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Topics

Theoretical geometry, exposed by synthetical or analytical methodology:

* Descriptive and constructive geometry
* Projective geometry
* Central projection, Perspective and Restitution
* Cartography
* Theory of Polyhedra
* Fractal geometry

Geometry and Graphics applied in Engineering and Architecture:

* Engineering graphics
* Computational geometry (algorithms, computer modeling of abstract geometrical objects, structures, procedures and operations)
* Computer Aided Design and Drafting; Geometric and Solid Modeling; Product Modeling; Image Synthesis; Pattern Recognition; Digital Image Processing; Graphics Standards; Scientific and Technical Visualization
* Kinematics Geometry and Mechanisms
* Applications of Polyhedra theory
* Fractals
* Computational restitution
* Stereoscopy and Stereography
* Virtual reality

Geometry applied in Visual Arts and Design:

* Theory and application of Visual Aesthetics
* Geometrical and mathematical criteria of Aesthetic values
* Perception and meaning of colors
* Geometrical forms applied in Visual Arts
* Optical illusions and its applications

History of Geometry:

* Famous scientist and their contribution
* Origin, derivation and development of particular geometrical branches
* History of geometrical education

Education and didactics:

* Descriptive Geometry and Graphics Education, including the Reform of Education
* Education Technology Research
* Multimedia Educational Software Development
* Virtual Reality Educational Systems
* Educational Software Development Tools Research and so on

SEMINARY PAPER AS AN ADDITIONAL TASK IN TEACHING DESCRIPTIVE GEOMETRY

Marija Obradović[89]
Magdalena Dimitrijević[90]
Slobodan Mišić[91]

RESUME

As a result of introducing Bologna process in education, classes of Descriptive geometry were reduced. In order to acquire such a complex matter as Descriptive geometry, it was necessary to provide an additional task as homework. After three years of experience in practicing classic additional supplementary problems, we made an attempt to innovate homework, following an idea to achieve creativity in appliance of Descriptive geometry knowledge in engineering practice. During the training classes, we recognized the students' problem of connecting abstract apprehensions and principles of Descriptive geometry with basic problems and tasks of engineering practice. Form of seminary paper was chosen as an appropriate one for handling the themes and method units of Descriptive geometry program. Each student, in a group of 30 students, had its own theme to elaborate in text interpretation and drawings, also recognizing (photos ...images) and presenting examples in real life (buildings or other examples in art, design or industry).

Key words: Descriptive Geometry, seminary paper, graphical appendix.

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1. THE STARTING ASSUMPTIONS

Experience in methods of teaching students, through exercises in classes and homework tasks, brought some conclusions useful for research and improvement of results in developing students' spatial perception abilities. The students have been doing their homework assignments satisfactorily, but their spatial perception was kept mainly at the level of 2D drawings. The students acquired the skills of drawing procedure, but at the exercises, in conversation with teaching assistant, there was an impression, considering formulation of their questions or the ways of setting an issue, that very few students really understood what does 2D drawing represents in space. The reason for this difficulty in accepting the "language" of Descriptive geometry (in further text - DG) and presenting 3D to 2D drawing, lies in several important facts :

Previous education: Most of the students have never had studied DG in previous education; graphic presentation of 3D space, understanding the projections (views) and its relations to a real 3D object were completely new way of visual communications.

Reduced lectures: Bologna reform process has reduced hours for lectures and exercises in DG, which led to some difficulties in accepting new and complex methods, significantly different from algebraic way of solving geometrical problems (used during previous education), because DG requests a direct, visual perception and graphic processing of problems, using drawings.

Lack of motivation: Despite the fact that 2D drawings are unique and international engineering "language", the emergence of new computer graphics software brought a belief among younger generations that classical presentation is anachronistic. The lack of motivation and inspiration influenced by a false belief (in group of subjects) that DG has "lost the race with the technology", due to inability of distinguishing the problems that DG resolves, from the current methodologies (technologies).

Economic factors: During the past 20 years, the teaching methods of DG in universities all over the world incorporated a large palette of graphic software solutions, suitable for different type of engineers, or unique DG software. AutoCAD with its numerous tools has the primacy in appliance.

Additional work is deemed necessary in order to motivate and encourage students to increase their interest in solving DG problems,

to get used to communicate using drawings, which is necessary skill for each civil engineer.

In the last three years, homework has shown a rather passive students' attitude towards the given tasks. Demands were fulfilled, but without the feedback of whether the task was understood and actually adopted, or not. The oral exam does not exist in the subject, for many years now.

1.1 The Segments of Elaboration

In order to get students acquainted with the procedures of studies (DG) and to prove that DG offers universal principles for solving different engineering problems, there was an idea to try, in two experimental generations of civil engineering students, to connect some segments of elaborating existing problem, in the form of seminary paper:

- To provide mental - visual connection of related topics (notions, elements, forms) and thus facilitate the adoption of unknown material, recognize examples from the engineering practice [1], the real environment, architecture, construction and even designing.
- To recognize abstract notions that DG deals with, in the concrete engineering practice through the application of its principles, analogies, methods, and geometric forms.
- Instead of form of an oral exam, for the first time students meet with the necessity to describe the subject of the drawing (touching an essential features of descriptive geometry- description), to use appropriate terms, and get motivated to use the literature[92].
- To give a response to a task (topic) using the appropriate drawings: one drawing has to be a solution of a DG task, similar to task on the training exercises, solved in the same manner and methods, using any available graphic tool; the other, supposed to represent a genuine solution of the problem in engineering practice, using the same DG methods, on a most elementary student's level.
- To provide an opportunity for the students to try and work in a computer graphics software (AutoCAD is recommended) to get

[92] It was observed that the students use literature less and less, even the basic one. A very small number of students, in general, have a DG textbook. Unfortunately, a large number of students pass the exam without reading it. Ignorance in terminology is high.

acquainted with a variety of the possibilities of facilitating a graphical representation of the tasks in subjects [3].

1.2 Basic Steps of the Curriculum

The basic idea was that, by producing seminary papers, students go through some elementary stages of adopting new material in terms of:

1. Studying
2. Reproducing
3. Exercising
4. Researching (examples and references in the available literature and on the internet)
5. Recognizing analogies (with familiar notions)
6. Solving the related problems independently;
7. Graphic presentation (adequately, with an academic approach, using modern electronic media opportunities).

1.3 Guidelines and Precautions

At the very beginning of the semester, each student has got the detailed guidelines for seminary paper, number and general names of the chapters with suggested contents included, as well as detailed instructions for each topic. It was suggested to reduce the scope of the paper to app.10 pages, in order to avoid the voluminous internet downloads, unnecessary for students' assignment level. Seminary paper was involved with 15% in the final score of the exam.

Aware that working at home carries certain risks of abuse; we did our best to minimize the possibility of "serial" production:

- Each student in the same group (average number of students in a group is 28) got a unique topic.
- The topics were grouped by similar subject and each of the 3 groups was reviewed by the same teaching assistant. In this way, one person had a full access to all the papers written on the same topic, and the possibility to take notice if identical papers appear.

2. THE EXPECTATIONS OF THE TASK

Long-standing practice has shown that the results vary depending on the motivation of students' personal engagement in

additional work. Individual differences affected the students' attitude towards the task and subsequent actions, as shown on the **Chart (1)**[93]. The same dedication and seriousness in approach from each student wasn't even expected. It differed from:

- Attitude towards the new procedures (for some students they represent a challenge and stimulus, while the others fear of the unknown)
- Working habits (vary from student to student)
- Level of previous education (important, especially in the field of Descriptive Geometry, but in the education in general, as well)
- Previous similar experiences (some students have already met with the form of seminar paperwork in high school)
- Participation in the exercises (independent work in school).

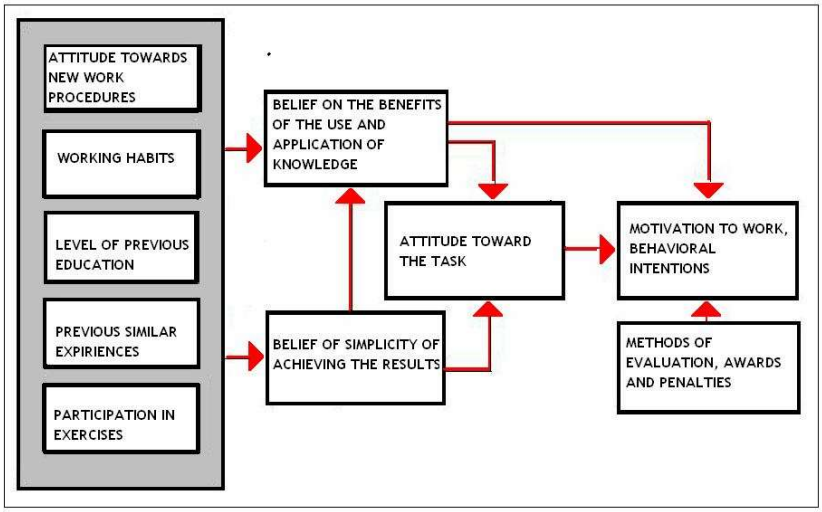

Chart 1: *Influences On Student's Motivation Towards The Task*

The set of all the previous characteristics would differently affect on students' motivation and engagement in achieving the task. If optimal, it would create a belief on the benefits of the usage and application of adopted knowledge, as well as the assurance about the simplicity of achieving results. Forms of evaluation, rewarding and

[93] Sample done by the study [1]

scoring this part of the pre-exam duties, further on, would take an influence on student's motivation to work and on the final results.

The simplicity of achieving task could be risk factor, as well as the challenge. The homework task bears the ability to be copied entirely, or even not to be authentic student's work. Regarding this, it was allowed to use the precise citation of references, in order to get students acquainted with the methodology of scientific research by citing sources. Therefore, students were encouraged to use literature, but with a remark that their interpretation was expected.

2.1. The Expected Positive Effects

Considering all the mentioned influences, we expected students to make an effort in:

- Detailed elaboration of the topic (to notice connections, applicability and permeation with some other topics and important principles in engineering in general)
- Research with deeper interest in one specific topic (through an interest for one specific topic to achieve an interest to DG itself)
- Updating and actualization of topics (through individual students' research)
- Writing some prominent papers – examples (to be a sample – „motivation guide" for the further generation of students - exhibited on bulletin board)
- Competitive spirit, creativity with elements of fun (within the best students, in order to exceed previous generations, became familiar to a subject through an actual form of media: internet, journals, etc., closer to younger generations)
- Achieving better results in the subject – DG (through an additional motivated effort).

2.2. The Expected Negative Effects

The form of the additional seminary paper allows some unwonted consequences like:

- The possibility of uncritical transcription (from the literature or internet media, in order to score the grades with minimum effort)

- Uncontrolled „help“ (of some experts or relatives including doing the hole paper)
- Misunderstanding of given instructions (hole topic or chapters)
- Attaching some inadequate examples or drawings

The important matter in balancing the positive and negative effects is the way of presenting the seminary paper method to students, itself. The guiding motivation impulse, interest and support, as well as the final manner of rewarding the students' efforts, which concerns the responsibility of all the participants in the teaching process, is also essential.

1. METHODS OF EVALUATION

In order to harmonize scoring criteria for all the topics, and to achieve consistent criteria for the teaching assistants, a model for evaluation was consisted of the following components:

1) **Summary** (description of contents)
2) **Introduction** (definitions, explanations of basic concepts related to the topic)
3) **The first drawing attachment** (task form the collection of tasks, performed in the manner and procedures applied on the similar tasks elaborated in the exercises)
4) **Examples** (picture attachments, photos from literature and other valuable sources, from the engineering practice: architecture, civil engineering, design, art ...etc., adequate to the related topics)
5) **The second drawing attachment** (original task that solves the problem of engineering practice)
6) **References** (all the citations from literature specified by authors or sources, internet addresses etc.)

Chart (2) represents the evaluation score in the listed components for all the students of generation 2009/10 who submitted the task in the first and the second exam term.

Legend:

Group 1 - represents topics related to: projections (orthogonal, oblique, axonometry) and polyhedra: Plato's and Archimedes solids.

Group 2 - represents topics related to: basic geometric solids and surfaces, conic sections, geometric surfaces (revolved, ruled and helical surfaces).

Group 3 - represents topics related to: construction of curved roads, inclined roads (on natural terrain or ideal terrain) and roof constructions.

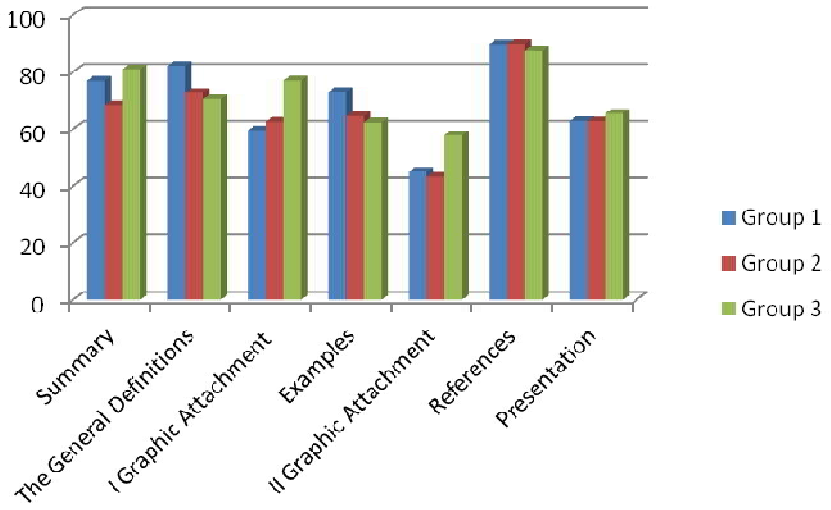

***Chart 2**: The scores in evaluation of separate components of task*

The best results, as shown in the chart, were achieved in the elaboration of general definitions to the related topics, as the passive approach - interpretation of literature or the other sources. On the other side, the worst results were in the creative part of task, in the original solution of some engineering problem.

Conclusions, regarding the results of research are:

- Student use passive interpretation of knowledge rather than creative[94].
- The First grade students are not yet familiar with problems concerning engineering practice.
- Some segments of lecturing should be modified, for the benefit of application in the engineering practice.

[94] Creative interpretation considered as an constructive, imaginative, adequate manner (not as artistic-expresed, like it would be expected from the students of Architecture).

- Second graphic attachment should be somewise differed in concept.

2. THE RESULTS, EFFECTS AND CONSEQUENCES

The final results, after evaluation of submitted papers, were in accordance with previous expectations.

Some minor percentage of students who didn't understood the structure of the task, attachments and examples, slightly let down our expectations. That is in relation to the fact that some students have rarely had an experience with a task that involves a personal and original approach to solving the concrete problem. The other cause was a lack of student's motivation or ambition to achieve some better grades, considering the fact that the score from the other pre-exam obligations was successful enough for some of them.

As an opposite case, a group of students had a different, serious approach and did their papers on the satisfactory level of elaboration. Their papers will be exhibited as the examples and the evidence of the contributions of some of the students who went a step further in their effort.

One of the side effects of this approach is a more direct contact of students and teaching assistants. In fact, students came more often to the consultations, asking constructive and creative questions, bringing their papers for the reviews, and actively participated in tasks. Therefore, more ambitious and hard working students have got some valuable knowledge and informations which will enrich their engineering education.

The final score – the average final grades in this subject in January and April terms for generations of students 2008 and 2009, compared to previous DG study program of generations 2006 and 2007 indicated some, but not significant change in the percentage of passing exam students, and the average score of grades (***Chart 3 and 4***).

This shows that students quickly adapt to new studying methods, and accept changes in the methodology well enough to give space to new ideas in teaching.

However, it also shows that statistics never reveal the true level of accepted knowledge, the criteria for evaluation, or number of exceptional individual achievements. The charts also show that the criteria for evaluating the students was preserved, as well as the average number of students who passed their exam in the first two terms, which can be considered positive, since the results in the previous generations were quite satisfactory, as well.

So, we can conclude that this new method did not affect significantly the final grade, but it certainly contributed to the widening of knowledge and perception of the need for DG applications in engineering.

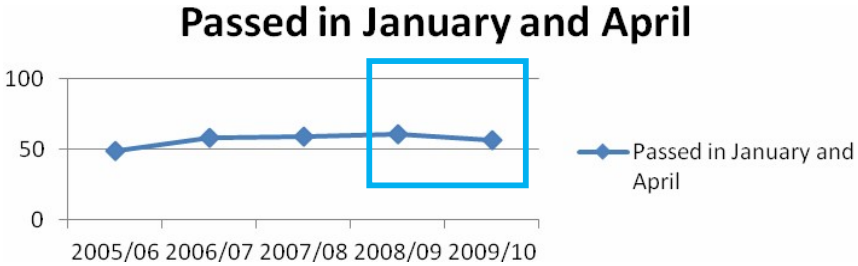

***Chart 3**: The Percentage Of Students That Have Passed The Exam In January And April, Through Five Generation Of Bologna Process, The Last Two Of Which Have Had The Seminary Paper As The Additional Task*

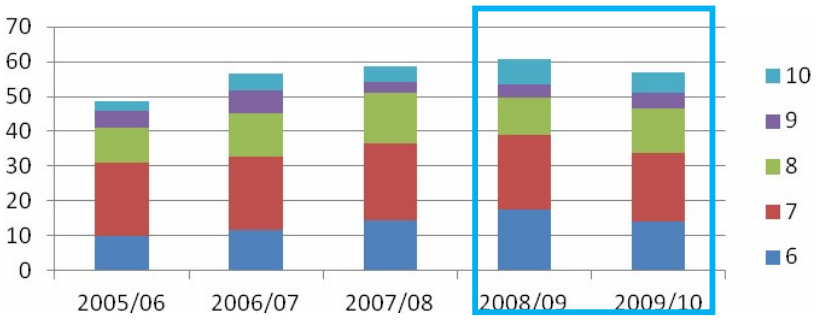

***Chart 4**: Students' Results through the Five Generations, the Last Two of Which Have Had the Seminary Paper as the Additional Task*

It is obvious that this kind of a task took additional time and more engagement of the teaching assistants in guidelines and directions, consulting, and reviewing. Their motivation for this kind of effort was in the new dynamism and interest, accomplished in closer interaction to the students' thinking and individuality in solving the problems, instead of classical routine of dealing with the established kind of tasks, from year to year.

3. CONCLUSIONS

Seminary paper, as an additional homework task, made some evident changes in long practice of classical teaching methods.

Results, after two experimental generations of students suggest:

- The students are capable to give an adequate answer to the given task.
- Motivation level was satisfactory, even higher than expected, in the group of the best students.
- The final grades do not lag behind the previous generations, despite of more complex and more difficult task.
- The students generally coped better with the tasks that required application of procedures, then the ones that required active thinking and application of knowledge.

These conclusions open some new ideas for further research and a motivation to improve some segments of a task.

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