the access to educational free software. It gives them the opportunity of practicing examples from lectures and laboratories on their own. The informatics course focuses on learning the software tools which are used to efficiently enhanced preparing projects or calculations e.g. on mechanical course. Among these tools Mathcad, Maple and VBA (Visual Basic for Application) can be distinguished. The proper usage of the programs make it easier for students to deal with the other course projects only on the condition of acquiring proficiency in managing the programs. The task demanded from a teacher of humanities high school graduates is to transfer the knowledge about proper use of the programs in as accessible way as possible. During the Languages and Technics of Programming course students are learned to use the VBA environment [1–3].

During the course lectures the introduction theory is presented at the beginning. Next the students obtain some keywords (variable types, data types with their ranges, functions labels and their syntax etc.). The keywords are prepared in the form of the handy instructions. The example of MsgBox function is presented in Figures 1 and 2 (because the classes are held in Polish language the original instruction in this language is presented).

INSTRUCTION MsgBox
Syntax: *MsgBox(prompt[,buttons][,title][, helpfile,context]))*
Example: *a = MsgBox(„Treść w oknie”, vbYesNoCancel, „Tytuł okna”)*
Parameters description: – **prompt** (mandatory) – text is displayed in dialog box 1024 characters – **buttons** (optional) – expression describing number and type of buttons, icon style, default button, – **title** (optional) – text on title bar in case of lack of application name – **helpfile** (optional) – string of characters enabling using of help for window – **context** (optional) – number indicating help topic Number and type of buttons: – vbOKOnly – only button OK – vbOKCancel – button OK and Cancel – vbAbortRetryIgnore – button Abort, Retry and Ignore – vbYesNoCancel – button Yes, No and Cancel – vbYesNo – button Yes, No Style and icons: – vbCritical – vbExclamation – vbInformation – vbQuestion Buttons and icons: – vbDefaultButton1 – active first button – vbDefaultButton2 – active second button – vbDefaultButton3 – active third button – vbDefaultButton4 – active third button

Fig. 1. The handy instruction of the MsgBox function

Rys. 1. Instrukcja MsgBox

The next step during a lecture is realization simple examples common with a teacher. A PC computer with proper software is connected to a slide projector so the students can follow every step of the teacher. The first examples are additionally described in details in the slides – step by step (Fig. 3).

Lastly, the students are encouraged to active discussion about more difficult examples, where the student suggestions are immediately implemented in the program by a teacher and effects are clearly visible. The feedback created this way definitely makes the lecture more interesting and involving.

Fig. 2. The execution of the MsgBox function

Rys. 2. Styl ikony okna da instrukcji MsgBox

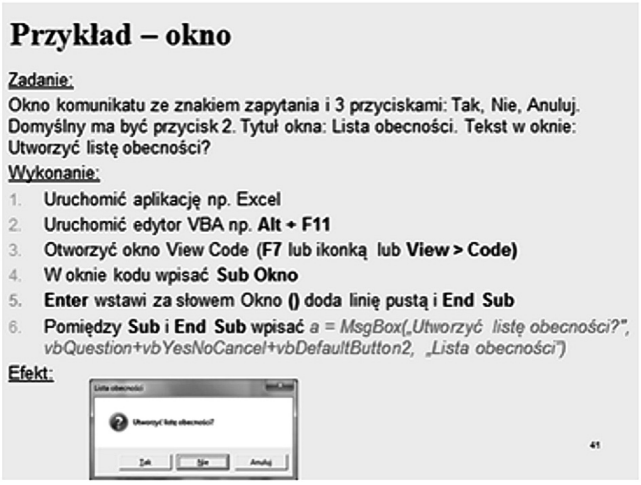

Fig. 3. The example described in details – step by step

Rys. 3. Przykład ćwiczenia z podanym schematem rozwiązania

On the other hand during project classes students work alone on the prepared tasks. However, the first steps in implementing a programming code are also presented by a teacher through a slide projector and followed by students. The fact that human beings learn mostly by eyesight increases the efficiency of the process.

6. Conclusions

One of the article co-author also graduated from a high school of biological and chemical sciences and on its own experience knows how much effort and strain required studying during the first years at the technical university. It is clear that for "non-technical" people a first contact with science courses is very demanding. In technical university syllabuses traditional science courses focus on advance mathematics and physics as well as on trade

courses as mechanics, electronics etc. are obligatory. For technic and science high school graduates the first contact is much easier because they know already the basis.

The knowledge may be transferred on many ways but the most important factor is to be accessible and comprehendible. The education success is not measured by a satisfaction of a teacher but by a satisfaction of students. It is especially true in the case of the Biomedical Engineering students who should after classes believe that studying it is not beyond their capabilities. The author's purpose was to present the proven example of such teaching.

References

[1] Walkenbach J., *Excel 2007 Bible*, ISBN-10: 0470044039/ISBN-13: 978-0470044032/Edition: PAP/CDR. 2007.

[2] Willett E.C., Cummings S., *Wiley & Sons, Incorporated, John*, Wiley & Sons, Incorporated, John 1392 pages. 2001.

[3] Łoś M., *MS Office 2000 i 2002/XP. Tworzenie własnych aplikacji w VBA*, Helion, Gliwice 2003.

[4] Department of Control and Supervision of Polish Ministry of Science and Education (http: //www.nauka.gov.pl/fileadmin/userupload/szkolnictwo/Dane statystyczne o szkolnictwie wyzszym /20220104/Wyniki rekrutacji 2010.pdf).

[5] Cracow University of Technology: 2010/2011 recritment: 2010/2011 (http://www.pk.edu.pl/ rekrutacja/index.php?option=com_content&task=view&id=178&Itemid=234).

[6] The standards of the Biomedical Engineering (http://www.nauka.gov.pl/fileadmin/user upload/16/19/16197/inzynieria biomedyczna.pdf).

[7] Zadroga A., *Oblężenie kierunków technicznych na uczelniach*, Gazeta Wyborcza 19.7.2010.

[8] The students Internet forum (http://www.uczelnie.info.pl/index.php?mod=kierunki_studiow &id=74).