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Article

Development of stem skills and national identity through 3D modeling in educational programs

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Abstract: This paper explores the advancement of STEM skills and national identity through the incorporation of 3D modeling into the curriculum of secondary educational institutions using Blender software. It focuses on how 3D modeling can be used to enhance students' technical prowess and creativity while simultaneously bolstering their motivation and sense of civic duty. The significance of modern educational technologies in nurturing critical thinking, investigative skills, and effective communication, which together foster the holistic development of the individual, is emphasized. The main objective of this article is to showcase practical experiences in embedding 3D modeling within middle school curricula to cultivate STEM skills and promote a sense of patriotism. It examines how hands-on activities and projects can motivate students to actively engage in rebuilding and progressing their nation, underscoring the critical role of patriotic education in today's learning environments. Illustrating this, the article describes a lesson titled "Creating 3D Objects," where students utilize Blender to work on a mini-project called "Street of Peace and Freedom," involving the design of 3D building models. This project saw enthusiastic participation from students, who not only developed new skills but also acknowledged their contributions towards the future of their country. The role of educators in selecting suitable educational programs and materials, especially the integration of Blender for teaching 3D computer graphics in ninth-grade informatics courses, is discussed. The insights from Taras Liutsiuk on the integration of textbooks and effective utilization of Blender's functionalities highlight the need for skilled pedagogical approaches. Particular attention is paid to the impact of this teaching methodology on ninth graders, a critical period for intense development of both academic and social competencies. Furthermore, the article addresses the future prospects of STEM education in Ukraine, advocating for equitable education access for all students, enhancements in pedagogical strategies, and the adoption of cutting-edge technologies in educational settings.

Keywords: secondary education; STEM education;3D modeling; national identity; blender

1. Introduction

The integration of modern technologies into educational programs has become a key objective in shaping a more dynamic and responsive learning environment. In recent years, STEM education, particularly the use of 3D modeling, has gained significant attention as a means to foster critical technical skills and innovative thinking among students. 3D modeling serves as a bridge between theoretical concepts and practical application, providing students with hands-on experience in fields such as engineering, architecture, and design. The focus on STEM education in Ukraine, driven by national educational reforms, aligns with global trends in equipping students with the necessary tools for future careers in high-tech industries.

Furthermore, 3D modeling not only enhances technical competencies but also offers unique opportunities to instill a deeper sense of civic responsibility and national pride among students. In the context of the ongoing challenges faced by Ukraine, including the need for post-war reconstruction, integrating 3D modeling into educational programs can empower students to actively contribute to the rebuilding efforts. This approach allows students to apply their skills to real-world problems, fostering both a technical understanding and a patriotic connection to their work. By engaging in projects that focus on rebuilding cities and communities, students not only gain valuable professional skills but also develop a commitment to their country's future.

2. Statement of the problem

Given the adoption of the Law of Ukraine "On Education" in 2017, we emphasized integrating STEM education, particularly by including 3D modeling in the curriculum [1,2]. This aspiration not only contributes to the growth of students' technical literacy but also develops a comprehensive approach to problem-solving and innovative thinking in the context of the real challenges of the modern world [3–7]. The updated STEM-focused curricula include components that encourage students to gain a deeper understanding of scientific and technical principles while reinforcing their knowledge with practical skills in 3D technologies.

In addition to updating the curriculum, considerable emphasis is on training teachers to effectively implement STEM education using modern technologies, including 3D modeling in Blender. Training and skills development programs for teachers ensure that they can integrate the latest technological solutions into the learning process, thereby improving the quality of STEM education [8]. It provides not only better learning by students but also promotes their interest and motivation, making learning more relevant and exciting.

However, despite the significant potential, numerous challenges require thorough analysis and resolution.

One of the main problems is the lack of qualified personnel who can effectively integrate 3D technologies into the educational process [9–11]. It threatens the quality of education and the ability to realize the full potential of such technologies [12,13]. Also, the problem of equipping schools with the necessary technical resources remains relevant, which can significantly limit access to 3D modeling in less affluent regions.

In addition to technical and personnel aspects, there are issues of student engagement and motivation [14]. Despite the growing popularity of 3D modeling as a hobby or professional field among young people, the school curriculum often does not consider the needs and interests of students. It can lead to formal rather than engaging learning.

The patriotic component, which is essential for national consciousness, also requires special attention in the context of 3D modeling. In the context of current challenges the country faces, training students to use modern technologies for state restoration and development is becoming a key aspect of the educational program.

In the context of the ongoing martial law in Ukraine, it is vital to involve young people in the recovery process by developing modern technologies, including 3D

modeling. The war has caused significant damage to infrastructure, creating great reconstruction challenges for cities and villages. Teaching students how to create 3D models can be directly applied to the design of new buildings and the restoration of affected areas, which not only contributes to the practical learning of valuable skills but also supports the development of patriotism and civic responsibility. Involving students in such projects can play a crucial role in shaping their understanding of the importance of making a personal contribution to the future of their country.

Thus, 3D modeling integration into education requires a comprehensive approach that includes technical capabilities, staffing, students' interests, and motivation, as well as national educational priorities. Addressing these issues will be an essential step towards creating an effective and modern educational system.

3. Analysis of key research and publications

The research conducted by Ukrainian scholars such as L. Hrynevych, N. Morze, and N. Valko primarily focuses on developing innovative methods for teaching STEM disciplines and integrating information technology into education [15]. Their approaches, though robust, generally overlook the specific application of modern technologies like 3D modeling, which our research directly addresses by enhancing STEM competencies and fostering national identity.

V. Kamyshyn discusses the humanization and standardization of educational systems, viewing STEM education as a system that fosters innovation through critical thinking, creativity, and teamwork. In contrast, our research extends these foundational ideas by practically applying 3D modeling to enhance STEM skills and national identity, presenting a novel integration not extensively covered in Kamyshyn's framework [16]. The work of Osadchyi, Valko, and Kuzmich on the use of augmented reality to enhance STEM education provides a basis for our study, which broadens this application by employing 3D modeling to enrich interactive and engaging learning experiences, thus indicating a divergence in application scope and context [16].

Balyk et al. [17] conceptualize STEM competency as a dynamic system involving a range of cognitive and non-cognitive skills. While they emphasize innovation capacities such as creativity and critical thinking, our study adds a layer of specificity by applying these competencies within 3D modeling contexts, suggesting a nuanced approach to skill application in technological fields.

Semerikov [18] focuses on integrating environmental education into the STEM curriculum, aligning with our emphasis on using digital tools to enhance environmental awareness. Our approach explores how 3D modeling can be leveraged to foster environmental literacy among students, thus expanding on Semerikov's findings.

Stryzhak [19] and Strutynska [20] advocate for interdisciplinary and arts-integrated approaches within STEM/STEAM education. We build on these methodologies by examining how 3D modeling can develop complex problem-solving skills, critical thinking, and creativity, areas that may be underexplored in their studies.

Internationally, researchers like Norris [21], Resnick [22], Hutchinson [23], Darling-Hamblett [24], Zeynep [25]; Barnaby and Baumer [26], Su [27]; A. Carnevale,

Melton and Smith [28]; Corbett and Dumarest [29]; Firman [30], Jang [31], Kaniawati [32], Korbel [33], Sejati [34], Siekmann [35], Song [36] explore new pedagogical approaches and develop innovative strategies for STEM education. Their work promotes creativity and deeper scientific learning, which informs our application of 3D modeling to enhance these areas effectively.

Building on the insights gathered from the existing literature, it becomes evident that while substantial progress has been made in integrating STEM education across various contexts, the practical application of 3D modeling within this framework remains underexplored. Our research addresses this gap by focusing on the unique intersection of STEM skill development and the enhancement of national identity through innovative educational approaches. By drawing from both theoretical and empirical sources, we seek to demonstrate how the integration of 3D modeling can not only elevate technical proficiency but also foster a deeper sense of patriotic consciousness among students.

In summary, our research not only aligns with but also significantly extends the current literature by providing concrete applications of 3D modeling within STEM education. This integration enhances the technical skills and national identity development, addressing educational and cultural objectives comprehensively and offering a new dimension to the existing theoretical frameworks.

Therefore, the purpose of this paper is to present an example of integrating 3D modeling into high school science curricula, highlighting its role in developing STEM competencies while fostering civic responsibility and national pride.

4. Research methods and techniques

In this study, the project-based learning approach was implemented in an open lesson context, involving a specific group of secondary school students. The participants were selected based on their enrollment in a technology-focused course, which provided an appropriate setting for integrating 3D modeling into the curriculum. The primary aim of the project was to develop both technical and critical thinking skills through the creation of a “Dream House” 3D model, which allowed students to engage actively with complex technical tasks. Data collection was observational, focusing on students’ participation, problem-solving abilities, and the level of engagement throughout the project. Feedback from both students and the instructor was gathered to provide qualitative insights into the learning process.

While the project did not adhere to a formal experimental framework, the outcomes were evaluated based on the qualitative analysis of the students’ work and their responses during the project. The tools employed included Blender software for 3D modeling and digital resources to facilitate project completion. Although the reliability and validity of this approach are subject to the constraints of non-experimental settings, the project provided valuable insights into the integration of 3D modeling within STEM education. We acknowledge the limitations regarding the generalizability of the findings but believe that the project serves as a relevant case study in the application of project-based learning in secondary education.

The rapid development of digital technologies leads to new requirements for the skills and competencies of workers, many of which are closely related to the STEM

approach. STEM education is a direction in education that, under its conditions, enhances the natural science component in curricula using innovative technologies. The development of STEM disciplines in education is crucial for the advancement of modern society, as STEM education forms the foundation for training specialists in high technology, including future professions capable of creative thinking and innovation. Furthermore, according to the Education Commission of the USA (2017), the demand for STEM professionals is growing twice as fast as in other professions. Similar trends are also observed worldwide. However, in many parts of Europe, employers struggle to hire people with adequate STEM skills, especially IT professionals. Latest data from PISA (Programmer for International Student Assessment, 2018) show that one in five 15-year-old teenagers in Europe is functionally illiterate in reading, mathematics, and science. Thus, there is a need to increase the motivation of modern youth in STEM subjects.

One possible solution to this issue is to add the so-called Art component to the sciences. Therefore, disciplines related to creativity, art, and design are included in STEM education, collectively termed Arts (STEAM-STEM and Arts). The main goal of implementing STEAM education is to expand opportunities for youth by providing (developing) technical and natural science education (based on establishing connections between STEAM fields) with an emphasis on developing critical and creative thinking in students. This approach is crucial to apply from primary to higher education to ensure the country with four categories of intellectual investments, which include: creative teachers and lecturers capable of successfully teaching STEAM subjects; scientists, engineers, and IT professionals who explore and develop the technological progress necessary for the country's economic success and solving global issues; technologically skilled workers capable of creating, designing, supporting, and operating complex technological innovations; scientifically and technologically literate citizens who can critically explore, understand, and respond to challenges for improving the environment. The problems of implementing STEM/STEAM education in Ukraine have been extensively studied by domestic researchers and practitioners, yet an analysis of their scientific and methodological works and the study of their experience show the need for developing a well-founded methodological system for implementing STEAM education in Ukraine.

In Ukraine, elements of STEAM education are increasingly being incorporated into the educational process, but currently, it mainly comprises informal and extracurricular STEAM education: science and math Olympiads, activities of the Junior Academy of Sciences, scientific competitions and events for students (Intel Techno Ukraine, Intel Eco Ukraine, Sikorsky Challenge Science Festival), scientific picnics, hackathons, etc. Significant steps have been taken towards spreading STEAM education in Ukraine: in 2015, a STEAM education coalition was established; in 2020, the "Concept of Development of Natural Science and Mathematics Education (STEM Education)" was approved for implementation until 2027; and in February 2021, the Ministry of Education and Science of Ukraine approved the "Standard Educational Program for Grades 5–9 of General Secondary Education Institutions," which includes interdisciplinary integrated courses such as "STEM" and "Robotics." This indicates the need for training (retraining, advanced training) of teachers for teaching STEM/STEAM and developing relevant competencies. The Concept of Development

of Natural Science and Mathematics Education (STEM Education) specifies the competencies aimed at through STEM/STEAM education. However, the competencies needed by teachers for teaching STEM/STEAM remain undefined. From the analysis of issues related to approaches to structuring and modeling STEM/STEAM competencies based on the analysis of works by leading researchers who addressed similar issues, the author has identified components of STEAM competencies for teachers and constructed a corresponding generalized model. The structure of this model includes: knowledge, skills, abilities in the field of STEAM, research, information-communication and methodological competencies, flexible skills, and certain components of key competencies. To prepare youth for future professions in high technology, it is also important to involve modern sectors that are rapidly developing. Such directions include robotics and 3D technologies, as they are a popular and effective method for studying significant fields of natural sciences, technical sciences, and design, based on active use of modern digital technologies in production and a high intellectual level of specialists who will work in an innovative economy. Education using robotics and 3D technologies provides opportunities for students to solve real-life problems that require knowledge of STEAM subjects, including mathematics (spatial concepts, geometry for understanding the movement mechanisms of robots; for creating 3D models of objects); physics (electronics, principles of sensor operation, which are the basis of robots); technology and design (design of robots, their parts, their printing on 3D printers, construction of robots); computer science and ICT (working with software tools for 3D modeling, 3D design, programming of robotic systems). Ways to implement robotics and 3D technologies as promising directions for the development of STEAM education can include: for schools-integrated (elective) courses in robotics and 3D technologies; inclusion of relevant STEAM projects in the school course of computer science and/or technology; for universities-teaching robotics and 3D technologies as separate disciplines and/or blocks of disciplines, implementation of research projects based on robotics and 3D technologies (including STEAM projects).

This article describes the practical application of integrating 3D modeling into middle school curricula, emphasizing the development of STEM competencies and the enhancement of patriotic consciousness. The study does not employ a traditional experimental design; instead, it focuses on a project-based learning approach, where students actively engage in creating a “Dream House” 3D model. This project aims to deepen students’ understanding of technical aspects of the Blender software, while also fostering creativity and technical innovation.

Project Implementation. Transitioning from theoretical aspects to practical application, this project allows students to apply and develop their competencies in 3D modeling. The process includes multiple stages, from initial design to the visualization of the completed model, offering students an excellent opportunity to develop their skills in solving complex tasks and making critical decisions within the context of real project challenges.

Educational Environment. The lesson plan was specifically designed to utilize Blender software, enhancing subject-specific competencies such as the ability to create three-dimensional objects following necessary steps, and fostering a creative approach to modeling. Beyond technical skills, the lesson also aims to develop key

competencies such as communication in the native language, patriotic consciousness, digital literacy, and learning abilities.

Equipment and Resources. The classroom setup includes computers, a projector for presentations, a blackboard, notebooks, and textbooks, creating an effective learning environment. This comprehensive approach not only improves students' technical skills but also promotes the development of their creativity and critical thinking.

Documented Experience. The practical experience shared by teacher Taras Liutsiuk involves integrating educational textbooks "Informatics. Textbook for the 9th grade of general secondary education institutions" by N. Morze, O. Barna and another textbook by Y. Rivkind, T. Lysenko, L. Chernikova, V. Shakotko, into the classroom. This approach has demonstrated high performance during an open lesson conducted on 7 February 2024, at Lutsk Lyceum №23 of the Lutsk City Council, involving 13 students.

The methodology of this study reflects the broader aims of contemporary educational initiatives which emphasize the development of essential 21st-century competencies such as critical thinking, creativity, communication skills, and collaboration, ensuring that students are well-prepared to participate actively in the technological and civic spheres.

5. Research results

Specialized training of future computer science teachers should be aimed at developing competencies necessary for innovative professional activity [37], which involves improving the ability to think creatively and critically, forming skills for creative and innovative problem solving, developing the researcher's personal and creative potential, and project organization and management skills. The ability to conduct scientific analysis, solve complex research problems, make informed decisions, and evaluate performance are as crucial as developing competencies for flexible and effective interaction which contributes to professional excellence [29].

In our opinion, the integration of STEM education, especially through the use of 3D modeling technologies using Blender, opens up new opportunities for future computer science teachers [30]. The training helps them become innovative, purposeful, creative, and reliable members of the educational community and society. STEM introduction into the educational process gives benefits for students, affecting both the individual and the collective level.

Students get the opportunity not only to learn effectively through practical experience but also to understand scientific processes more deeply by modeling them themselves. It contributes to the development of comprehensive professional competencies in the field of digital technologies, critical thinking, and research abilities. It also significantly improves the skills of effective communication and teamwork, which are crucial for the modern educational and professional environment [31].

The prospects for STEM education development in Ukraine promise significant opportunities to ensure equal access to education for all students, including those with special needs [38]. It also contributes to pedagogical methods improvement and forms

of activity that lead to innovations in learning. The public presentation of achievements in research and project activities helps to recognize and disseminate innovative approaches implemented by students and teachers [39]. In addition, modern technologies and methodologies implementation in all aspects of the educational process improve the overall quality of education and prepare students for active participation in the economic and social life of the country [25].

Thus, STEM education not only contributes to the development of core academic skills but also prepares students to actively participate in the social and economic development of the country, playing a crucial role in the recovery and progress of Ukraine.

Moving from theoretical aspects to the practical application of the acquired knowledge, we will now focus on a specific project implementation that will allow students to apply and develop their competencies in 3D modeling. Today's task is to create a 3D model of the Dream House, which will help students better understand the technical aspects of working with Blender and provide an opportunity to show creativity and technical ingenuity [40]. This process will include several stages: from the initial design to the visualization of the finished model, which will be a brilliant opportunity for students to develop their skills in solving complex problems and making critical decisions in the context of real project challenges.

An interesting tool for STEM and the New Ukrainian School is the use of Lego construction kits. To this end, the international program "Six Bricks" was introduced into the educational process. Lego-based projects help develop fine motor skills, attention, memory, critical thinking, and communication skills, while also increasing motivation to learn. They also foster spatial awareness, teamwork, and collaboration skills. STEAM is a universal, practice-oriented approach that equips students to tackle challenges of varying complexity, allowing them to apply their knowledge in real-world situations.

The core of STEAM education lies in a system-activity approach, encouraging independent research work by students. Although STEAM education is now widely used in schools, many educators tend to refer to it using more familiar terms, such as "project-based learning." Project creation inherently involves interdisciplinary knowledge, and under the STEAM framework, students apply their understanding from various fields—mathematics, engineering, design, and the use of digital devices and technologies. Through this approach, students gain a comprehensive understanding of the project development process. STEAM education enables learners to apply their knowledge to practical problems, whether they are technical or everyday tasks, requiring the integration of knowledge from multiple domains.

This approach is highly relevant in modern schools, as the traditional subject-based education model gradually loses its significance. With the easy access to information via the internet, mere knowledge transfer has become obsolete. What schools must now focus on is developing students' ability to apply information practically, a skill that must be cultivated early on in their education.

Not all textbook authors have studied the professional environment for creating three-dimensional computer graphics "Blender." The teacher Taras Lutsiuk, who developed a workshop on the topic "Creating 3D objects" using the integration of textbooks "Computer Science, shared his practical experience. Textbook for 9th grade

of general secondary education institutions" by N. Morse, O. Barna and "Informatics. Textbook for 9th grade of general secondary education institutions" by Y. Ryvkind, T. Lysenko, L. Chernikova, V. Shakotko. This type of work demonstrated high results during the open lesson. On 07.02.2024, the event was held in the 9-B class of the municipal institution of general secondary education Lutsk Lyceum №23 of the Lutsk City Council (http://surl.li/urohg). In the process, 13 students were involved (**Figure 1**).

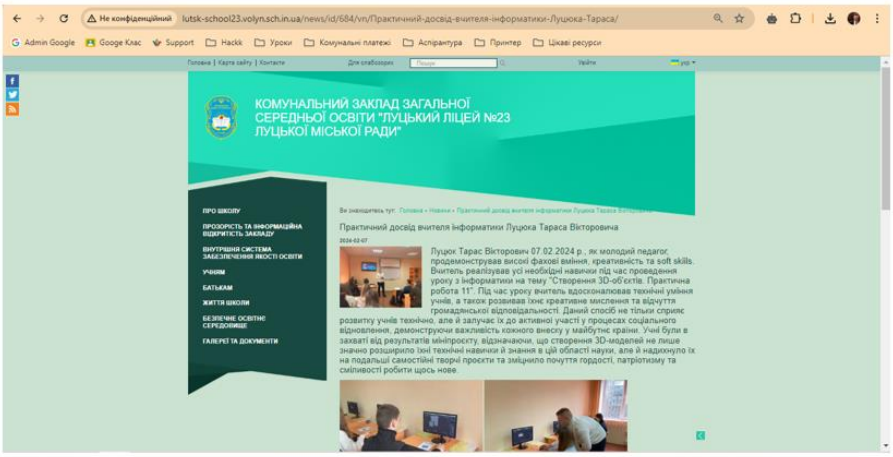


Figure 1. A fragment of news on the website of Lutsk Lyceum No. 23 of the open class by T. Lutsiuk.

During a 9th-grade computer science lesson, the teacher uses a practical lesson plan focused on creating 3D objects using Blender software. The lesson aims to develop students' subject competencies, such as the ability to create three-dimensional objects following the necessary steps and to develop a creative approach to modeling. In addition to technical skills, the lesson also includes core competencies development, such as communication in the mother tongue, patriotic awareness, information and digital literacy, and learning skills. The classroom is equipped with computers, a projector for presentations, a whiteboard, notebooks, and textbooks, which helps to create an effective learning environment. Thanks to this integrated approach, the lesson improves students' technical skills and promotes their creativity and critical thinking.

At the beginning of a computer science lesson, the teacher greets students and encourages them to work productively by checking the class's readiness for the new lesson. To refresh their knowledge, the teacher invites them to play a small dice game where each student has to give an answer and explain it. It helps to understand their level of preparation for the new material and relieve emotional tension.

Then the teacher motivates the students to discuss the current Ukrainian challenges, including the war and its consequences for the country and its citizens [34–36]. He emphasizes how important it is for everyone to contribute to the country's recovery by using the skills they develop, including 3D modeling, to help rebuild and recover cities and communities. The teacher introduces the topic of the lesson, 'Creating 3D Objects', making the connection between the educational goals and the

needs of the country and goes into detail about the skills and tools they will need to work in Blender, the 3D modeling software they will use to create 3D models.

Students are encouraged to develop a joint mini-project called Peace and Freedom Street, where they design and build models of buildings for a peaceful future for Ukraine (**Figure 2**). The aim of this project is not only to improve students' technical skills but also to develop their creative thinking and sense of civic responsibility.

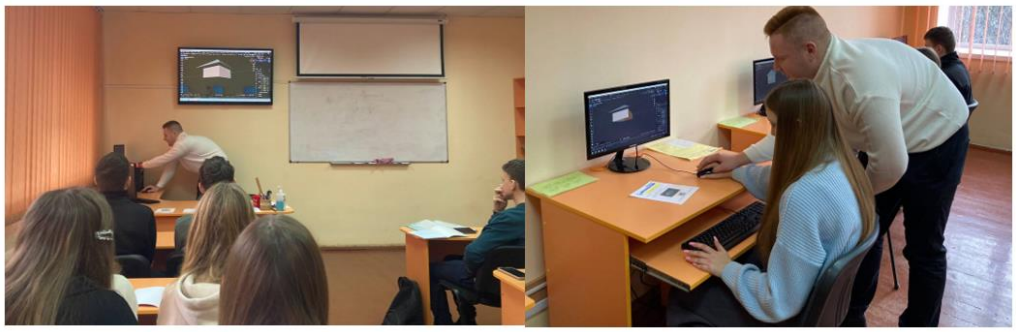
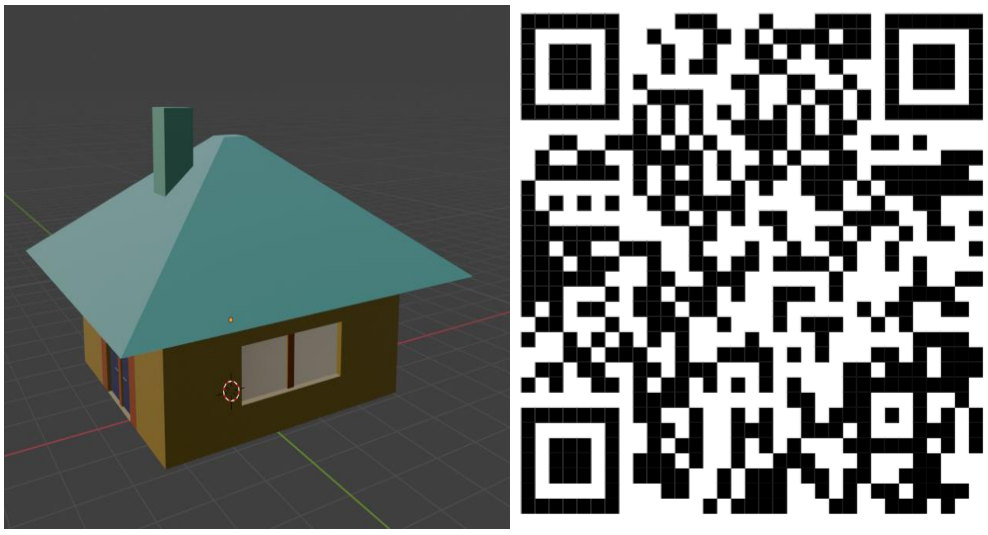


Figure 2. Open lesson. Motivating students during an open lesson.

Before creating a three-dimensional model of your dream house (**Figure 3a**), you need to scan the QR code [37] using a smartphone (**Figure 3b**) and watch the video tutorial to complete the task.



(a) **(b)**

Figure 3. Example and video instructions for completing the task. **(a)** creating a three-dimensional model of your dream house; **(b)** using a smartphone and watch the video tutorial to complete the task.

6. Results and discussions

The integration of 3D modeling into secondary school curricula has shown significant results in the development of STEM competencies and the support of patriotic consciousness among students. By using Blender software, students were

able to enhance both their technical skills and creative abilities, which are essential in modern education.

One of the key outcomes of this integration was the substantial improvement in students' technical skills. Specifically, students effectively mastered the basics of 3D modeling, which contributed to the development of their mathematical and spatial thinking. Additionally, students demonstrated an increased level of digital literacy, allowing them to incorporate modern technologies more effectively into their learning processes. These findings indicate that 3D modeling not only improves technical competencies but also deepens the students' understanding of engineering principles and natural sciences, which are crucial for building STEM competencies.

The study also revealed that 3D modeling significantly increased students' motivation to learn. Students actively engaged in creating models, fostering teamwork, creativity, and the ability to solve complex tasks. The project-based learning approach allowed them to apply knowledge from various subjects, making the learning process more engaging and relevant. These results suggest that involving students in real-world projects not only boosts their motivation but also enhances their ability to understand the interconnections between different disciplines.

A particularly noteworthy result of the study was the development of patriotic consciousness through educational projects aimed at state restoration and development. Students participated in creating 3D models of buildings and infrastructure, directly applying their skills to practical tasks related to the country's reconstruction needs. This not only helped students develop valuable technical skills but also fostered a sense of responsibility and commitment to their country's future. Engaging students in such projects plays a critical role in shaping their understanding of how they can contribute to national development.

This approach not only contributes to the student's technical development but also engages them in active participation in the processes of social recovery, demonstrating the importance of each contribution to the country's future (**Figure 4**).

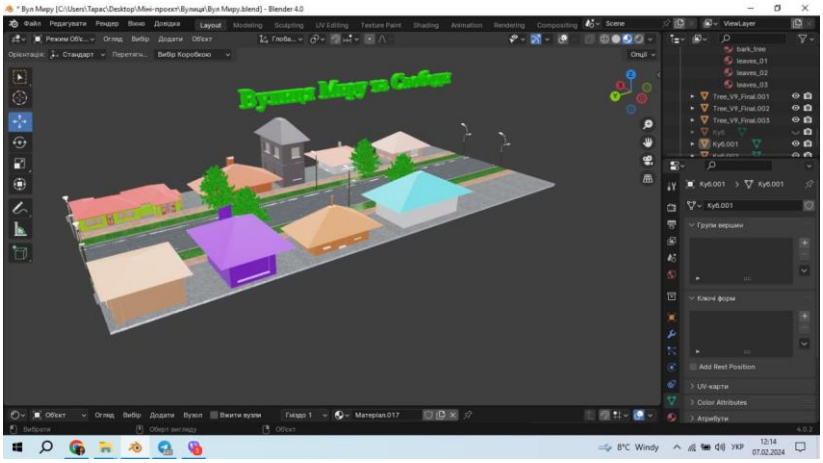


Figure 4. Result of the integrated mini-project.

The students were excited by the results of the mini-project, noting that creating 3D models not only significantly expanded their technical skills but also inspired them to pursue further creative projects and strengthened their sense of pride and patriotism.

Despite the overall positive results, several challenges were identified. One of the main issues is the lack of technical resources and equipment in some schools, which hinders the full implementation of educational projects. Additionally, not all teachers have the necessary training to integrate 3D modeling into the educational process effectively. Addressing these challenges will require investment in teacher training and the provision of adequate technical resources. These measures are essential for successfully integrating modern technologies into the learning process and improving the quality of STEM education.

In conclusion, the integration of 3D modeling into STEM education has proven to be an effective way to enhance both technical skills and national identity development. However, overcoming challenges related to resources and teacher training is crucial to realizing the full potential of this educational approach.

7. Conclusions

In conclusion, the integration of 3D modeling into secondary school curricula has proven to be a vital component in the development of modern competencies that are essential for students in today's world. By incorporating 3D modeling as part of STEM education, students are not only gaining valuable technical skills but also developing critical thinking, creativity, and problem-solving abilities that are crucial for their future professional lives. This approach enhances students' digital literacy and understanding of engineering and scientific principles, equipping them with the tools needed to succeed in the fast-paced, technology-driven global environment.

Moreover, 3D modeling serves as a highly engaging and practical method for involving students in real-world projects. By working on tasks that require them to apply knowledge from various disciplines, students are more motivated and connected to their learning. The integration of such technology encourages interdisciplinary learning and helps students recognize the relevance of STEM subjects in everyday life and broader societal contexts. In addition, these hands-on projects foster teamwork, collaboration, and innovation—skills that are indispensable in both educational settings and the workforce.

Importantly, the introduction of 3D modeling in the educational process not only prepares students for the demands of the labor market but also plays a critical role in shaping their sense of civic duty and patriotism. By engaging students in projects related to the reconstruction and development of their country, 3D modeling helps instill a sense of responsibility and pride in contributing to national progress. This approach strengthens the connection between education and real-world application, making learning more meaningful and purposeful for students.

The findings of our study highlight the potential of 3D modeling to address both educational and cultural objectives. The initiative creates a pathway for students to become not only skilled professionals but also responsible citizens who are capable of making meaningful contributions to society. The ability to apply technical skills in a way that benefits the country's recovery efforts underscores the dual importance of developing both STEM competencies and national identity.

Prospects for further research include the in-depth study of the long-term impact of 3D modeling on the development of STEM competencies and patriotic

consciousness. Future studies should also explore the scalability of this approach, particularly in resource-limited schools, and assess how 3D modeling can be further refined to maximize its educational and societal benefits.

Author contributions: Conceptualization, TL and HA; data curation, TL; formal analysis, HA; funding acquisition, TL; investigation, TL and HA; methodology, TL and HA; project administration, TL and HA; resources, TL and HA; software, TL and HA; supervision, TL and HA; validation, TL and HA; visualization, HA; writing—original draft preparation, TL and HA; writing—review and editing, TL and HA. All authors have read and agreed to the published version of the manuscript.

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