Experience in developing the educational program "3D Print Lab. Modeling Workshop" for the development of adults' STEAM skills

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Abstract

Non-formal and adult education are now important parts of a holistic education system. They expand opportunities for acquiring new professional skills, changing professional orientation, and developing personality. Our research is aimed at finding ways to solve individual tasks of non-formal adult education in Ukraine, in particular: the development of STEAM skills, creating opportunities for internally displaced persons to acquire new professional skills. To achieve the research goal, it was decided to develop an educational program for teaching adults the basics of 3D modeling and 3D printing. The article presents the content of the educational program "3D Print Lab. Modeling Workshop" and the results of its testing in the system of non-formal adult education based on the Public Union "Social entrepreneurship "Adult Education Centre "Pershyi". The target group of the program is adults who have no experience in 3D modeling and 3D printing, and beginners who want to expand their knowledge and improve their skills in the basics of modeling products for printing. Special attention is paid to involving internally displaced persons in training. The purpose of the educational program: to provide participants with basic knowledge and to develop primary practical skills in 3D modeling and 3D printing. The total duration of the educational program is 30 hours. The training includes 15 classroom sessions of 2 hours each. A project approach was used in the learning process: students worked on individual projects and demonstrated the created products at the last lesson. In addition, discussion of problematic issues was practiced, relying on the previous experience of individual students. The program was implemented in the Public Union "Social entrepreneurship "Adult Education Centre "Pershyi". The experimental group consisted of 7 learners. The group was diverse in age, education, and previous experience. However, all students had a common goal – to gain 3D modeling and 3D printing skills. 5 participants successfully completed the training. The results of the survey showed that the students were satisfied with the program. At the same time, problems and limitations were identified that need to be resolved.

Keywords

adult education, 3D printing, informal education, training course, public organization

1. Introduction

An obligatory component of a modern person's life is learning in its various types and forms, in particular through formal, non-formal and informal education. The education system is aimed to create conditions for this activity and, as a result, to ensure the educational needs of an individual and society. Within the framework of this study, we highlight such tasks as: the formation of key competencies, abilities and readiness for personal and professional self-realization in various fields of activity, for lifelong learning, the development of scientific, mathematical, technical thinking and creativity. In solving these tasks, the leading role belongs to formal education, which provides training, education and development of youth. In the field of adult education, they are quite successfully solved thanks to non-formal education, which is more flexible, in particular, allows to obtain specialized skills based on already existing competencies

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in a short period of time. Currently, active providers of non-formal education in Ukraine are public and charitable organizations. For example, Public Union "Social entrepreneurship "Adult Education Centre "Pershyi" (Zaporizhzhia, Ukraine) studies the educational needs of the adult population, develops and implements relevant educational programs for adults, participates in the development of regulatory documents that contribute to the development of adult education [1].

In the process of surveys, which are systematically conducted by specialists of the Adult Education Centre "Pershyi", it was found out in particular that persons who have been forced to change their place of residence are interested in the formation and development of technical skills that will allow them to expand the scope of finding a job. These include the skills of 3D modeling and 3D printing using specialized software and equipment. Accordingly, the task was to develop and test an educational program aimed at the formation of these skills of adults, as well as their acquisition of their first practical experience.

The purpose of the article: to present the content of the developed educational program "3D Print Lab. Modeling Workshop" and the results of its testing in the system of non-formal adult education based on the Adult Education Centre "Pershyi".

2. Literature review

The issues important for achieving the goals of our study are sufficiently thoroughly presented in scientific publications, which emphasizes their relevance.

Researchers pay considerable attention to the problems of studying 3D printing as a modern industrial technology, as well as its educational application as a means of teaching and creating clarity. Ford and Minshall identified the following areas of use of 3D printing in education: teaching students about 3D printing; teaching educators about 3D printing; as a support technology during teaching; producing artifacts that aid learning; creating assistive technologies; support outreach activities [2].

The scientific works highlight such aspects as: STEM education [3, 4, 5, 6, 7, 8, 9]; approaches to developing a 3D-Printing STEAM curriculum for high school, college, and university students [10, 11, 12, 13, 2, 14, 15]; using modern methods and teaching aids (immersive technologies, virtual reality, separate access to equipment, gamification) in the process of learning 3D printing [16]; using 3D printing technology in various STEM learning activities [17, 18, 19, 20, 21, 22].

At the same time, technological progress, social processes and the development of views on personality lead to the need to systematically work on finding new and improving existing educational technologies [23, 24, 25].

In particular, Nuissl, Sava, and Farkas note that despite a 30-year period of development, the adult education system in the European Union has significant shortcomings that hinder the development of democracy and social solidarity [26, p. 1]. Therefore, one of the important tasks is the development of adult education, in particular non-formal education.

3. Case of public union "Social entrepreneurship "Adult Education Centre "Pershyi"

In order to expand the range of educational services for the adult population of Zaporizhzhia, the educational program "3D Print Lab. Modeling Workshop" was developed. The program was implemented on the basis of the Public Union "Social entrepreneurship "Adult Education Center "Pershyi".

3.1. Description of the educational program

The relevance of the educational program is due to the growing use of 3D printing and the need to train specialists capable of performing complex technical tasks using modern technologies. 3D printing is a promising technology that is actively used in industry, medicine, architecture, education, and art. The ability to create physical objects from digital models provides new opportunities for prototyping and

mass customization of industrial products, as well as for actualization the creative potential of modern human. Learning the basics of 3D printing and modeling in 3Ds Max allows to obtain practical skills that are in demand in the labor market, promotes the development of critical thinking and technical creativity, and helps to psychologically relieve a person through creative activity.

The target audience of the program is adults who have no experience in 3D modeling and 3D printing, and beginners who want to expand their knowledge and improve their skills in the basics of modeling products for printing. Special attention is paid to involving people with the status of internally displaced persons in training.

The purpose of the educational program: to provide participants with basic knowledge and to develop primary practical skills in 3D modeling and 3D printing for the self creation of functional products.

Participants will achieve such learning outcomes:

- to understand the capabilities and principles of 3D printers;
- to know the main types of materials for 3D printing and their properties;
- to have basic polygonal modeling techniques in the Autodesk 3Ds Max environment;
- to be able to create closed, ready-to-print 3D models;
- to be able to adjust the wall thickness and hollowness of models to optimize printing;
- to be able to detect and correct errors in models for 3D printing;
- to be able to export models to STL format and work with slicer programs;
- to gain experience in preparing and printing the first physical product.

The total duration of the educational program is 30 hours. The training includes 15 classroom sessions of 2 hours each. The duration of the program is determined by the following factors:

- informal adult education programs are aimed at people who mainly have limited time resources, therefore they are interested in gaining practical skills in a short time;
- this time is enough to form the initial skills of 3D modeling and 3D printing and consolidate interest in this area of activity.

Content of the educational program:

Lesson 1. Introduction to 3D modeling and 3D printing: 3Ds Max interface; tools and toolbars; basics of 3D printing (principle of operation, materials, types of printers).

Lesson 2. Basic objects and transformations: creation and modification of basic 3D primitives; transformations (scaling, rotation, translation); exercises in creating simple shapes.

Lesson 3-4. Polygonal modeling. Introduction: introduction to polygonal modeling; conversion of primitives to Editable Poly; basic polygonal modeling tools (vertices, edges, faces).

Lesson 5-6. Polygonal modeling. Practice: creation of more complex models using polygonal modeling tools; concept of a “waterproof” model and checking the model for errors for printing.

Lesson 7. Preparation for 3D printing: practice using extrusion, cutting, and vertex merging tools; introduction to geometry optimization for 3D printing (minimum wall thickness, support).

Lesson 8. Preparing a model for printing in 3Ds Max: working with modifiers (Shell, Boolean); creating hollow models to save material; converting the file to STL format.

Lesson 9. Getting to know 3D printing software: introduction to the Cura slicer; setting print parameters (layer height, print speed, infill).

Lessons 10-11. Creating an individual project: defining a specific model for self-printing; discussing ideas and designing models.

Lesson 12. Practice preparing a model for printing: loading a model into a slicer; setting print parameters for a specific model; creating supports for the model; printing a simple model to demonstrate the process and result.

Lesson 13. Model quality control: checking the printed model for errors and defects; analyzing possible printing problems (overheating, layer displacement, plastic sticking); rules for using different types of plastic.

Lesson 14. Preparing and finalizing the model for printing: optimizing the model and setting up the slicer for final printing; checking the supports, correct positioning of the model on the platform; launching the first models for printing.

Lesson 15. Completing the project and printing: final printing of the models; finalizing, connecting parts (if any), correcting errors; summarizing the course, presenting the work.

To assess the level of achievement of learning outcomes by participants, the following activities are planned:

- testing theoretical knowledge of the principles of 3D modeling, 3D printing, materials and equipment settings;
- analysis of the quality of 3D models created by participants;
- analysis of the quality of objects printed on a 3D printer.

To assess the effectiveness of the program, the following activities are planned:

- assessment of the activity of participants during practical tasks and discussions;
- collection of feedback on the program, level of satisfaction with the training and achieved results through a questionnaire.

3.2. Characteristics of course participants

The recruitment of students for the educational program was carried out by specialists from the "Adult Education Centre "Pershyi". To disseminate information, the media resources of the public organization (social networks, messengers, official website) were used, as well as the media resources of the Charitable Organisation "Open Space For Support "Right Here".

A total of 7 students took part in the educational program, including 4 men and 3 women. The main characteristics of the participants are given below.

Distribution by age categories (see figure 1): young age (25-45 years) – 4 people; middle age (46-65 years) – 2 people; elderly age (66-75 years) – 1 person.

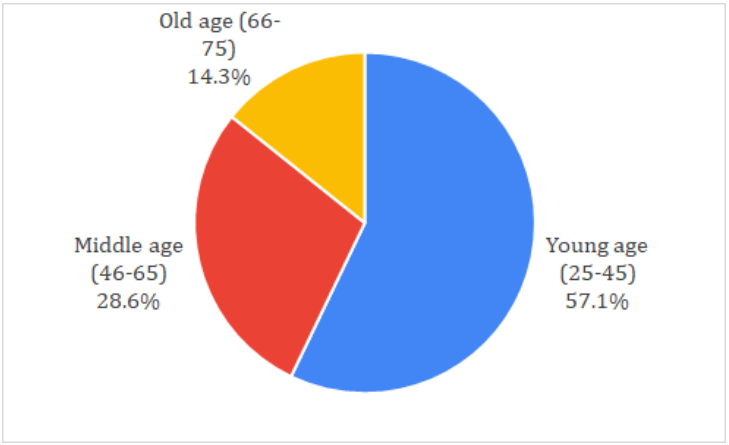

Figure 1: Distribution of participants by the age categories.

All students lived in Zaporizhzhia during the study. At the same time, 6 participants have the status of an internally displaced person (see figure 2).

Education level and employment. The vast majority of participants have higher education (85.7%) and are employed (71.4%). The distribution of participants by field of activity is presented in figure 3. In addition, 2 students already had 3D modeling skills in the Blender environment.

At the beginning of the training, the students indicated the following personal goals: to learn 3D printing for further professional activity (5 persons), self-development (1 person), deepening existing skills (1 person).

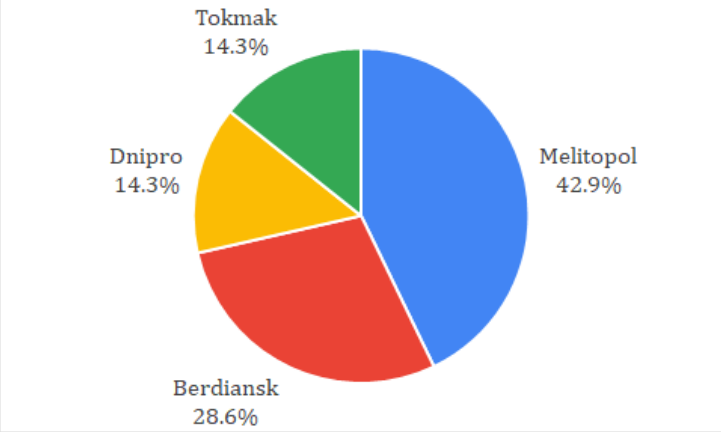

Figure 2: Distribution of participants by the place of registration.

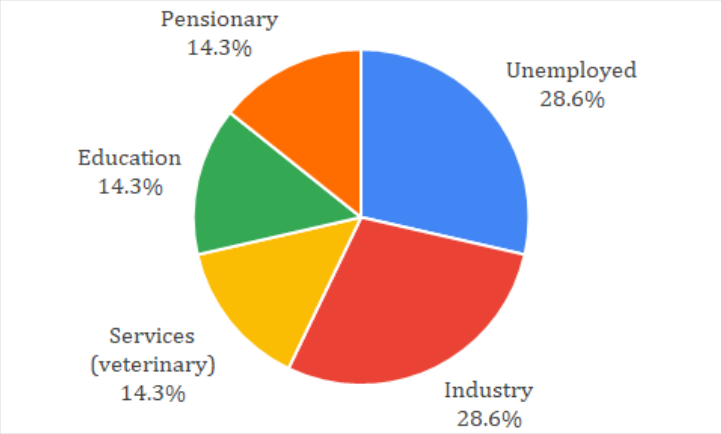

Figure 3: Distribution of participants by the field of activity.

3.3. Results of the implementation of the educational program

The classes were held in accordance with the approved course program on the basis of the Public Union "Social entrepreneurship "Adult Education Centre "Pershyi".

14 practical classes and a final class with a presentation of printed models were held. During the classes, the trainer explained the necessary theoretical aspects, demonstrated practical techniques of 3D modeling and 3D printing, organized a discussion of problematic issues for creative ideas. The use of a project approach was important, when each student of the program worked on his own model and presented it at the end of the training.

The first session included an introduction to the students, identification of their expectations from the course, presentation of the goal, objectives and content of the educational program. During the substantive part, the students were introduced to the concepts of 3D modeling and 3D printing, 3D modeling software, the names of the main tools of the development and editing environment for 3D objects. The session also examined the types of printers for 3D printing and the features of working with them, safety rules during the printing process.

In the second session, the trainees examined the interface of the 3Ds Max program, its modifications and settings, toolbars and individual tools.

The third session was aimed at developing practical skills in copying, grouping, reflecting objects on the scene, polygonal modeling.

The fourth session was aimed at consolidating polygonal modeling skills. Using the example of working with primitives, methods of modifying objects through their components were considered.

In the fifth lesson, the interns developed the first 3D model using splines and modifiers, and also

translated it into an editable polygonal model. In practice, they consolidated their skills in working with the constituent elements of a polygonal model.

The sixth session was devoted to expanding their knowledge of polygonal modeling. They examined the Edit Geometry toolbar for vertices and edges of a 3D model.

In the seventh session, the interns got acquainted with the tools for modifying polygons as a structural unit of a polygonal model, learned to apply and configure modifiers before printing the created model.

The eighth session was held to consolidate the skills of preparing a model for printing. They got acquainted with the process of saving the developed models in the format of the slicer program, considered possible settings and optimization methods.

During the ninth session, they considered the interface and capabilities of the Cura slicer software. Using the example of downloaded models, they learned to configure the main parameters of the future product, analyzed the dependence of the parameters on each other and their impact on the speed and quality of printing.

In the tenth session, the interns selected templates for independent model creation, configured the development environment for the physical dimensions of the future product, theoretically consolidated the basic rules and mandatory requirements for modeling for printing on a 3D printer, and began creating a model under the guidance of a trainer.

In the eleventh session, the interns completed the development of the model, checked the readiness and correctness of the model for printing using modifiers. If there were any errors, they found and corrected them. They saved the created model at a scale of 1:1 in the correct format.

During the twelfth session, the students loaded their models into the slicer. By changing the size and print settings, they determined the speed and method of printing the models. Also, using the example of the result of each participant, they examined why everyone has a different model printing time.

During the thirteenth session, the students looked at the 3D printer, analyzed its technical characteristics, settings that can be made before starting work, as well as during the printing process. They got acquainted with the plastics - filaments available for work. They looked at the finished products in order to identify possible errors. The first independently developed model was launched for printing, thanks to which the errors made were identified.

At the beginning of the fourteenth session, existing errors in the slicer were corrected by changing the model parameters. Then, new models with different settings and sizes were launched for printing.

At the fifteenth session, the printing of the models was completed, and the finished products of each participant were finalized. In the second part of the session, the interns presented their work, discussed and evaluated the results, and formulated conclusions based on the results of their training according to the educational program.

Most of the trainees successfully mastered the program and achieved the planned results. However, two participants did not complete the training.

At the end of the training, a questionnaire was conducted to obtain feedback from the trainees. In general, the respondents positively assessed the quality of the program and its content, the trainer's skills, training conditions, and the results obtained. Some trainees noted that the different levels of the participants' skills slowed down the learning process. The answers received and the trainer's observations allow us to reveal the following issues:

- A small number of students, despite the recruitment campaign for the program. Therefore, there is a need to form a positive attitude towards non-formal adult education and awareness of its relevance in society.
- The different level of training of the students complicated the educational process, since individual trainees needed more attention from the trainer.
- Not all students were able to successfully complete the training due to objective (inconvenient schedule for them) and subjective (complexity of the material, lack of interest) reasons.

So, we formulate the following recommendations for improving the program:

- when enrolling trainees, it is advisable to conduct a preliminary assessment of existing skills and, depending on the results, form the composition of the groups;
- before implementing the program, it is imperative to test the models to identify shortcomings and problems;
- to pay more attention to identifying and correcting errors in the models that prevent obtaining a high-quality result during printing.

It should be noted that our research was of a purely applied nature. It was aimed at solving a specific task, namely: to create opportunities for the formation of adults' 3D printing competencies. The recommendations formulated above will contribute to the improvement of the educational program. At the same time, it is advisable to pay attention to the psychological and pedagogical aspects of the research to overcome existing problems and limitations. In particular:

- Adult students are sufficiently motivated to study the proposed material, as they choose the program to develop their professional competitiveness. However, not all of them complete their studies. Therefore, it is advisable to thoroughly analyze the motivation of program participants and its impact on their performance, identify existing problems and formulate recommendations.
- It is quite difficult for non-formal education providers to form groups of adult students who have approximately the same level of previous training and social characteristics. Therefore, the task of minimizing the negative impact of such differences is relevant. To solve it, it is necessary to focus on adapting STEAM learning methods for adult students.
- In the process of teaching 3D printing, collaborative learning techniques, problem-based learning, and project-based learning can be used. It is advisable to investigate the effectiveness of their application in conditions of non-formal education and a limited period of study.

4. Conclusions

In accordance with the research objectives, an educational program "3D Print Lab. Modeling Workshop" was developed to form and develop adults' STEAM skills by studying the basics of 3D modeling and 3D printing. The total duration of the educational program is 30 hours. The main target group is internally displaced persons. The main topics are considered: Introduction to 3D modeling and 3D printing; Basic objects and transformations; Polygonal modeling; Preparation for 3D printing; Preparing a model for printing in 3Ds Max; Getting to know 3D printing software; Creating an individual project; Model quality control; Completing the project and printing. A project approach was used in the learning process: students worked on individual projects and demonstrated the created products at the last lesson. In addition, discussion of problematic issues was practiced, relying on the previous experience of individual students. The program was implemented in the Public Union "Social entrepreneurship "Adult Education Centre "Pershyi".

The group consisted of 7 learners. The group was diverse in age, education, and previous experience. However, all students had a common goal – to gain 3D modeling and 3D printing skills. 5 participants successfully completed the training. The results of the survey showed that the students were satisfied with the program. At the same time, problems and limitations were identified that need to be resolved. To overcome them, it is advisable to apply the methodological apparatus of modern pedagogy. This is the direction of our further research.

Author Contributions

Conceptualization, Iryna V. Krasheninnik; methodology, Hanna E. Ustiuhova; software, Hanna E. Ustiuhova; writing – Petro P. Kozhevnykov; writing – review and editing, Maryna V. Osadcha; visualization, Iryna M. Serdiuk. The authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

No new data were created or analysed during this study. Data sharing is not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

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Declaration on Generative AI

The authors have not employed any Generative AI tools.

References

[1] Public Union ‘Social entrepreneurship ‘Adult Education Centre ‘Pershyi’, 2025. URL: https://pershyi.org.ua/.

[2] S. Ford, T. Minshall, Invited review article: Where and how 3D printing is used in teaching and education, Additive Manufacturing 25 (2019) 131 – 150. doi:10.1016/j.addma.2018.10.028.

[3] D. Andryushkina, A. Zolkin, M. Perova, E. Dudukalov, I. Pivovarova, Analysis of the Essence of the Model of STEM Education, volume 2948, 2023. doi:10.1063/5.0165362.

[4] S. Balovsyak, O. Derevyanchuk, V. Kovalchuk, H. Kravchenko, Y. Ushenko, Z. Hu, STEM Project for Vehicle Image Segmentation Using Fuzzy Logic, International Journal of Modern Education and Computer Science 16 (2024) 45 – 57. doi:10.5815/ijmecs.2024.02.04.

[5] V. Hmyria, N. Kuznetsova, STEAM education as a modern educational tool: The skill of the future, 2023.

[6] O. Kudria, B. Skovronskyi, O. Marushchak, N. Honcharova, V. Sipii, The Role of Innovative Techniques in Development of STEM-education in Ukraine, Academia (Greece) (2024) 132 – 155. doi:10.26220/aca.5006.

[7] K. Szczepanska-Woszczyna, O. Lyulyov, T. Pimonenko, A. Infante-Moro, A. Zimbroff, S. Solodovnikov, The Contribution of Higher Education to Innovation Development: Long-Term and Short-Term Analysis, Forum Scientiae Oeconomia 12 (2024) 8 – 29. doi:10.23762/FSO_VOL12_NO4_1.

[8] A. Zabasta, V. Kazymyr, O. Drozd, S. Verslype, L. Espeel, R. Bruzgiene, Development of Shared Modeling and Simulation Environment for Sustainable e-Learning in the STEM Field, Sustainability (Switzerland) 16 (2024). doi:10.3390/su16052197.

[9] N. R. Balyk, G. P. Shmyger, Y. P. Vasylenko, V. P. Oleksiuk, STEM centre as a factor in the development of formal and non-formal STEM education, Journal of Physics: Conference Series 2288 (2022) 012030. doi:10.1088/1742-6596/2288/1/012030.

[10] Y.-H. Chien, Developing a pre-engineering curriculum for 3D printing skills for high school technology education, Eurasia Journal of Mathematics, Science and Technology Education 13 (2017) 2941 – 2958. doi:10.12973/eurasia.2017.00729a.

[11] Y.-H. Chien, P.-Y. Chu, The Different Learning Outcomes of High School and College Students on a 3D-Printing STEAM Engineering Design Curriculum, International Journal of Science and Mathematics Education 16 (2018) 1047 – 1064. doi:10.1007/s10763-017-9832-4.

[12] S. Chong, G.-T. Pan, J. Chin, P. L. Show, T. C. K. Yang, C.-M. Huang, Integration of 3D printing and industry 4.0 into engineering teaching, Sustainability (Switzerland) 10 (2018). doi:10.3390/su10113960.

[13] A. Draghici, C. Sticlaru, A. Lovasz, L. Ivascu, A proposed model for 3d printing education in the university, in: C.-Y. Huang, R. Dekkers, S. F. Chiu, D. Popescu, L. Quezada (Eds.), Intelligent and Transformative Production in Pandemic Times, Springer International Publishing, Cham, 2023, pp. 821–830. doi:10.1007/978-3-031-18641-7_76.

[14] F. M. Gómez-Campos, E. I. Amenyah, S. Rodríguez-Bolívar, J. E. Carceller, M. Frenay, E. Bourgeois, Perceived instrumentality value and engagement in 3D training, animation and modelling for university lecturers, International Journal of Innovation and Learning 12 (2012) 95 – 108. doi:10.1504/IJIL.2012.047313.

[15] S. Ishutov, K. Hodder, R. Chalaturnyk, G. Zambrano-Narvaez, A 3D printing Short Course: A Case Study for Applications in the Geoscience Teaching and Communication for Specialists and Non-experts, Frontiers in Earth Science 9 (2021). doi:10.3389/feart.2021.601530.

[16] P.-H. Chen, The design of applying gamification in an immersive virtual reality virtual laboratory for powder-bed binder jetting 3dp training, Education Sciences 10 (2020) 1 – 22. doi:10.3390/educsci10070172.

[17] M. Avinal, A. Aydın, The Effects of Activities Designed with Three-Dimensional Printing Technology on Science Education, Journal of Turkish Science Education 19 (2022) 887 – 910. doi:10.36681/tused.2022.155.

[18] M. Bonorden, J. Papenbrock, Evidence-Based Optimization of Classroom Teaching Units Using 3D Printers for Designing Models—From the 2D Picture to the 3D Flower Model, Education Sciences 12 (2022). doi:10.3390/educsci12110831.

[19] N. Budinski, Z. Lavicza, T. Houghton, Opportunities for 3D printing in Hybrid Education, Open Education Studies 4 (2022) 339 – 344. doi:10.1515/edu-2022-0175.

[20] O. Kalman, A. Nazim, I. Pavlenko, V. Ivanov, Advantages of 3d printing in the education process, in: M. Balog, A. Iakovets, S. Hrehová, K. Berladir (Eds.), The 2nd EAI International Conference on Automation and Control in Theory and Practice, Springer Nature Switzerland, Cham, 2024, pp. 3–17. doi:10.1007/978-3-031-59238-6_1.

[21] K.-Y. Lin, H.-S. Hsiao, Y.-S. Chang, Y.-H. Chien, Y.-T. Wu, The effectiveness of using 3D printing technology in STEM project-based learning activities, Eurasia Journal of Mathematics, Science and Technology Education 14 (2018). doi:10.29333/ejmste/97189.

[22] C. Thyssen, M. Meier, 3D Printing as an element of teaching—perceptions and perspectives of teachers at German schools, Frontiers in Education 8 (2023). doi:10.3389/feduc.2023.1233337.

[23] S. J. Papadakis, S. O. Semerikov, Y. V. Yechkalo, V. Y. Velychko, T. A. Vakaliuk, S. M. Amelina, A. V. Iatsyshyn, M. V. Marienko, S. M. Hryshchenko, V. V. Tkachuk, Advancing lifelong learning and professional development through ICT: insights from the 3L-Person 2023 workshop, in: Proceedings of the VIII International Workshop on Professional Retraining and Life-Long Learning using ICT: Person-oriented Approach (3L-Person 2023), volume 3535, 2023, p. 1 – 16. URL: https://ceur-ws.org/Vol-3535/paper00.pdf.

[24] S. Papadakis, A. E. Kiv, H. M. Kravtsov, V. V. Osadchyi, M. V. Marienko, O. P. Pinchuk, M. P. Shyshkina, O. M. Sokolyuk, I. S. Mintii, T. A. Vakaliuk, A. M. Striuk, S. O. Semerikov, Revolutionizing education: using computer simulation and cloud-based smart technology to facilitate successful open learning, in: Joint Proceedings of the 10th Illia O. Teplytskyi Workshop on Computer Simulation in Education, and Workshop on Cloud-based Smart Technologies for Open Education (CoSinEi

and CSTOE 2022) co-located with ACNS Conference on Cloud and Immersive Technologies in Education (CITEd 2022), volume 3358, 2023, p. 1 – 18. URL: https://ceur-ws.org/Vol-3358/paper00.pdf.

[25] M. Ampartzaki, M. Kalogiannakis, S. Papadakis, V. Giannakou, Perceptions About STEM and the Arts: Teachers', Parents' Professionals' and Artists' Understandings About the Role of Arts in STEM Education, Lecture Notes in Educational Technology (2022) 601 – 624. doi:10.1007/978-981-19-0568-1_25.

[26] E. Nuissl, S. Sava, E. Farkas, Adult education in the European Union since 1993, European Journal of Education 59 (2024). doi:10.1111/ejed.12719.