GEOMETRY AND ENGINEERING GRAPHICS WITHIN THE NATIONAL QUALIFICATIONS FRAMEWORK- STUDENTS NEEDS AND THE ROLE OF EDUCATORS

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Abstract. The National Qualifications Framework is a new and revolutionary approach to the definition and the description of the educational process in Poland according to the European Qualifications Framework. It points eight levels of education described by so-called learning outcomes divided into three categories: knowledge, skills and social competence. The paper presents a brief description of the module-*Geometry and engineering graphics*, which is taught at Civil Engineering Faculty of Rzeszow University of Technology. It shows which aspects of the teaching should be considered when describing the module, in order to meet both students' needs and the National Qualifications Framework requirements. The paper reflects the role of the educators in the adaptation of the topics, teaching methods, and tools correspondingly to the needs of the future engineer. It also points their responsibility for the quality of education.

Keywords: Geometry and engineering graphics, the National Qualifications Framework, AutoCAD

1 Basic information

The Bologna Process initiated by **the Bologna Declaration signed in 1999**, defined the comprehensive activity undertaken by the European countries aspiring to restructuring and unifying the educational system in Europe. In many respects, it has been the revolutionary approach to the cooperation in European higher education [4]. The main aim of it was to create **the European Higher Education Area**, which could enable the wide cooperation of the participating countries in the field of higher education. The activity and the cooperation within the **European Higher Education Area** focus, among others, on the following aspects: qualifications framework, employability, mobility between professions, student–centered learning, education, research, and innovation. The qualifications framework defines the qualifications of the educational system, and it shows how they interlink. It also describes what students should understand, know, and be able to do on the basis of the acquired qualifications, as well as, how they can change their qualifications within the system of education.

The European Qualifications Framework constitutes the model for **the National Qualifications Framework**, which points eight levels of education in Poland. Each of the levels is described by so–called learning outcomes, which are divided into three categories: knowledge, skills, and social competence, with a special stress on skills. The learning outcomes describe abilities to use the knowledge and skills for solving the particular tasks by students in a specific area.

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2 Geometry and engineering graphics in the Bologna Process

The Bologna Process has had significant influence on a new educational system in Poland. It has brought creation and development of the new curricula at Polish technical universities. Moreover, it has caused limitations of the teaching hours of the particular subjects, as well as, elimination and creation of the new ones [3]. On the other hand, constantly developing CAD technology influenced technical education at all levels of study. Thereby, the contents of teaching geometry as a technical subject has changed a lot too. Being one of the fundamental subjects of engineering education, *Geometry and engineering graphics* (*Descriptive geometry* previously) was brought into line with changes in the overall system of education, and it was submitted to the new rules. The contents of teaching this subject started to include not only descriptive geometry and technical drawing, but also introduction to computer aided design. Thereby, the methodology for teaching the subject required some changes and improvements, as well as, rethinking of all existing teaching aids and methods. Next, according to [1], there was the need to elaborate the teaching system matching the level of the technical education and demands of the National Qualifications Framework at the same time [1]. However, the contents of the subject were allowed to be determined and defined by universities, since they got the great autonomy in creating programs of study. The only condition for it was the acquisition of the required competences by students [1, 2].

3 Geometry and engineering graphics within the National Qualifications Framework at Rzeszow University of Technology

Geometry and engineering graphics is taught entirety at Civil Engineering Faculty of Rzeszow University of Technology during two semesters of the first year of study.

The brief description of the module according to the National Qualifications Framework is as follows:

The name of the module: **Geometry and engineering graphics**
The area of study: **technical sciences**
The profile of study: **general academic**
The level of study: **first degree study**
The name of the discipline: **Civil Engineering**
The module status: **mandatory for the teaching program**
The position in the studies teaching programme: **sem: 1, 2 / L45 C15 Lb30 P15/ ECTS 9**
The main aim of studying: **achievement of the adequate knowledge and abilities in the scope of geometrical basis of the graphical mappings applied in technology**

The contents of the module include descriptive geometry with freehand drawing and engineering graphics - technical drawing by means of computer. They are described by adequate learning outcomes in three categories: knowledge, skills and social competence.

According to the National Qualifications Framework requirements, education should be **linked with labour market requirements,** and should be **oriented on solving practical problems**. To meet above requirements, the theory of Geometry and engineering graphics has been linked with **practical applications.** The part of the module devoted to descriptive geometry is a training for space perception, and it gives fundamental basis of the graphical mappings. Therefore, it is incontestably significant for every civil engineer. The geometrical tasks covering all of the topics are based on the simple engineer tasks. However, the connection of student's tasks with the future engineer needs is the most visible for this part of the module which is concerned with technical drawing. For this reason, let us concentrate on the aspects of teaching engineering graphics now. This part of the module is carried out by means of AutoCAD program.

Due to small amount of the academic hours (20h) specified for getting acquainted with the bases of creating technical drawings in a computer lab, teaching has been limited to constructing only two-dimensional drawings. After being introduced into principles of the work with AutoCAD, students carry out the laboratory exercises presented below (Fig.1, 2, 3, 4).

1. The technical drawing of a figure.

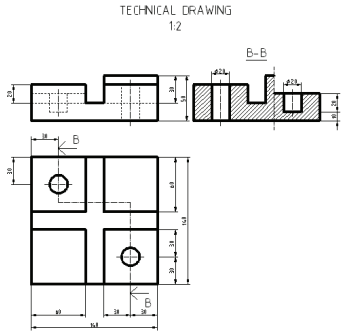

Figure1: The example of a student's technical drawing

2. The architectural drawing of the ground floor plan of a building

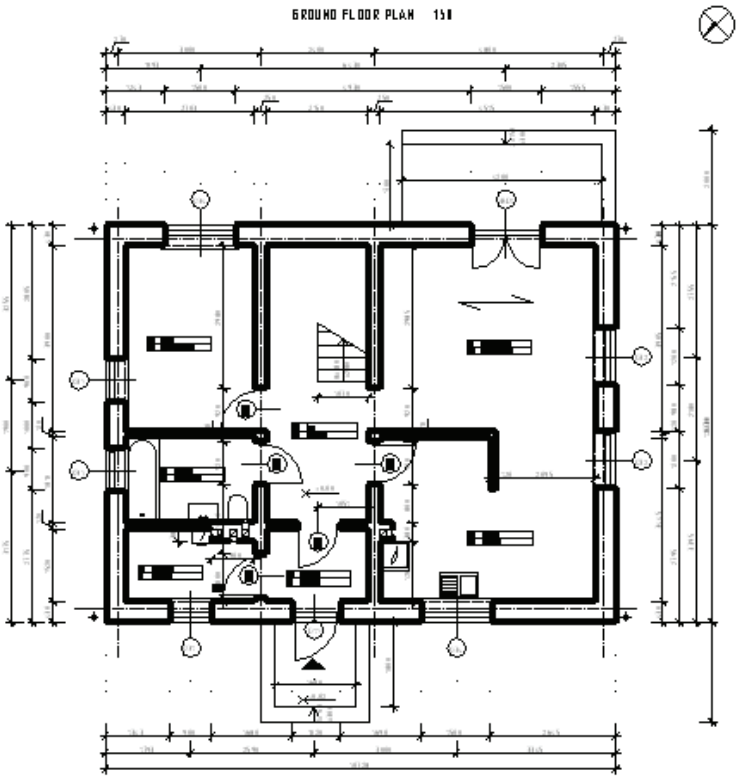

Figure 2: The example of a student's architectural drawing

3. The working drawing of a reinforced concrete beam

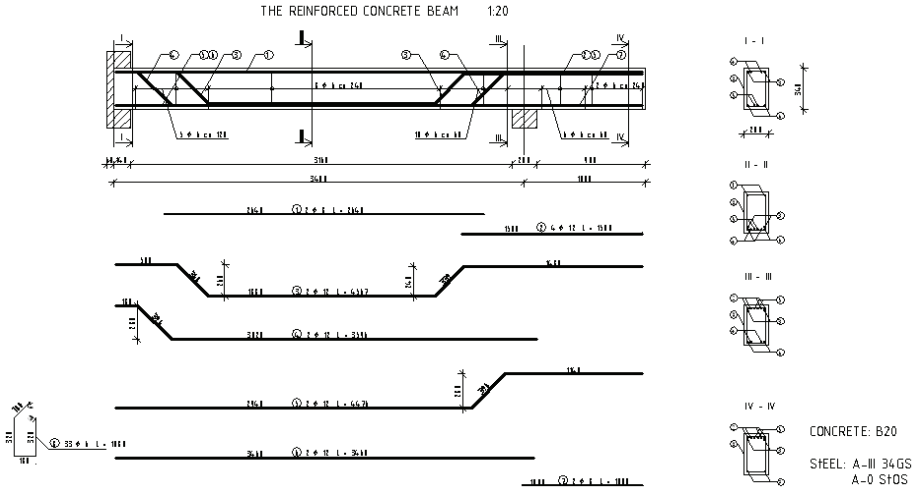

Figure 3: The example of a student's working drawing

4. The working drawing of a steel pole or the base of a pole

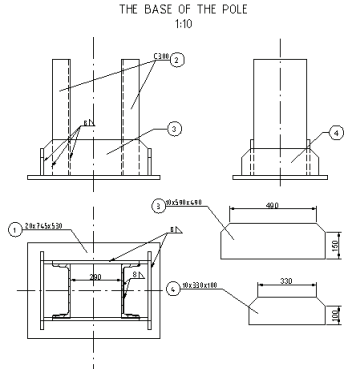

Figure 4: The example of a student's working drawing

It is worth noticing that students work independently with the designing assumptions prepared individually. Not only the completion of exercises requires the knowledge of necessary elements of the image, the contents of projections, and the principles of dimensioning according to standards, but also mastering AutoCAD as a drawing tool.

The other important aspects of the National Qualifications Framework are both the **time limitation**, as well as, the **criteria for judging** the efficiency of the educational process. All of them have to be defined precisely at the beginning of the course. Moreover, according to the National Qualifications Framework requirements, the learning outcomes have to be determined for the average student, and they have to be **measurable**, **acceptable**, and **realistic**. Only the student who reaches the intended level of knowledge, learns the required skills, has specific social competence defined in the module learning outcomes, can complete the module. The student's workload corresponding to the level of education is expressed in **ECTS points** [1, 2].

4 Students' attitude to the module

Practice shows that critically thinking students accept the subjects and the tasks related with their future profession, since they easily understand the purpose of studying them. They want to be aware of the usefulness of learning for their future engineering work. The students like

the clear terms of the assessment, namely, the way of giving component module grades and a final grade.

The observation of students' attitude to the module permit to state, that computer aided drawing within computer lab arouses more interests in students than descriptive geometry course. Computer aided drawing is very attractive for students because it enables producing high–quality graphics in easy way. Since the students have free access to an educational version of AutoCAD program, the ability of using the program varies for different students. It depends on the amount of the time they devote to mastering it. Practice showed that after going through three first laboratory exercises, students managed to acquire the skill at drawing with computer assisting quite well. However, being supposed to copy the assumption of the last exercise (the working drawing of the steel pole), they started to be bored a little. Simultaneously they showed the big interest in 3D modeling.

5 The role of educators

Not only imparting knowledge is the role of educators, but also making students reach the intended level of knowledge, and learning the required skills. It is also their responsibility to choose right methods and tools for it. In the author's opinion, the educators should meet both students' interests and demands of the National Qualifications Framework at the same time. It can be shown on the example of the didactic experience resulting from introducing a new concept of the laboratory exercise [3]. Namely, to make the students be more interested in drawing tasks, and to make their work be more effective and attractive, the last lab exercise has been modified. That is, 2D drawing was replaced by 3D one. Due to the time limitation, the students were not taught modeling technique which based on primitives and Boolean operations, however. They created 3D model of the steel pole using just one command – extrude, which enabled creating 3D solid by extruding 2D region object. Next, they created three projections of the pole in the layout automatically, completed the drawings, and made dimensions. In this way, abilities of the AutoCAD 2012 program were exploited, which simplified drawing projections considerably.

The results of the students' work showed that the students made the construction drawing of the pole on the base of the spatial model of it far more quickly than they drew the flat projections of it. What is more, they were more interested in what they did. The new concept of the students' task released the students from the monotonous work, and left more time for the creation of new forms, and the accumulation of the certain skills and knowledge. They were able to achieve some module outcomes very quickly, mastering new practical skills using AutoCAD program. In this way, the quality of the education understood as the effectiveness of achieving deliberate (guaranteed) outcomes was able to grow.

The creation of the spatial model of the pole has enabled making the step forward, that is placing the poles in the array, and designing the cover composed of the fragments of a ruler surface above them (Fig.5a,b,c).

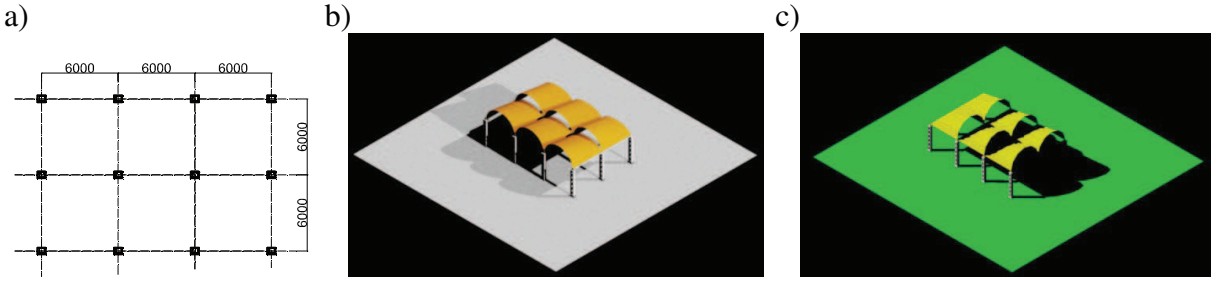

Figure 5: The modeling exercise: a-assumptions, b, c- the result of the students' work

At first, this part of the exercise was some kind of innovation, the optional task to inspire students to independent future work. It turns out, however, that even the students with poor achievements got interested in the creation of the three-dimensional model, and coped quite well with it. Due to this fact, the students' tasks and exercises should be considered again. That is in accordance with the National Qualifications Framework, since systematic **verification of the learning outcomes** and **improvement of educational programs** are the main factors deciding on efficiency and quality of education.

In the author's opinion, drawing with CAD software being used as a part of curricula, is the prominent aspect of the quality of the educational process and the motivation for students' work. Newer and newer versions of AutoCAD give newer and newer possibilities of the simplification of drawing, and make it more effective. Therefore, there is no doubt; this improved drawing tool should be used in students work. However, it is educators' responsibility to implement it properly in the educational process, according to the level of education, as well as, the progress of teaching. Otherwise, the quality of students' education may be imperiled seriously. Being focused on the learning outcomes all time, the educators should consider what they teach and how. Although, they have to move within the National Qualifications Framework, they have some freedom of the creation of the educational process.

Conclusions

- To meet both the students' needs and the National Qualifications Framework requirements, the theory of Geometry and engineering graphics has to be linked with the practical applications, and be oriented on solving problems.
- The module learning outcomes should be: specific, measurable, acceptable, realistic, and time-scaled.
- It seems that drawing with CAD software used as a part of curricula, is a prominent aspect of the quality of the educational process, and the motivation for students' work.
- The right choice of teaching methods and the application of the new drawing tools should be crucial.
- Being focused on learning outcomes, the educators should consider what they teach and how.
- Moving within the National Qualifications Framework, they should analyze carefully the needs of the future engineer, and they should adapt the topics and the teaching methods correspondingly.
- To make students be creative and be interested in the new material, the educators should be flexible, and responding to the contemporary world.
- The systematic verification of the learning outcomes and improvement of educational programs are the main factors deciding on efficiency and quality of education.

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GEOMETRIA I GRAFIKA INŻYNIERSKA ZGODNIE Z KRAJOWYMI RAMAMI KWALIFIKACJI – POTRZEBY STUDENTÓW I ROLA NAUCZYCIELI

Krajowe Ramy Kwalifikacji stanowią nowe podejście do definicji i opisu procesu edukacji w Polsce zgodnie z Europejskimi Ramami Kwalifikacji. Wyodrębniają one osiem poziomów edukacji, z których każdy opisany jest przez tzw. efekty kształcenia w wyróżnionych trzech kategoriach: wiedzy, umiejętności i kompetencji społecznych. Artykuł przedstawia opis modułu *Geometria i grafika inżynierska* realizowanego na Wydziale Budownictwa i Inżynierii Środowiska (kierunek budownictwo) w Politechnice Rzeszowskiej. Wskazuje jakie aspekty nauczania należy brać pod uwagę opisując moduł, aby sprostać potrzebom studentów oraz wymaganiom Krajowych Ram Kwalifikacji. Pokazuje rolę nauczyciela w doborze treści, metod i narzędzi kształcenia oraz podkreśla jego odpowiedzialność za proces edukacji.

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