

Possibilities of Developing Creativity through the Study Subject of Geometric Modelling: Students' Point of View

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Abstract- *The article is based on an interdisciplinary approach that incorporates research on education and a study subject. An interdisciplinary approach is extremely important in modern higher education when the same object is studied in the context of two or more subjects. It is also the field of engineering education that is currently highly relevant for universities with a technical profile. Lecturers of the subject should consider not only the content of the study subject but also the didactics of higher education and general competences, including creativity competence, which is perceived as a necessity in the workplace of the 21st century. Therefore, the aim of the article is to analyse the possibilities of creativity through the study subject of Geometric Modelling from the point of view of students. This study subject was chosen deliberately since students are learning to work with AutoCad and Blender software. Their goals are to create 3D models, model them, and visualise them. The article discusses the case of the study subject of Geometric Modelling delivered at VILNIUS TECH. Quantitative research was used, involving a survey of first-year students, which included 93 participants from the Multimedia and Computer Design study programme. To explore the competence of creativity, the areas of exploration, generation, creation, and evaluation were identified. Although most students believe that the study subject fosters creative thinking, they do not always perceive the analysed topics or assigned tasks as contributing to their creativity. They treat it more as the ability to learn how to work with the program and master its functions. It appears that this is influenced not only by the specifics of the study programme and the study subject, but also by the nature of first-year studies. The findings further highlight the importance of expanding the interdisciplinary approach in higher education institutions.*

Keywords- *competence of creativity, Geometric modeling, AutoCad, Blender, engineering education, didactics of higher education.*

I. INTRODUCTION

In today's fast-paced technological context, creative thinking skills are becoming essential skills that enable students and graduates to adapt to new challenges and innovations in any sector of the labour market. The ability to find new solutions, to improve, develop, and visualise complex models encourages students to think outside the traditional box and to continuously search for new solutions. Creativity is gaining more and more attention as technology is penetrating into different areas of life and even changing some of the functions of human work. According to recent international surveys, creativity can be defined as "the competence to engage productively in the generation, evaluation and improvement of ideas, that can result in original and effective solutions, advances in knowledge and impactful expressions of imagination" [1].

Geometric modelling (GM) has become an interesting and important branch of engineering in recent decades. Its theories are mainly related to mathematics and computer science, and its applications are diverse: industrial design, computer graphics and animation, CAD/CAM, architecture, and others. Different programs are used in GM studies nowadays: Blender, Autodesk 3ds Max, Autodesk Maya, SketchUp, Zbrush and others. Depending on the field of study and the intended learning outcomes, universities decide on their choice individually. VILNIUS TECH currently uses Blender and Autodesk AutoCAD computer programs for GM in the study programme "Multimedia and Computer Aided Design". It is expected that by using these programs students will be able to create innovative, safe and aesthetically pleasing products that will meet the needs of the market today and promote sustainable technological development.

Geometric modelling is an essential component of multimedia and computer-aided design, as it allows the

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creation and manipulation of three-dimensional shapes and objects. One of the most important aspects is the creation of detailed and realistic objects that can be used in a wide range of applications, from animation to architecture. For example, the modelling of trees has been widely explored in computer graphics. Recent improvements in high-resolution sensors and data processing techniques make it possible to collect 3D datasets of real trees and create increasingly realistic branch structures [2]. A geometry-aware image compositing process has been developed to create new urban self-driving scenarios by augmenting existing images with dynamic objects from other scenes [3]. Realistic human head avatars are created from a single photo [4] using an RGB-D selfie camera [5], based on specific personal characteristics [6], and detailed 3D models of people are generated with different clothing and corresponding skin weights [7]. In game development, GM is used for creation of interactive environments and characters that react to player actions. A new method has been developed to rapidly simplify 3D geometric models in digital twin-based manufacturing systems, reducing the complexity of the model data, speeding up rendering and ensuring fast interaction of the digital twin with the physical manufacturing system, resulting in a low-latency visual effect [8].

II. MATERIALS AND METHODS

Data were collected through an analysis of the scientific literature and a quantitative research approach using written surveys. The survey targeted first-year Multimedia and Computer Design students at VILNIUS TECH and was conducted in May 2024. The 1st course consists of 3 groups of Lithuanian students and 1 international student. The questionnaires were distributed to 105 first-year students and 93 responses were received. Students study the GM study subject for one semester. The acquired knowledge and abilities are the basis for learning subjects in higher courses. Therefore, the research aims to analyse the possibilities of creativity from the students' perspective through the study subject of Geometric Modelling. In this course, it was decided to use only two programs: Blender and AutoCAD. Blender is focused on creative and artistic modeling and only surface objects are created in it. AutoCAD knowledge provides additional tools for technical and precise modeling when preparing objects for 3D printing. The main goal of GM is the ability to model precise three-dimensional objects using the aforementioned software. The study is longitudinal and continues in the higher course, where the focus is on the variety and complexity of tasks in order to develop students' creativity.

III. RESULTS AND DISCUSSION

Regarding the creativity fostered by the course of GM, the first thing analysed was the students' attitude towards whether the content and tasks of the study subject foster creativity (Fig. 1). The results show that as many as 75% of students confidently state that this subject encourages their creativity. This attitude is revealed and elaborated in the following questions. There were no respondents who

pointed out that the subject stimulates creativity little or not at all. This result directly reflects the focus of the course content and the tasks on the development of creativity in engineering studies.

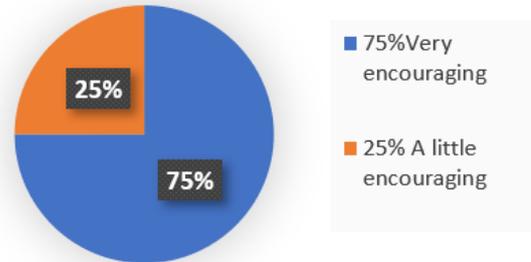


Fig. 1. Development of creativity in the study subject of Geometric Modelling.

Creativity competence is developed through four interrelated components, which can be flexibly applied in a variety of creativity-enhancing study methods or just used as steps in a task:

research (identifying problems and creative opportunities, gathering, connecting, and critically evaluating information necessary for creativity);

idea generation (conceiving and proposing ideas, selecting those significant for oneself and others, and considering them from various perspectives);

creation (acting ethically and independently, embracing risk and mistakes, using creative methods and tools flexibly, and refining, presenting, and sharing creative outcomes);

evaluation of creative ideas that are significant to oneself and others (assessing and reflecting on the novelty, value, and creative process of the product/solution).

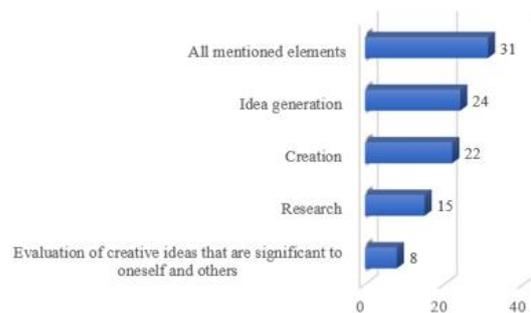


Fig. 2. Elements of creativity in the understanding of students.

It is important to identify the students' perception of the dimensions they attribute to creativity competence (Fig. 2) and the dimensions of creativity they apply in the GM subject (Fig. 3). An analysis of the answers shows that the results of both questions highly correlate with each other. The students' attitudes on two items are in full agreement. Firstly, as many as 31% of the students say that all the items identified belong to the creativity competence (Fig. 2) and that they all are applicable to the study subject of GM (Fig. 3.). Secondly, there is complete agreement (8%) on the last element of creativity, which concerns the evaluation of

creative ideas that are significant for oneself and others. This result is worth paying attention to and thinking about what could improve the results. The GM lecturer should point out that much more attention should be paid to the discussion and reflection on the completed tasks. The assessment part is important for creativity competence, as reflecting on one's own performance and evaluating the work of others encourages students to develop creativity competence by explaining the value of the task or solution to oneself and to others, making comparisons, and suggesting what could be done differently or improved. In this way, the result can acquire other forms or be related to interdisciplinary contexts.

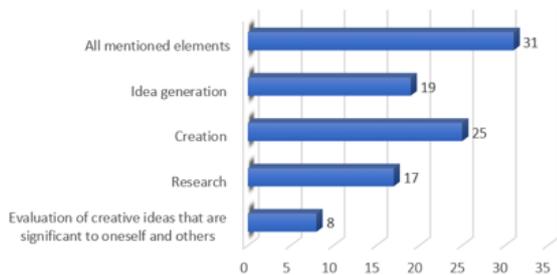


Fig. 3. Elements of creativity applied in the study subject of GM.

Another difference between the perception of creativity by the students (Fig. 2) and the application of creativity in the study subject of GM (Fig. 3) should be noted. A 5% difference can be seen when students assess the component of idea generation. This could be explained by the fact that students receive their tasks from a lecturer who has planned the study process and is working towards the set outcomes of the study subject. The variety or differentiation in the presentation of tasks could probably be considered. The lecturer could vary and, depending on the learning outcomes of the course, could allow/suggest that students come up with the idea of the task, work it out and achieve the result. Without the idea generation phase, students lose the opportunity to develop their creativity competence.

After clarifying students' attitudes and perceptions about the structure of creativity competence, it is important to know how students feel about each task they are given. Students were asked to rate 6 tasks on a scale from 1 (definitely not) to 5 (definitely yes).

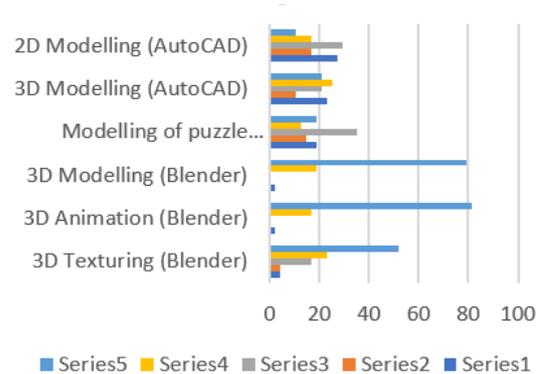


Fig. 4. Level of creativity of GM tasks (students' views) (rate from 1 (definitely not) to 5 (definitely yes).

The creativity of students is highly stimulated by GM, as confirmed by other researchers. In architecture and engineering, for example, geometric modelling enables the creation of accurate and detailed visualisations of buildings and other structures, which help to better understand and plan projects. Banfi [9] discusses how buildings have evolved from being physical objects to digital expressions, where not only their structure but also the information related to them is important. The interactive geo-information three-dimensional model developed by Ahmad et al [10] includes the creation of a digital terrain model and three-dimensional spatial object models, determines the quality of the provided cartographic material, and shapes the development methodology. It also allows for the efficient creation and editing of complex objects, saving time and resources, and the production of appropriate visualisations. For example, low-cost modelling techniques are essential and widely needed for heritage conservation, especially in poorer countries [11]. Xu et al. [12] proposes to create and visualise three-dimensional models using the 3D Tiles data format and WebGL technology. These models help to accurately represent the geometric properties of buildings and other objects and users are able to interactively view and analyse the data in an online environment. This is particularly important for digital construction and efficient project management. Zheng et al. [13] offer a new dataset using professional interior designs and automatically extracting 3D structures. It provides large-scale photorealistic images with rich annotations of 3D structures. The researchers present a generative model that directly generates 3D textured mesh structures with complex topology, rich geometric details and high-quality textures [14].

GM is used in a wide range of industry sectors such as animation, architecture, game development and industrial design. In film and animated series, geometric modelling facilitates the creation of complex characters and environments that appear lifelike and realistic [15].

Two programs, Blender and AutoCAD, are used in the course of GM at VILNIUS TECH. Both give students the opportunity to experiment with different design and model making techniques. Blender and AutoCAD are excellent training programs due to their popularity and a wide range

of applications. AutoCAD is used in the fields of architecture, engineering, and construction, known for its accuracy and ability to create detailed technical drawings. It is also particularly useful for 3D printing, as it facilitates easy editing and optimisation of models to ensure that the final products are of high quality and accuracy. It integrates easily with other Autodesk applications, allowing for a seamless transition from design to production. Meanwhile, Blender makes the creation of more complex 3D models and animations possible, which encourages students to try out new ideas and techniques. Using these applications together, a high level of creativity and technical accuracy can be achieved, which is very valuable in various projects.

However, students' attitudes towards the tasks performed with the software vary (Fig. 4). The 2D Modelling (AutoCAD) task is ranked as the least creativity-enhancing one (5 - 10.4%; 4 - 16.7%). This can be explained by the fact that when students learn precise drawing and editing commands in this program, they do not realise where they can apply it. This can also be linked to the Generation Z trait, where students aim for the fastest possible result with little effort, and associate the purpose of their learning with the benefits they receive. Thus, this result also inspires the lecturer to modify/think about other or more varied processes for the content and delivery of the 2D Modelling (AutoCAD) assignment. Analysing the results further, it can be seen that the Task of Modelling of Puzzle Parts (AutoCAD) is also rated as not very creative (5 - 18.8%; 4 - 12.5%). This is probably also related to the development of specific skills rather than creativity. Of the AutoCAD programmes, only Task of 3D Modelling (AutoCAD) is rated by students as the most conducive to creative thinking (5 - 20.8%; 4 - 25%). It could be argued that AutoCAD tasks are considered by students to be less creative than Blender. The results of the study clearly show that tasks with Blender are significantly more creative: tasks of 3D Animation (Blender) (5 - 81.2%; 4 - 16.7%), 3D Modelling (Blender) (5 - 79.2%; 4 - 18.8%), and 3D Texturing (Blender) (5 - 52.1%; 4 - 22.9%).

Researching students' views on the creativity of tasks would also require knowledge of their relationship to the content of the study subject of GM. Students were asked to rate which topics develop their creativity (Table 1. 1st column). The authors of the article established the links between the topics and the tasks that realise them. The analysis of the results shows that the highest-rated topics are also those in which students specifically use Blender software. These findings are valuable, as they provide insight for adjusting and refining the relevance of the task and intended learning outcomes. On the other hand, the results indicate that the GM course develops diverse competencies due to the variety of tasks used.

TABLE 1. LINKS BETWEEN GEOMETRIC MODELLING (GM) TOPICS AND TASKS

Topics	Tasks
Development and animation of 3D model control systems, surface deformations and visualization.	3D Modelling (Blender) 3D Texturing (Blender)

Topics	Tasks
Model preparation for different environments (18%)	
Creation of free-form geometric surface objects using typical object modelling methodologies (polygons, subdivision surfaces, Metaball). Topology of objects (14%)	3D Modelling (Blender) 3D Texturing (Blender) 3D Animation (Blender)
UV Maps and Texturing. Creating materials for 3D models using texture maps (Diffuse, Normal, Specular, AO, Bump, Roughness, Displacement) (11%)	3D Texturing (Blender)
Creating objects of complex geometric shapes. Applying Bezier curves and NURBS (11%)	3D Modelling (Blender) 3D Animation (Blender)
Precise 3D modelling. Creation of volumetric objects (10%)	3D Modelling (AutoCAD)
Introduction to modelling of three-dimensional geometric objects. Blender user interface. 3D object data structure (7%)	3D Modelling (Blender)
Modelling in AutoCAD (7%).	2D Modelling (AutoCAD)
Application of Boolean operations to model creation. Modifiers (7%)	3D Modelling (Blender) 3D Modelling (AutoCAD)
Preparation of 3D models for 3D printing (5%)	3D Modelling (AutoCAD)
Application of Boolean operations to object creation. Collisions and tolerances of 3D part arrays (4%)	3D Modelling (AutoCAD) Modelling of puzzle parts (AutoCAD)

To form a final opinion on creativity development through the GM course, students were asked the following question: *Do you agree that after completing Geometric Modelling (GM) you will be able to...?* They were presented with 10 abilities corresponding to three different levels of Bloom's taxonomy: understanding, application, and evaluation/creation.

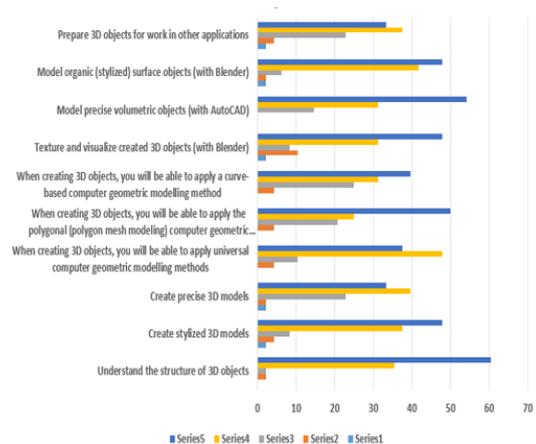


Fig. 5. Abilities that will be developed through the subject of GM (student opinion) (mark from 1 (definitely not) to 5 (definitely yes)).

The results show that students chose the ability "Understand the structure of 3D objects" as the most developed (5 - 60.4%; 4 - 35.4%). The next result is also surprising. The second most developed ability was "Model

precise volumetric objects (with AutoCAD)" (5 - 54.2%; 4 - 31.2%). The paradox is that earlier (Fig. 4) students marked this task as the one least likely to develop creative thinking. It can be assumed that students learn better those tasks which are precise, which are shown and explained by the lecturer in a clear manner, which do not require creative abilities (the level of understanding is sufficient) and the time to complete them. The ability "Prepare 3D objects for work in other applications" scored the lowest percentage (5 - 33.3%; 4 - 37.5%). This ability is associated with interdisciplinarity and a wider context. Thus, there is a trend that creativity education in engineering disciplines requires a different approach, which would be helped by a consistent adherence to the creativity education strands, in particular assessment and reflection on task performance.

IV. CONCLUSIONS

Students consider the study subject of GM, i.e. its content and tasks, to be a real stimulus to the development of their creativity competence. This was underlined by most of the students (75%). However, a few important points can be made when elaborating on this broad view.

Firstly, creativity is not so much inspired by the topics and the objectives of the tasks, but rather by the way in which students pursue these objectives. Attention should not only be paid to the content of the topics and tasks, but to the teaching/learning process itself. Students should be allowed to generate their own ideas about how they will achieve the outcome of the task more often. In particular, the assessment of creativity should be addressed, and students should be provided with opportunities to evaluate their peers' work more and reflect on their own results. The role of the lecturer is therefore very important in the GM subject. Although the lecturers have to work with the computer programs provided to them to teach the content of the subject (i.e. the content of the tasks), they should reinforce and organise the learning process in accordance with the four stages of creativity development. It is also very important that this process of creativity development is consolidated from the first year of studies. This would allow students to continue to develop this competence in the upper years. The researcher [16] encourages the integration of creativity in an interdisciplinary teaching and learning environment, so that students learn and have access to different perspectives. The development of creativity through the integration of creativity into subject competences is a prerequisite for future professionals in the exact sciences, as the development of innovation depends on the abilities they develop. As researchers [17, 18] argue, creativity is the basis for innovation.

Secondly, tasks that are carried out in Blender are perceived by the students as being more conducive to creativity compared to AutoCad. Although it requires more precision and focus, the current generation of Z students should be taught to emphasise its benefits and to show the different products that have been developed using it. In this way, students will see the relevance of the application. Combining both programs in GM is necessary as students have to acquire subject-specific knowledge. However, by

developing creativity competence, they will learn to use subject knowledge to develop innovations or improve what has already been developed. With the aim of exploring how the variety and complexity of subject-specific tasks determine creativity, the study is currently being continued with other groups.

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