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PROBLEMS IN ENSURING CONTINUITY OF GRAPHICAL SKILLS BETWEEN EDUCATION LEVELS

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ABSTRACT

Core curriculum in mathematics in general upper secondary education includes an extensive insight in geometry. Authors of the article conclude that the initial level of geometrical and graphical background necessary for engineering graphics studies at the university does not correspond to learning outcomes set in the core curriculum of upper secondary education. Therefore, in order to save contact hours and to exclude repetition of matters to be taught at school, authors are offering a number of measures to improve the organisation of teaching process and teaching methodology in engineering graphics.

KEYWORDS: Engineering Graphics, Descriptive Geometry, Teaching Practice.

INTRODUCTION

Rapid changes in the society, also called „information boom", rejuvenation of technical area and development of new technologies set high requirements for the engineer's profession and education in general. Welfare of whole states and their citizens depends on the development of new technologies and their domestication. It would be no exaggeration to say that the engineer is the main figure in scientific technical progress [1].

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In order to tackle professional issues, the engineer needs the following skills:

- to develop geometrical (visual) models of technical objects,
- to analyse the possibilities to solve technical and technological tasks with geometrical methods and tools,
- to apply graphical methods in solving tasks by employing CAD programmes.

Geometrical-graphical background of engineers makes the basis of these skills. The basis of geometrical-graphical training consists of descriptive geometry, a comprehensive discipline, and this knowledge makes a fundamental basis for the studies of other engineering disciplines.

1. DEVELOPMENT OF GEOMETRICAL KNOWLEDGE AT UPPER SECONDARY SCHOOL

Studies of descriptive geometry may be successfully undertaken on the basis of knowledge of geometry acquired during upper secondary education. Core curriculum of general upper secondary education, notwithstanding mathematics (algebra and geometry) as the compulsory subject defined by the professionally-oriented upper secondary programme, sets out for these studies 4 lessons per week in each academic year of upper secondary education. On the whole, in three years time mathematics is taught for 420 academic hours, out of those 210 are allotted to algebra and 210 to geometry. Besides, 12th year pupils of the technically-oriented programme have a chance to choose additional 100 academic hours in mathematics (50 hours of those in geometry). Thus, altogether geometry in school is studied for 210 or 260 hours.

According to the results of a questionnaire made within the research, on subjects that cause difficulties for the pupils of 8th and 11th forms, geometry is among the three subjects mastered with most difficulty (Fig.1 and Fig. 2).

Answers of respondents show that the exact sciences - algebra and geometry - are considered as the most difficult subjects at school (53.8% and 53.6%, correspondingly).

Summary of results shows that in the view of 11th class pupils the most difficult subjects to master are physics (56.6%) and chemistry (54.2%), as well as geometry (47.4%) and algebra (40.8%).

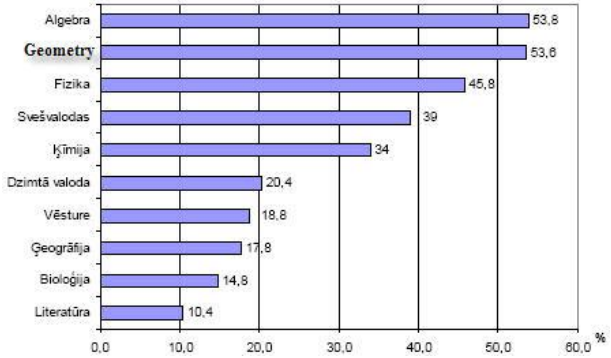


Fig. 1. Difficulties in acquiring various subjects in the view of 8th class pupils

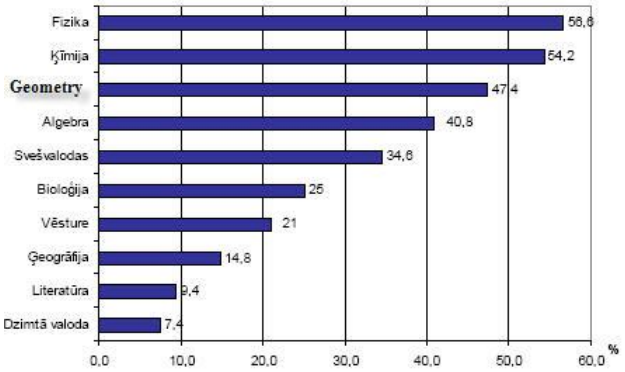


Fig. 2. Difficulties in acquiring various subjects in the view of 11th class pupils

2. MEASURES FOR ACTIVIZATION OF TEACHING PROCESS AT UNIVERSITY

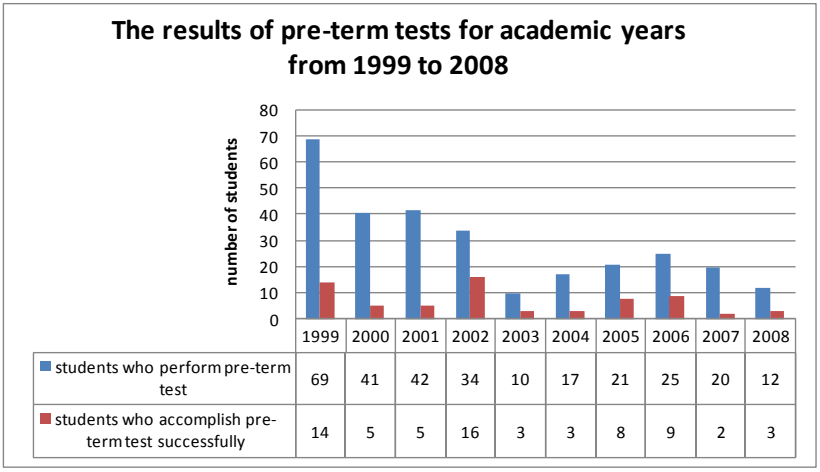
Knowledge acquired in geometry studies and geometrical imagination is necessary not only to engineering experts in design work but also to any expert in exact sciences. Studies of descriptive geometry and engineering graphics in Riga Technical University are directly related to geometry studies in upper secondary school.

In spite of the fact that the subject of geometry belongs to compulsory curriculum with a considerable number of academic hours, knowledge of geometry is insufficient. Geometrical-graphical skills of pupils are even

more weakened by the exclusion of technical drawing from compulsory curriculum. Students, who undertake studies at the university with an insufficiently trained spatial and geometrical imagination, face almost insurmountable difficulty in mastering engineering graphics. An insufficient spatial imagination is observed at 67-82% of first year students [3].

The level of geometrical-graphical preparedness of first year students is also characterised by a measure practiced in our department for several years successively, i.e. a pre-term test in engineering graphics. Only those students may participate who have a record on mastering of a course in descriptive geometry, technical graphics or technical drawing in the certificate of upper secondary education. The task in the test does not differ from the one set out in the university programme and contains two graphical works – a complex task in descriptive geometry and a detail drawing. Students who accomplish the tasks successfully (with the minimum mark of 6 points) are exempted from compulsory graphical works and presence in engineering graphics lessons till the end of semester.

The results of such tests summarised in the diagram (Fig. 3) show not only a decreasing number of participants, but also a decreasing success level.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
students who perform pre-term test	69	41	42	34	10	17	21	25	20	12
students who accomplish pre-term test successfully	14	5	5	16	3	3	8	9	2	3

Fig. 3. Results of pre-term tests for academic years from 1999 to 2008

Analysing psychological-pedagogical sources and carrying out surveys testify other reasons that, apart from the above-mentioned lack of knowledge, hinder a successful study process at the university:

- lack of motivation in relation to the choice of profession,
- essential differences between organising learning process at upper secondary school and at university creating a wrong impression on the ways of acquiring knowledge and its evaluation in first year students,
- inability to prepare for lessons independently resulting in about 25% of students who come to lessons unprepared, according to surveys,
- immature skills of independent learning, acquirement and analysis of information and making synopses of lectures.

One of components of geometrical-graphical education's pedagogical model is the principle of continuity in geometrical knowledge, i.e. relation of a previously acquired knowledge in geometry with the corresponding engineering graphics matters. One of the subjects in engineering graphics programme is "Sections of polyhedrons" that starts to be mastered with activating the previously mastered knowledge, separating the known matters from the ones to be learned (Table 1).

Table 1. Arrangement of themes for the subject "Sections of polyhedrons"

Matters that have to be known or repeated before the theme to be acquired in engineering graphics programme	Themes to be acquired in the higher education engineering graphics programme
Definition of polyhedron Types of polyhedrons Edges, faces, apexes of polyhedrons Depiction of polyhedrons in a graphical way Construction of point and straight line belonging to a polyhedron's face in the given figure Notion of a polyhedron's section by plane and its construction in the given figure Task for the repetition of course: to construct a section of quadrangle's prism with a plane given with three points belonging to edges	Cinematic method of creation of polyhedron faces Depiction of polyhedrons in a complex technical drawing Construction of point and straight line belonging to a polyhedron's face in a complex technical drawing Construction of a polyhedron's section by plane in a complex technical drawing

This is the list of matters for each of the programme's themes that students have to get familiar with before lessons in engineering graphics and repeat

previous teaching contents. This information is available to students in the portal ORTUS, e-studies system.

3. CONCLUSIONS

- The low level of students' success in descriptive geometry and engineering graphics may be explained by the fact that learning geometry causes difficulties for most pupils already in upper secondary school. The subject of technical graphics is included only in optional curriculum. Notwithstanding this situation, the department has taken certain measures in order to inform technical graphics teachers at schools on recent trends in teaching engineering graphics so that teachers and pupils were motivated to a more advanced approach to the studies of this subject at school.
- In the portal available for students one may find questions for repeating the school geometry course.
- The approach in organising engineering graphics lessons saves time in the beginning of lessons which would otherwise be spared for repeating school geometry matters.
- Preparing for the next lesson promotes the development of independent working skills, while questions for self-control provide an idea on the requirements for the contents to acquire.

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