

## CHOSEN METHODS SUPPORTING DIDACTICS OF DESCRIPTIVE GEOMETRY

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**Abstract.** The article presents some discussion on the practical methods used to support the teaching processes in the context of psychological theories of learning and motivation. Such activities were undertaken by the Students` Scientific Society of Geometry and Engineering Graphics KRESKA, which for a few years has worked in the Faculty of Civil and Environmental Engineering in Gdansk University of Technology. The Scientific Society has taken various actions to create a friendly learning environment in which the students have opportunity to choose the forms of activity, the style of work and the scope of design projects. Under the discreet supervision of the tutor, the students acquire knowledge that is related to practical applications. The students organize the exhibitions and competitions, work in a CAD, participate in a teaching process during the tutorials. Moreover, the higher year students have opportunity to act as trainee assistants during the descriptive geometry classes. Although all the described here activities take place outside of the regularly scheduled appointments, the work within the Scientific Society has a positive impact on the work with the regular classes and moves to them. Among others, the measure of success of these actions is a large number of Civil Engineering students who participate in the annual edition of the Geometric Competition which is organized at the end of the first term and present their projects at the time of the Baltic Festival of Science.

**Keywords:** descriptive geometry, didactics

### **1 Preparation of the learning/teaching environment**

Current standards of preparation of any descriptive geometry course includes developing a program together with a series of lectures and topics of exercises which are available online at any time and from any place. This type of learning environment brings positive results provided the fact that the students meet the demands of psychological constructivist learning theory and that they actively use the collected didactic material. The efforts of the educators will be rewarded by receiving well done final tests and getting a positive feedback from the course assessment. It seems, however, that even the best-designed program has no chance of success, if not accompanied by interest from students.

### **2 Behavioral and constructivist approach in didactics**

In contemporary didactics, there are many and sometimes contradicting opinions regarding the theory of teaching. However, the opinion prevails that the individual benefits the most from the process in which the learner is in the center of the didactic process and the teacher only helps and mentors the student. Therefore the teacher should aim at creating such an environment in which the students will develop both as individuals and as a group.

The contemporary didactics refers to psychological theories: constructivist and behavioural. Constructivist model assumes that all people are active individuals who transform and interpret their experience. Moreover the reflection over the personal experience

is a starting point for constructing the individual understanding of the world. At the same time the behavioural model of learning is seen as a reaction to the impulse. Hence the teaching methods are based on a system of rewards and punishment which models the expected behavioural response in this educational system [1,2].

In the constructivist approach the learner and the process of acquiring knowledge are the focus point, the teacher is no longer a central person in the educational process. Characteristic features of this learning model are: assumption of students' independence and activity, lack of direct supervision, approval of various styles and rates of students' work. In the process of solving the problems the emphasis is put on real-life projects that supports individual learning and original reflections over personal experiences.

The features of behavioural teaching are mainly: organisation of work based on planning of activities, creation of ordered sequences of tasks, repetition of information and testing the effectiveness of teaching. The rewards are mainly of a motivational character.

In practice the modern learning environment requires fusion of both constructivist and behavioural models. The research provides evidence that the combination of both models brings the most effective results.

### 3 Motivation to learn

Motivation is a key component of learning – it does not only help reaching the goals but makes also foundation of an educational process. The theory of motivation distinguishes between external motivation (marks, personality of the teacher, influence of the environment) and internal motivation (need for gaining knowledge, interest in learning, ambition and determination, belief in practical application of knowledge). The students possess various levels of internal motivation which essentially influences the effectiveness of education process [1, 2].

One of the most important questions the teacher needs to give an answer to is: “To what extent the lecturers are able to influence the levels of student's self-motivation?”. Psychologists claim that less motivating lecturer is concentrated on controlling students by setting orders and restrictions. It turns out that better motivating is a teacher who accepts the autonomy of students, who employs moderate persuasion and who encourages independent research. In a learning process the important factor is the freedom of choice. What is more, the students who achieve success are better motivated, while those who fail reaching success are discouraged from taking up any further activity. By creating opportunities to experience the joy and satisfaction of successful project may therefore increase the level of internal motivation. In practice it means that the teacher needs to work out a set of the reasonable, feasible and well defined tasks that have the appropriate level of difficulty [4].

In many countries, the importance of motivation has been recognized long time ago. For example, the educational system in Great Britain has implemented mentoring system, where students receive individual support on each step of their education. On the other hand, in many educational systems there is still a large gap between the lecturers and the students which does not help creating motivation. In Poland mentoring has already been adopted in business and is gradually becoming more popular in higher education [5].

A characteristic feature of mentoring is a partnership between a master and a pupil which focuses on developing individual potential of the learner. It is based on inspiring, stimulation and leadership; it involves consultancy, evaluation and assistance. The aim of mentoring is to motivate the pupil to engage him/her into a given task or to achieve progress in his/her career path. Mentor directs student's learning process and his role is to carefully react to solutions proposed by a student. Therefore the base for his actions is to discover what

are the student's "strong points" and at the same time allow him/her making independent decisions. Moreover, the mentor should make the pupil become responsible for the achieved results [3]. Despite the fact that mentoring is not so widely used in everyday educational practice today we can prove that it can be effectively employed within the students' scientific society environment.

#### 4 Scientific Society as a part of the learning environment

*The idea of a scientific society perfectly fits to the concepts of modern theory of didactics which focuses on an individual and his/her own interests and activities. The scientific society is a fantastic place for young people, where without pressure or stress they can develop the knowledge and skills according to their own interests. The main objective is to encourage students' research activity and inspire them to improve their skills in the chosen areas of knowledge. Another goal is to develop organizational skills, enhance team work and often facilitate career start.*

Work in the scientific society fuses constructivist and behavioural models of education. According to the constructivist teaching model students should make most of decisions concerning topics of assignment. Moreover students should be able to do a team work, to share the particular tasks between them as they share the group projects, to conduct tutorials for others, to organise competitions, prepare posters, hand in prizes and publish their own work on exhibitions. The role of the tutor is to mentor students in order to inspire, motivate and to help them.

On the other hand, the behavioural model strengthens the internal motivation through rewards. As the success increases motivation, the teacher's role is not to miss an opportunity to reward the students. There are various means of rewards, e.g. a praise, a diploma, the prize awarded by the Dean of the Faculty, the further recommendations given in writing.

The Scientific Society KRESKA is addressed to the first year students who have interest in descriptive geometry and spatial modelling. Surprisingly, a large number of students joins the one-hour per week classes, while on average there meet about 30 people during one session, the group is flexible because the meetings are open to everyone, not just to the members.

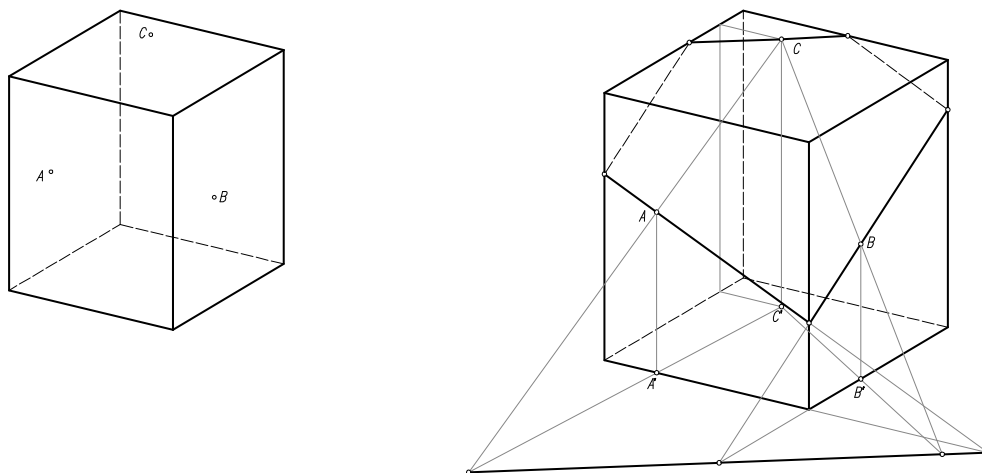


Figure 1: The Geometric Competition 2012: "Draw the intersection of the polyhedron with the plane ABC. Assume that the points ABC are located on the visible walls of the polyhedron"





Figure 2: The Geometric Competition 2011: “Draw the construction of the roof. Assume that the planes which rise from the eaves parallel to the longest side have twice the slope of the other planes”

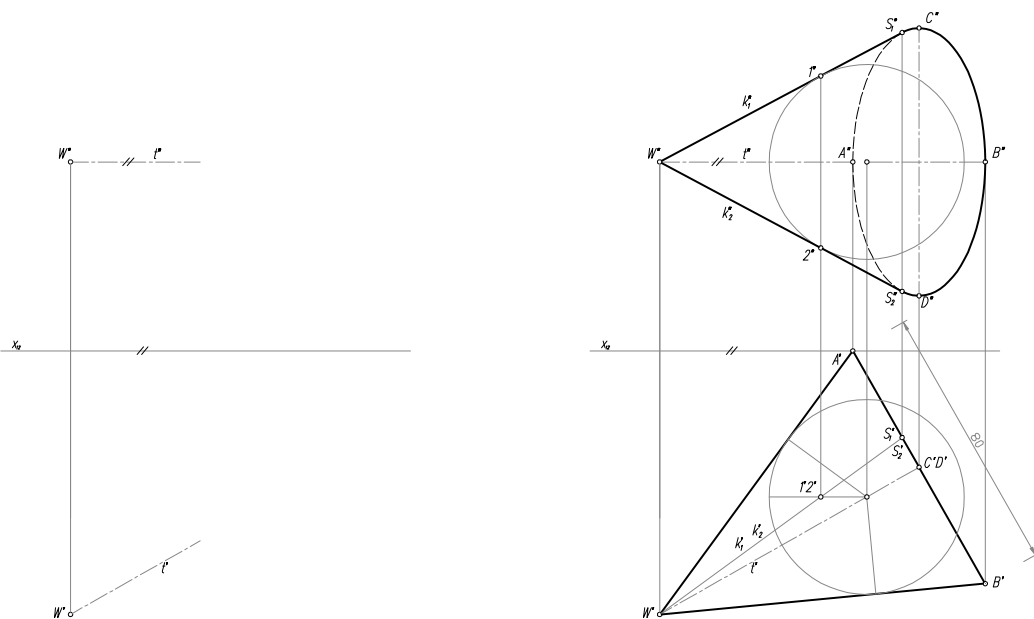


Figure 3: The Geometric Competition 2012: “Draw the right circular cone with the vertex  $W$  and the axis  $t$ . The base of the cone is a circle of 80 mm diameter tangent to the vertical projection plane”

During the first semester, the classes are primarily focused on developing a passion for geometry and they serve deepening the knowledge of traditional graphic techniques. The culmination of work is the annual Geometric Competition, during which the students are solving the tasks with a higher degree of difficulty (Fig.1, 2, 3). The best students are promoted and rewarded.

In the second term the students are solving the problems connected with spatial modelling. The results of their works are presented later during the Baltic Festival of Science which takes place at the end of May. One of the works prepared by the students from KRESKA is a set of geometric puzzles which is solved by the festival visitors (Fig.4). The role of the mentor is to assist the students in formulation of aims and means, so that the realisation of the project is achievable within limited resources and time. Therefore it is essential to adjust the scope and level of difficulty of problems, so that it is possible to reach the goal. Hence the given task should be concise and related to the subject matter; it must not contain too many unnecessary details. After finding a solution to the given problem the students are expected to practically apply the acquired knowledge. Accomplishment of such a

project is linked to the fast achievement of a success and prevents the students from the feeling of boredom or discouragement.

Modelling in CAD programs and concentration on the functions which are directly linked to specific geometric issues helps quickly receiving attractive results. Let us provide here as a good example the tasks on shadows and lighting of buildings, the problems that are usually omitted in a basic descriptive geometry course in the Civil Engineering Faculty. The students enjoy making models with application of materials and textures in order to provide a realistic visualisation of a designed or existing object. One of the group projects within the Scientific Society KRESKA was the model of a historic campus building which was exported to Google Earth database (Fig.5, 6). It has to be pointed out that the students are highly creative and willing to work hard on their research project. It undoubtedly helps that the students perceive a computer as an acquainted and natural learning tool.

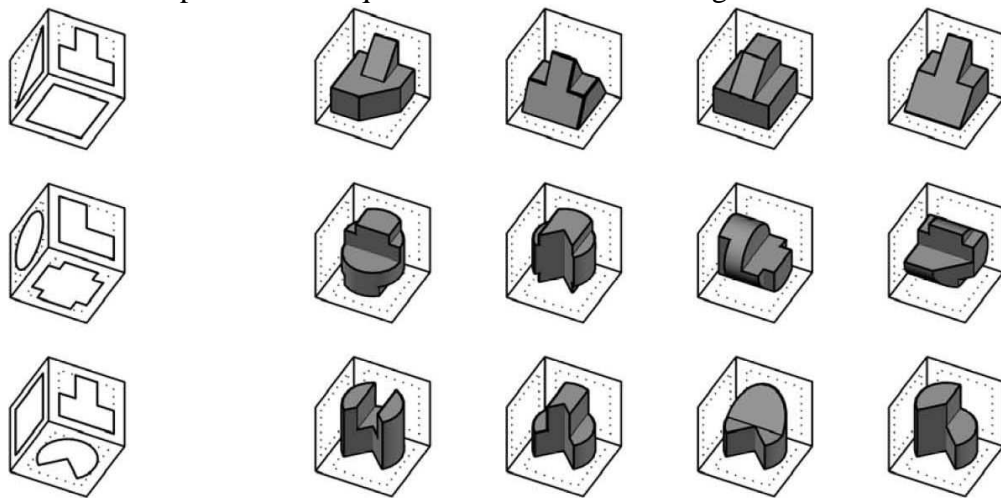


Figure 4: The example of geometric puzzles „Gymnastics imagination” prepared by the students from the Scientific Society KRESKA for the Baltic Festival of Science 2012. The task is to identify the solid which resulted from passing through the holes placed in three mutually perpendicular plates

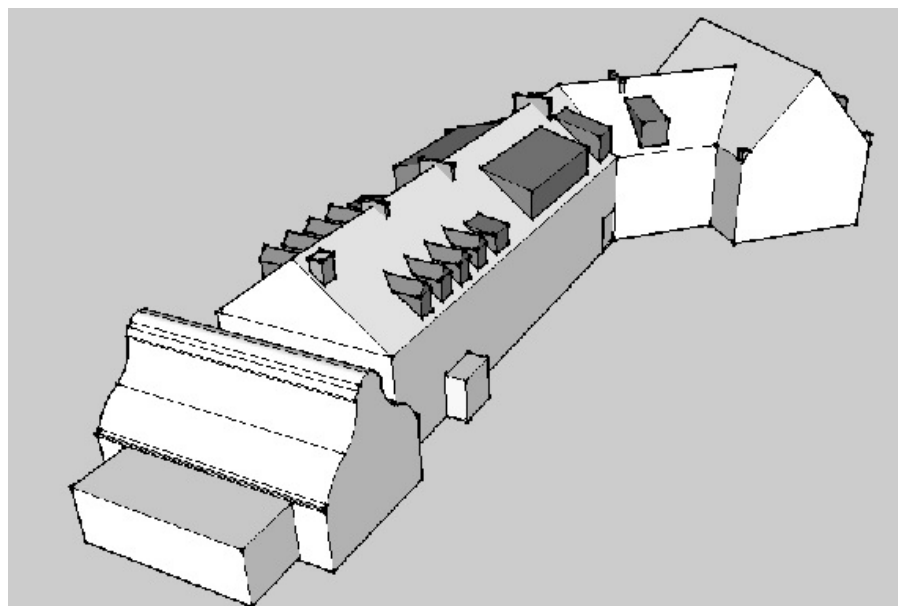


Figure 5: The model of a historic campus building, Gdansk University of Technology, Group Project of the Scientific Society KRESKA 2011



Figure 6: Rendered model of a historic campus building, Gdansk University of Technology. The model was published to Google Earth database. Group project of the Scientific Society KRESKA 2011

## 5 Conclusions

Based on the observations and a long-term teaching experience the author has a deep conviction that the presented in this publication style of work that has been applied during the courses on descriptive geometry and within the group of the Students` Scientific Society KRESKA enhances the levels of the students` self-motivation to take up a creative work. Although it has not been proved by any quantitative scientific research, the author dares claim that the methods applied during the courses have brought many positive results. The presented methods of work are subject to a number of limitations. It is also very difficult to widespread use such methodology due to the fact that there exist unsuitable conditions within collective education systems. The implementation may be difficult in the light of the limited availability of computer laboratories, and also, due to problems with hourly adjustments and timely scheduling. The work described here has been performed both by the students and the mentors outside the established timetable and thus it provided extra duty to both parties.

It seems, however, that the benefits of taking such challenges are significant and worth the effort. First of all, it involves a change in the perception of the usefulness and suitability of descriptive geometry by students. Secondly, working in a Scientific Society with the students is also very inspiring for the mentor especially in terms of new topics. Therefore, the author believes that this type of cooperation benefits both sides.

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## WYBRANE METODY WSPOMAGAJĄCE DYDAKTYKĘ GEOMETRII WYKREŚLNEJ

W artykule przedstawiono refleksje nad praktycznymi sposobami wspomagającymi procesy dydaktyczne w kontekście psychologicznej teorii uczenia się i motywacji. Działania takie podjęto w ramach Koła Naukowego Geometrii i Grafiki Inżynierskiej KRESKA, które od kilku lat działa przy Wydziale Inżynierii Lądowej i Środowiska Politechniki Gdańskiej

W ramach koła naukowego podejmowano różnorodne działania zmierzające do utworzenia przyjaznego środowiska uczenia się, w którym studenci mają możliwość wyboru form aktywności, stylu pracy, zakresu zagadnień. Pod dyskretnym okiem opiekuna naukowego studenci zdobywają i wykorzystują wiedzę geometryczną w praktycznym działaniu; organizują wystawy i konkursy, pracują w CAD, uczestniczą także w dydaktyce współprowadząc tutoriale, a nawet jako studenci wyższych semestrów zajęcia z geometrii wykreślnej na stanowisku asystenta-stażysty.

Chociaż opisywane działania odbywają się poza regularnymi ćwiczeniami, to pozytywne aspekty pracy w kole naukowym przenoszą się na salę zajęć. Między innymi, miarą sukcesu tych przedsięwzięć jest liczny udział studentów w dorocznej edycji Konkursu Geometrycznego organizowanego na koniec I semestru oraz prezentacja własnych projektów w czasie Bałtyckiego Festiwalu Nauki.