

ERASMUS PROJECT VIRSTEM INTERACTIVE TOOLS FOR EDUCATION

Edgaras Timinskas¹, Daiva Makuteniene¹, & Olga Ovtšarenko²

¹*Department of Engineering Graphics, Faculty of Fundamental Sciences, Vilnius Gediminas Technical University (Lithuania)*

²*Center for Sciences, TTK University of Applied Sciences (Estonia)*

Abstract

In a modern education, the use of modern technologies is dictated by the time requirement to provide all spheres of life with competent specialists.

This article provides an overview of the first year of the project work of an international team consisting of teachers and researchers, software developers and modelers - specialists in BIM environment from different countries of the Baltic region, which was devoted to finding opportunities to improve the efficiency of teaching technical disciplines, integrating modern technological disciplines and virtual and augmented reality solutions with using the best traditional teaching methods, developing new approaches in educational and methodological work.

To create a modern learning environment and support the independent work of students of construction specialties in an open online course "Basic Engineering Graphics", interactive teaching material with visualization and integration of BIM is used: simulators of digital objects, interactive exercises, and tests. The free online course is designed for undergraduate students of construction specialties, both full-time and part-time studies, as well as for the professional development of specialists.

Involving the student in an active educational process to gain new knowledge is a priority to ensure the effectiveness of independent distance learning.

The statistical data presented in the article provide interesting material for analyzing the effectiveness of teaching methods, demonstrate the need to change the approach to using traditional teaching methods, and integrate virtual technologies with the best traditional methods of technical teaching.

The use of interactive objects, feedback with recommendations for further progress cannot fully replace the teacher and mentor but helps the student to plan their learning and is a very effective preparation for the next stage of learning.

Keywords: *Interactive learning, visualization, virtual reality, BIM, engineering graphics.*

1. Introduction

Strategic international partnership in the field of education is very important for improving the quality, unification, and harmonization of education.

The digital age provides an opportunity to work in a national, European, and international environment. Transnational cooperation of educational institutions allows not only to find and discuss technological solutions and methods in education, but also to analyze the process and clarify the needs of the industry, taking into account the practical experience of each country of the partner organization.

The international project VirSTEM Virtual technology for use in STEM (Science, Technology, Engineering, Mathematics) was developed and is being implemented to create an open electronic course Basic Engineering Graphics for independent work of first-year students of construction and architectural specialties.

The project partners are teachers from technical universities in the Baltic region. The exchange of best educational methods and materials helps to improve the quality of education in the educational institution of each partner. The collaboration of teachers from different countries is a powerful generator of innovative ideas and the creation of original solutions needed to create an innovative online course with interactive learning material.

International success lies in the fact that each partner brings knowledge from the point of view of their national context, approaches and experience, which ensures not only the exchange of the best successful and proven teaching methods and practical training materials but also the generation of new innovative ideas that are not found in ordinary academic days (Ovtšarenko, 2020).

2. Background

Skilled training requirements to address today's building challenges such as environmental and climate change are determined by the industry's expectations for innovation and production, as the goal of civil engineering is to develop the basic infrastructure that society needs: assessment, planning, design, construction, operation, and infrastructure services.

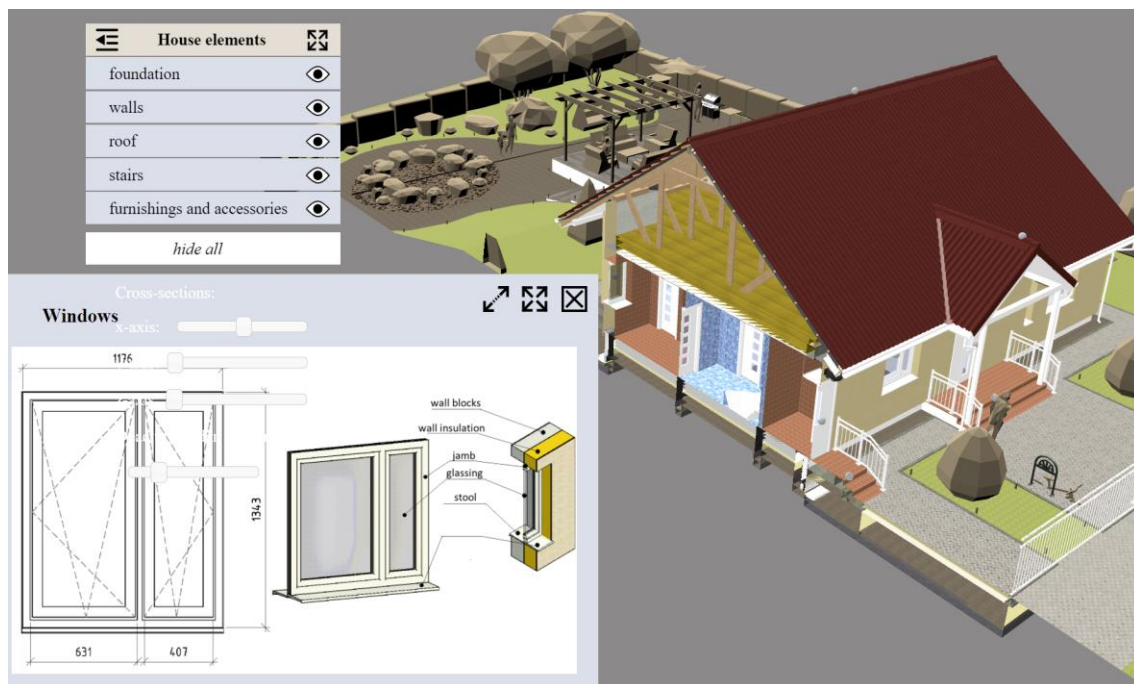
Spatial visualization skills are considered essential for various professions. Several studies have proven that 3D design software has a positive effect on students' spatial abilities. And also the BIM software supports 3D design (Pulido-Arcas, J.-A., 2021).

For students lacking field experience, visualizing the construction processes and thus making informed decisions is difficult.

Field trips, while valuable, are difficult to plan due to cost, safety, and time limitations. Creating 3D VR models and immersing students in that virtual world could provide an engaging and meaningful experience to both building science and architecture students (Salman, 2020).

The use of interactive objects in teaching allows the student to independently plan not only the time for classes, choose a place, but also independently evaluate the results achieved and choose the next step to consolidate the acquired knowledge and acquire new ones. Such an individual way of learning is very effective in providing the student with modern educational material using simulations, interactive tests, and feedback with recommendations. As part of the international project B, interactive educational materials are created, tested in the educational institutions of the project partners and improved in accordance with student feedback (Figure 1).

Figure 1. The house simulator in VirSTEM.



3. Objectives

The goal of the project VirSTEM - Virtual technology for use in STEM (Science, Technology, Engineering, Mathematics) is to create an international freely available educational resource - an online course "Basic Engineering Graphics" (3 ECTS) which innovatively integrates BIM (Building Information Modeling). The course will be designed for Bachelor-level engineering students of construction specialties, both daily and distance learners, as well as in-service training of specialists. Requirements of qualified preparation for solving today's construction problems, such as changes in the environment and

climate, due to industry expectations regarding innovation and production, since Civil Engineering goals are the development of the main infrastructure needed for society: the assessment, planning, design, construction, operation and maintenance of infrastructural works (Hjelseth, 2015).

Modern technologies that are developing in the construction industry are based heavily on BIM and require significant changes in the education of engineers. Monitoring of construction courses indicated lack of modern teaching materials with the integration of BIM objects and with interactive learning materials that would include 3D objects' simulators (Safiulina & all., 2020).

Moreover, considering the current global situation of physical distance, a new approach to the education of specialists is necessary, in which the leading role will be given to distance and independent learning using high-quality interactive learning materials.

The "Basic Engineering Graphics" course will consist of interactive learning material to get acquainted with BIM programs, to acquire practical skills in computer and engineering graphics, and modeling, and provide a better-fitted workforce for enterprises.

The course consists of related thematic modules, includes simulations of three-dimensional objects, short video guides, interactive exercises for students' study and practice, tests, and innovative intelligent rating system with feedback and certification.

The VirSTEM project is carried out by the team of five well-known higher education institutions that teach engineering in the countries around the Baltic Sea, TTK UAS Estonia, VGTU Lithuania, RTU Latvia, TAMK UAS, and Metropolia UAS Finland. These universities have long-term successful partnerships in the field of civil engineering in teaching construction specialties. Project teams consist of experienced teachers who are highly skilled experts in the field of BIM modeling with very valuable practical experience as well as good project management skills (Makuteniene & all, 2020).

4. Methods

The integration of BIM technology allows the use of a virtual environment for learning, which ensures increased involvement and motivation of students. The learning process can be described as "learning by doing", which is often difficult to implement in traditional lectures, and even more so in the student's self-study. In a virtual environment, it is possible to implement such tasks as navigation, selection, and manipulation of objects (Pulido-Arcas & all, 2021).

The use of educational material of the e-course in learning various STEM subjects enables linking of a piece of parametric information about the studied objects and provides a solid basis for engineering education. The online course is very efficient due to its simplicity, cost-effectiveness, and form of the game.

As described by scientists (Wong, Kwan, 2021) student readiness contributes to gains in game-based learning environments, informing the factors affecting the implementation of the game-based approach. Some gaming features are in the VirSTEM application together with theoretical parts and tests.


Mobile learning expands the scope of distance learning by providing access to quality content regardless of the time and place of training - so the course will reduce the need for teaching in the classroom (Martín-Gutiérrez, 2017).

Engineering thinking should ensure the use of acquired knowledge to solve practical problems that were or were not taken into account during student training. In other words, the engineer must be able to apply all the knowledge gained and find the optimal solution for a standard or non-standard task, which means processing the initial data about the object, creating and regulating the relationships between the parameters of the object or between objects, or between the object and the environment.

The innovation of the VirSTEM project is to introduce BIM technology already into the first-year subjects of bachelor level engineering studies. The project plans to create and use simulations of three-dimensional objects both for an interactive course in engineering graphics and for other basic engineering courses.

The simultaneous use of a three-dimensional model of an object in the study of basic technical subjects with BIM integration is innovative and will enhance interdisciplinary communication, ensure a better understanding of goals, and enable the use of objects for various purposes in various conditions. For interactive exercises on the web page of the e-course, the built-in three-dimensional objects Geogebra, Revit are used (Figure 2).

Figure 2. The integration of BIM into the subject of basic engineering graphics. Wall part of the house and model-interactive exercise.



1. Use the house part for measures getting:

the window height from the floor

the height of the window

the height from the floor to ceiling

the roof angle degree

2. Use the house wall layers for measures getting:

the height of the wall block

the wight of the wall block

the insulation thickness

3. Use the house floor and foundation layers for measures getting:

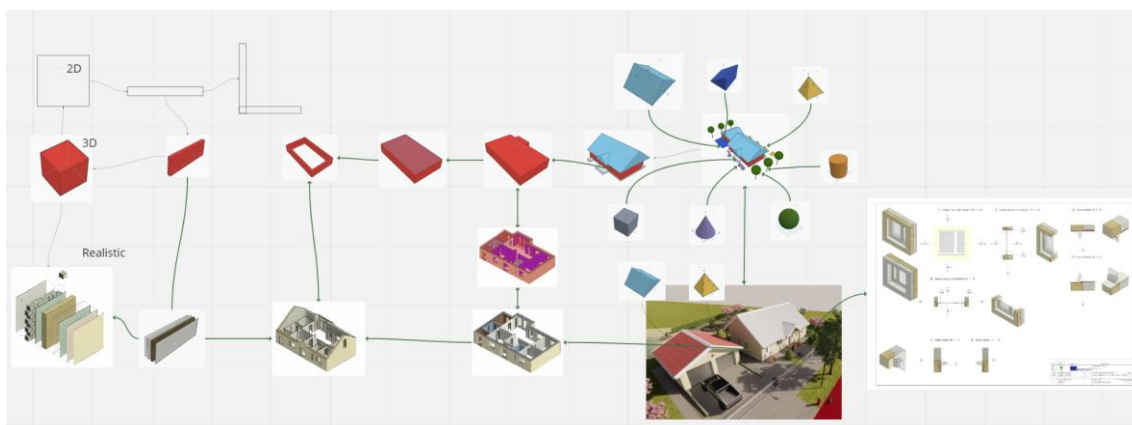
concrete layer thickness

Engineering thinking skills are acquired in an interactive playful way, providing a fundamental basis for target groups for future BIM technology use, for training to support creative thinking in everyday work, and for developing the potential for innovation.

The project partners are working to create a free online course "Basic Engineering Graphics" with BIM integration - 80 hours (3 ECTS) for bachelor students of construction/ architectural specialties self-work, with an interactive learning material, which includes simulations of three-dimensional objects, interactive exercises, and tests. This course goal is to eliminate the need for classroom teaching of the introductory part of the subject of Engineering Graphics and plans to be used for further training BIM programs use and the acquisition of practical skills for computer drawing and modeling.

The e-course consists of thematic modules, logically interconnected, providing a step-by-step study of the course of engineering graphics, the possibility to use objects and the contents of a specific module in the study of mathematics and physics to link, parameterize and clarify information of the same object (Figure 3).

Figure 3. The structure of integration of BIM into the subject of Basic Engineering Graphics.



Supported by basic technical parameters, information about the object is better absorbed by students, thus laying the fundamental knowledge of a future specialist.

In addition, at the choice of the teacher, it is possible to use thematic modules for blended learning, independent and classroom, for example, for continuing education courses.

5. Conclusions

The online course is planned as a prototype of a new concept of modern intellectual education. In his approach to learning, he will help:

- reduce the need for human and material resources for the acquisition of fundamental knowledge in basic technical subjects and the initial use of BIM,
- open the possibility of more in-depth teaching of special subjects at the next stages of the bachelor's degree,
- help enterprises speed up training/upskilling of workers in the workplace,
- to provide high-quality and innovative educational material for beginners in the construction professions and interested users of BIM, regardless of their level of education, material or physical fitness.

VirSTEM project activities use the most modern methodologies of information and communication technologies. Emphasis is placed on developing and improving virtual learning methods and evaluating learning outcomes. The project focuses on creating and promoting blended and flexible learning paths using groups and mobile learning, as well as providing opportunities for learner choice and creativity, support and feedback as the driving force behind his/her development.

References

- Hjelseth, E. (2018). Experience from Norway on implementing BIM in existing bachelor engineering curriculum. In J. Karlshoj, & R. Scherer (Eds.), *eWork and eBusiness in Architecture, Engineering and Construction: Proceedings of the 12th European Conference on Product and Process Modelling (ECPPM 2018)*, September 12-14, 2018, Copenhagen, Denmark
- Makutėnienė, D., Ovtšarenko, O., Safiulina, E., Timinskas, E. (2020). Education technology based on a 3D model of the house VirTec. Paper on the 6th International Conference on Higher Education Advances (HEAD'20), 2-5 June 2020, Valencia, Spain. Ed. Josep Domenech, Paloma Merello, Elena de la Poza, Raúl Peña-Ortiz. 2020, Editorial Universitat Politècnica de València, 545–553 pp. DOI: 10.4995/HEAD20.2020.11104.
- Martín-Gutiérrez, J., Mora, C.E., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual technologies trends in education. *EURASIA Journal of Mathematics Science and Technology Education*, 13(2), 469-486. DOI: <https://doi.org/10.12973/eurasia.2017.00626a>
- Mayer, E., Kriszun, K., Merz, L., Radon, K., Garrido, M.A., Kranzlmüller, D.A. (2021). Designing an Educational Virtual Reality Application to Learn Ergonomics in a Work Place. *IMX '21: ACM International Conference on Interactive Media Experiences*. June 2021, 247–252 p. DOI: 10.1145/3452918.3465504
- Ovtšarenko, O. (2020). Virtual technology for use in STEM (Science, Technology, Engineering, Mathematics) (Unpublished Application of the Erasmus+ Project 2020-1-EE01-KA203-077970).
- Pulido-Arcas, J.-A., Martínez-Rocamora, A., Folgar-Erades, A. (2021). Influence of BIM-Based Teaching Methodology on the Spatial Abilities of Construction Engineering Students. *Advances in Building Education*, Vol. 5 N°3. 9-26 pp. <https://doi.org/10.20868/abe.2021.3.4732>.
- Safiulina, E.; Ovtšarenko, O.; Makuteniene, D.; Timinskas, E. (2020). Development of Virtual Learning Environment in Technical Higher Education. *IV International Congress on New Trends in Science, Engineering and Technology ICONTENDS*, 86–95 pp.
- Salman, A. (2020) Student Learning Assessment from a Virtual Field Trip. *ASC 2020 (EPiC Series in Built Environment, vol. 1)*, 99-107 pp
- Wong, T.K.-T., & Kwan, Y.W. (2021). A study on using game-based method to improve learning efficiency of junior secondary school students (pages 79-83). Paper presented at the *International Conference on Education and New Developments (END 2021)*. ISSN (electronic version): 2184-1489. https://doi.org/10.36315/END-2021_Book-of-Proceedings.