INNOVATIVE DEVELOPMENT OF TECHNOLOGICAL SKILLS AND COGNITIVE PROCESSES IN CHILDHOOD EDUCATION: THE CASE OF BIT&BYTE ACADEMY OF LITHUANIA

Dileta Tervydytė[1], Aurelija Žilionytė[2], Dovilė Dilienė[2]

Vilnius University Business School (Lithuania)[1], bit&Byte Academy (Lithuania)[2]

dileta07@gmail.com, dovile@bitbyte.lt

INTRODUCTION

Introduction. The study of Education and Training Monitor report (2021) evaluated that in Lithuania, student outcomes, particularly in science, technology, engineering and mathematics (STEM), are generally poor, as it was shown by PISA 2018 and national tests. Tests also highlighted high dispersion within schools: 73% of school leavers in the 2020 'Matura' school-leaving exam deviated from the average level of maths achievement in their schools. According to this, almost one third of students failed the 2020 'Matura' school-leaving exam and almost 20% of 10th graders scored below satisfactory in a mathematics test in spring 2021 [9]. Another report emphasized that in the field of Education in Lithuania (2017) high priority was identified for developing a computer/programming skills/computational thinking skills for IT subject in primary education and medium priorities were for developing 21st century skills (critical thinking, problem solving, communication, collaboration, creativity and innovation) and linking formal, non-formal and informal learning using ICT (information and communication technologies) with providing equitable access to ICT (infrastructure, devices and content) [10]. Referring to this, technology development is a rapidly evolving field and is an integral part of our future, which particularly facilitates teaching and learning, and in the context of the fast-growing industrial revolution, children need new and innovative educational strategies and methods. With these following changes, it is necessary to integrate technological literacy with the development of 21st century skills in children's education, recognizing how this may affect their cognitive processes [20, 28]. Based on the example of the bit&Byte Academy in Lithuania, this work will present an overview of how innovative development of technological skills and cognitive processes intersect in childhood education.

The aim of the research—To explore the innovative development of technological skills and cognitive processes in childhood education using bit&Byte Academy of Lithuania case.

Objectives:

- To disclose the new insights on the case of bit&Byte Academy of Lithuania for innovative development of technological skills and cognitive processes in childhood education
- To theoretically elaborate on the innovative development of technological skills and cognitive processes in children's education
- Based on the case analysis of the bit&Byte Academy in Lithuania to propose the innovative development of technological skills and cognitive processes approaches in children's education
- Based on a discussion of the results of the case analysis of bit&Byte Academy in Lithuania and existing findings in the field, to suggest implications for innovative development of technnological skills and cognitive processes in childhood education

The method of the research— the standard systematic literature review employed by a manual search of 31 scientific studies and 2 reports, with proceeds to analyze and summarize the main features of innovative development of the technological skills and cognitive processes in childhood education.

Theoretical background

As teaching methods have evolved, new teaching methodologies have emerged, including gamification, where the structure of a game is used for educational purposes, using technology to create didactic resources [8]. The training of future technological workers is a strategic issue that determines the dynamism of a country's development, its success on the world market and its ability to export technical innovations [31]. With the globalization processes and the active development of high-tech and information industries, make it necessary to create a generation of leaders with intellectual potential [15].

Figure 1 represents 21st century skills, which cover the mastery of key competencies that must be promoted in student's education. These particular skills includes [1, 34]:

- **Learning** (Critical Thinking, Creative Thinking, Collaborating and Communicating);
- **Literacy** (Information Literacy, Media Literacy, Technology Literacy);
- **Life** (Flexibility, Initiative, Social Skills, Productivity and Leadership).

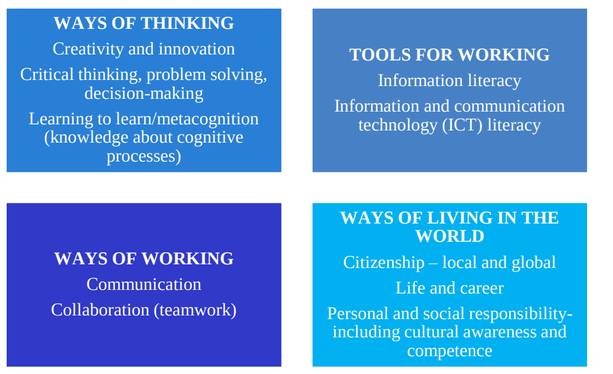


Figure 1: 21st century skills framework
Source: Qadir, J., Yau, K. L. A., Imran, M. A., & Al-Fuqaha, A., 2020

Computer Technology skills can be defined as the ability to learn, communicate effectively, collaborate, and problem solve about computer technology-related tasks and projects [1].

Figure 2: Innovative play-based learning and teamwork at bit&Byte Academy
Source: Authors'

The human cognitive process is essentially a two-stage process: through our sensory organs, which receive external information as input. Secondly, the input information is transmitted through nerves to the brain, where it undergoes complex processing such as storage, analysis and learning. The results of the processing are transmitted through the nervous system to different parts of the body and then each part generates an appropriate behavioral response. This creates a complete closed loop involving decision-making and action [6]. Researchers emphasize that "multiplayer" programming environments can help children with social thinking, 3D and augmented reality programming platforms can help with spatial experiences, and programming languages that use spoken language syntax can help children acquire verbal reasoning skills [30]. In addition, by creating and programming computer artefacts, children can engage in high-level cognitive processes involving problem solving, divergent thinking and reflection. Research shows that such activities can increase children's achievement in science, mathematics, language skills, creative thinking and help to develop general and higher-order thinking skills, which are crucial for problem solving [7].

Main findings

Programming

Figure 3: A mentor helps a child learn to code
Source: Authors'

At the **bit&Byte Academy**, young developers of the future learn to code from the very basics, which are based on an engaging format. It refers that through programming, children learn to solve problems in a systematic way, express themselves and their ideas using a variety of block-based programming software [7, 21, 24].

- **Code.org** website helps children get started with coding and develop their computational thinking, self-expression, creativity and learning [7].
- **Scratch** environment can help children to develop their computational and mathematical thinking, educate children through problem- based game projects [7, 24].
- **machinelearningforkids.co.uk** website involves children in innovative teaching technology solutions, encourages to explore the unknown, discover and create with curiosity [5, 27, 33].
- **makecode.microbit.org** is a codable hardware that supports the skills children need for writing programs and engages them in high-level cognitive processes [3, 12].

WEB/ APP design

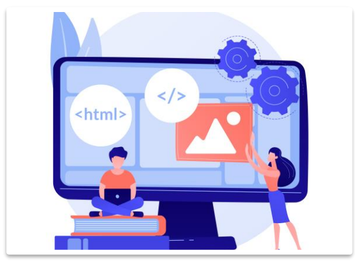


Figure 4: Website design
Source: https://www.freepik.com

This method strongly encourages children's creativity, because imaginative teaching methods, computer science and low-tech prototyping are used to develop creativity and new media literacy skills for kids [32].

The bit&Byte Academy's role is to find the appropriate tools and methods not only to motivate kids' learning and engage them in the learning process, but also to help them acquire the skills they need [25].

Marvel app, WIX

- **The applications cover:** Ideas, information, developers and users, technical solutions, and visual design.
- Solutions require creative thinking: developing ideas, making connections, creating, collaborating and communicating.

VR/ AR

Figure 5: A child exploring Virtual Reality
Source: Authors'

This approach plays an important role in teaching process, providing an interesting and engaging way of acquiring information. **Virtual Reality (VR) or Augmented Reality (AR)** is a more memorable environment to be remembered and bridging them with education, can bring teaching and learning experiences in an attractive and effective way [2, 7, 13].

The bit&Byte Academy uses such tools as **cospaces.io** that change the usual education where kids can feel more profound experiences and find them interested in learning with the increase of motivation [11, 23].

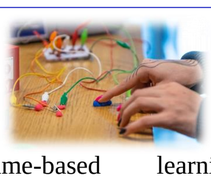
It applies for: engineering, technology and applications of science with the outcomes of decision making and choice, conceptual interface, reasoning, execution and sequential control [16, 19].

MAIN RESULTS AND CONCLUSIONS

Linking effective education to technology by introducing young developers to computational thinking can enhance and inspire their creativity with problem-solving skills. Well-designed coding assignments and programming tools can help children promote a wide range of thinking abilities [7, 21].

Creating web or app designs and prototypes can help children acquire design thinking skills that are important for identifying and developing innovative and creative solutions to problems. The design thinking mindset is valuable for children's learning, collaboration, and problem solving [14, 18, 32].

Using tangible technologies (VR, microbits, etc.) children can solve problems and process symbolic information, express themselves, reflect and improve their empathy skills. This approach can be recognized as recommendable educational use that increase learning outcomes [4, 17, 22, 29].



Game-based learning allows children to explore and interact in person. Incorporating technology-based and problem-solving approaches can contribute to the holistic development of children's social, emotional and cognitive load with increased learning outcomes [7, 22].

bit&Byte Academy's Recommendations

Let children **experiment** and **fail** to promote learning, building self-awareness and decision-making

Use the **design-thinking** approaches to foster their creativity and problem solving skills

Create **flexible learning environment** as infrastructure, ergonomic physical space, accessibility to sessions and activities

Develop **leadership mindset** to teach them planning, organizing, communication skills and self-confidence

Use **innovative technology tools** to build engagement capacities with uncover something new

Stimulate **project-based and play-based learning** to develop their imagination, subject knowledge and cognitive well-being

Promote **public speaking** practice to help them form connections, influence decisions and motivate change

References and bibliography are presented in separate page

References and bibliography

1. Ama, J. U., & Emetarom, U. G. (2020). EQUIPPING HIGHER EDUCATION STUDENTS WITH THE 21ST CENTURY SKILLS BEYOND COMPUTER AND TECHNOLOGICAL SKILLS FOR FUTURE EFFECTIVE PARTICIPATION IN THE GLOBAL ECONOMY. European Journal of Education Studies.
2. Ardiny, H., & Khanmirza, E. (2018, October). The role of AR and VR technologies in education developments: opportunities and challenges. In 2018 6th RSI International Conference on Robotics and Mechatronics (IcRoM) (pp. 482-487). IEEE.
3. Ball, T., Chatra, A., de Halleux, P., Hodges, S., Moskal, M., & Russell, J. (2019, October). Microsoft MakeCode: embedded programming for education, in blocks and TypeScript. In Proceedings of the 2019 ACM SIGPLAN Symposium on SPLASH-E (pp. 7-12).
4. Bereczki, E. O., & Kárpáti, A. (2021). Technology-enhanced creativity: A multiple case study of digital technology-integration expert teachers' beliefs and practices. Thinking Skills and Creativity, 39, 100791.
5. Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018). Artificial Intelligence trends in education: a narrative overview. Procedia Computer Science, 136, 16-24.)
6. Chen, M., Herrera, F., & Hwang, K. (2018). Cognitive computing: architecture, technologies and intelligent applications. Ieee Access, 6, 19774-19783.
7. Ching, Y. H., Hsu, Y. C., & Baldwin, S. (2018). Developing computational thinking with educational technologies for young learners. TechTrends, 62(6), 563-573.
8. Cóndor-Herrera, O., & Ramos-Galarza, C. (2021, February). Educational Technological Game for Children's Education. In International Conference on Intelligent Human Systems Integration (pp. 273-278). Springer, Cham.
9. European Commission. Education and Training Monitor report 2021. Link to website: https://op.europa.eu/webpub/eac/education-and-training-monitor-2021/en/lithuania.html viewed on 2022 04 10.
10. European Schoolnet. Country report on ICT in Education for Lithuania (2017). Link to website: http://www.eun.org/documents/411753/839549/Country+Report+Lithuania+2017.pdf/dd707697-196e-4c33-ba03-254f3698ea23 viewed on 2022 04 10.
11. Huang, X., Zou, D., Cheng, G., & Xie, H. (2021). A systematic review of AR and VR enhanced language learning. Sustainability, 13(9), 4639.
12. Kalelioglu, F., & Sentance, S. (2020). Teaching with physical computing in school: the case of the micro: bit. Education and Information Technologies, 25(4), 2577-2603.
13. Kamińska, D., Sapiński, T., Wiak, S., Tikk, T., Haamer, R. E., Avots, E., ... & Anbarjafari, G. (2019). Virtual reality and its applications in education: Survey. Information, 10(10), 318.
14. Kaplan, D. E. (2019). Creativity in education: Teaching for creativity development. Psychology, 10(2), 140-147.
15. Karpova, L., Shtefan, L., Kovalska, V., Ionova, O., & Luparenko, S. (2020). Information-Educational Environment as a Condition of Formation of Gifted Children's Informational-Digital Competence. Postmodern Openings, 11(2 Supl 1), 60-78.
16. Kumar, N. S. (2019). Implementation of artificial intelligence in imparting education and evaluating student performance. Journal of Artificial Intelligence, 1(01), 1-9.
17. Kustandi, C., Fadhillah, D., Situmorang, R., Prawiladilaga, D., & Hartati, S. (2020). VR use in online learning for higher education in Indonesia.
18. Mackare, K., & Jansone, A. (2019). The concept for e-material creating and formatting application prototype. Periodicals of Engineering and Natural Sciences, 7(1), 197-204.
19. Novak, E., & Wisdom, S. (2018). Effects of 3D printing project-based learning on preservice elementary teachers' science attitudes, science content knowledge, and anxiety about teaching science. Journal of Science Education and Technology, 27(5), 412-432.
20. Oke, A., & Fernandes, F. A. P. (2020). Innovations in teaching and learning: Exploring the perceptions of the education sector on the 4th industrial revolution (4IR). Journal of Open Innovation: Technology, Market, and Complexity, 6(2), 31.
21. Papavlasopoulou, S., Giannakos, M. N., & Jaccheri, L. (2019). Exploring children's learning experience in constructionism-based coding activities through design-based research. Computers in Human Behavior, 99, 415-427.)
22. Patterson, T., & Han, I. (2019). Learning to teach with virtual reality: Lessons from one elementary teacher. TechTrends, 63(4), 463-469.
23. Peng, L., Yen, Y., & Siswanto, I. (2020). Virtual reality teaching material-virtual reality game with education. In Journal of Physics: Conference Series (Vol. 1456, No. 1, p. 012039). IOP Publishing.
24. Pérez-Marín, D., Hijón-Neira, R., Bacelo, A., & Pizarro, C. (2020). Can computational thinking be improved by using a methodology based on metaphors and scratch to teach computer programming to children?. Computers in Human Behavior, 105, 105849.
25. Pusca, D., & Northwood, D. O. (2018). Curiosity, creativity and engineering education. Global Journal of Engineering Education, 20(3), 152-158.
26. Qadir, J., Yau, K. L. A., Imran, M. A., & Al-Fuqaha, A. (2020, October). Engineering education, moving into 2020s: Essential competencies for effective 21st century electrical & computer engineers. In 2020 IEEE Frontiers in Education Conference (FIE) (pp. 1-9). IEEE.
27. Sakulkueakulsuk, B., Witoon, S., Ngarmkajornwiwat, P., Pataranutaporn, P., Surareungchai, W., Pataranutaporn, P., & Subsoontorn, P. (2018, December). Kids making AI: Integrating machine learning, gamification, and social context in STEM education. In 2018 IEEE international conference on teaching, assessment, and learning for engineering (TALE) (pp. 1005-1010). IEEE.
28. Shatunova, O., Anisimova, T., Sabirova, F., & Kalimullina, O. (2019). STEAM as an innovative educational technology. Journal of Social Studies Education Research, 10(2), 131-144.
29. Stavroulia, K. E., Christofi, M., Zarraonandia, T., Michael-Grigoriou, D., & Lanitis, A. (2019). Virtual reality environments (VREs) for training and learning. In Learning in a Digital World (pp. 195-211). Springer, Singapore.
30. Strawhacker, A., & Bers, M. U. (2019). What they learn when they learn coding: investigating cognitive domains and computer programming knowledge in young children. Educational Technology Research and Development, 67(3), 541-575.
31. Tigrov, V., Tolstenko, A., Negrobova, L., Dobromyslova, O., & Piminov, E. (2021). Education, work and creation: ways for developing technological education of schoolchildren in Russia. Amazonia Investiga, 10(42), 206-216.
32. Tsortanidou, X., Daradoumis, T., & Barberá, E. (2019). Connecting moments of creativity, computational thinking, collaboration and new media literacy skills. Information and Learning Sciences.
33. Zhao, Y., & Liu, G. (2019, January). How do teachers face educational changes in artificial intelligence era. In 2018 International Workshop on Education Reform and Social Sciences (ERSS 2018) (pp. 47-50). Atlantis Press.
34. Rahman, M. (2019). 21st century skill'problem solving': Defining the concept. Rahman, MM (2019). 21st Century Skill "Problem Solving": Defining the Concept. Asian Journal of Interdisciplinary Research, 2(1), 64-74.