STEM-APPROACH TO THE TRANSFORMATION OF PEDAGOGICAL EDUCATION

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Abstract: STEM-education is one of the important areas of the educational reform of XXI century. Modern initiatives in the field of STEM require the development of a model for transforming education that would correspond to contemporary demands of society. Such a general scenario and preliminary statement confirm the thesis underlying this research: there is a need to transform the existing model of training, first of all, pedagogical staff from classical education to innovative STEM-education. It was found that institutions and scholars are searching for new approaches to prepare people for solving real problems of the surrounding world through different STEM-approaches in education. In the article, the authors describe the transformation model of education for the introduction of the STEM-approach in a pedagogical university in order to prepare educators of a new formation and the main indicators of its effectiveness.

Keywords: a model for transforming education, STEM-education, STEM-approach, STEM- practices, pedagogical university

INTRODUCTION

STEM-education is one of the most important areas of educational reform in the XXI century. The world of the XXI century involves competition at the global level, so countries have to invest a lot in STEM-education (Breiner et al. 2012, Kennedy, Odell 2014).

Modern digital technologies, STEM-technologies, which are becoming the foundation of an innovative economy, place new demands on staff at all levels:

- a request for qualified STEM-workers with practical skills in working with complex technological objects, with a new type of engineering thinking;

- a request for specialists with general STEM-literacy and general skills of problem-oriented thinking, that is, those who possess digital and social competences for the formulation and execution of the tasks in any and professional field.

All these requests over the last few years have been widely developing in connection with state and public attention to the IT-sector in Ukraine. Due to this attention the problems in education and staff training have been highlighted and discussed: the shortage of personnel for high-tech industries; low grades and poor knowledge of school graduates; the weakening of the natural-scientific and technical component of secondary education; weak professional orientation and the desire to master advanced technologies.

It is necessary that young people will be ready and would like to continue the STEM-career. Young people should understand that STEM is not fun and games; they must be ready to take on themselves the solution of the problems that arise in a constantly developing world. (Pittinsky, Diamante 2015).

These problems require not just the improvement of education, but also the search for new approaches for preparing people to solve real problems of the surrounding world. Therefore, nowadays more and more attention is focused on the so-called hybrid skills, when humanitarian and technical skills are equally well developed. To do this, it is necessary to train new generation teachers who are able to develop integrated STEM-skills for pupils and students. The teachers are constantly faced with new training strategies and techniques needed for successful STEM-learning and STEM-skills development. (Williams et al. 2015, Lund, Stains 2015). *As noted in* Williams et al., the concept of the STEM-approach varies greatly among educators, education researchers, curriculum developers and educational policy makers (Williams et al. 2015).

1. BACKGROUND

The STEM-approach is a wide range of actions, practices and techniques that are geared towards ensuring that society and humans will be ready for the future. These practices are only being developed today, and there is no definitive concept that would precisely and unambiguously determine the boundaries and frames of STEM-education. However, in recent years in different countries, a great deal of experience was received in the development of education in this direction. Reflection, analysis and special studies allow us to generalize and present the most significant characteristics of this approach.
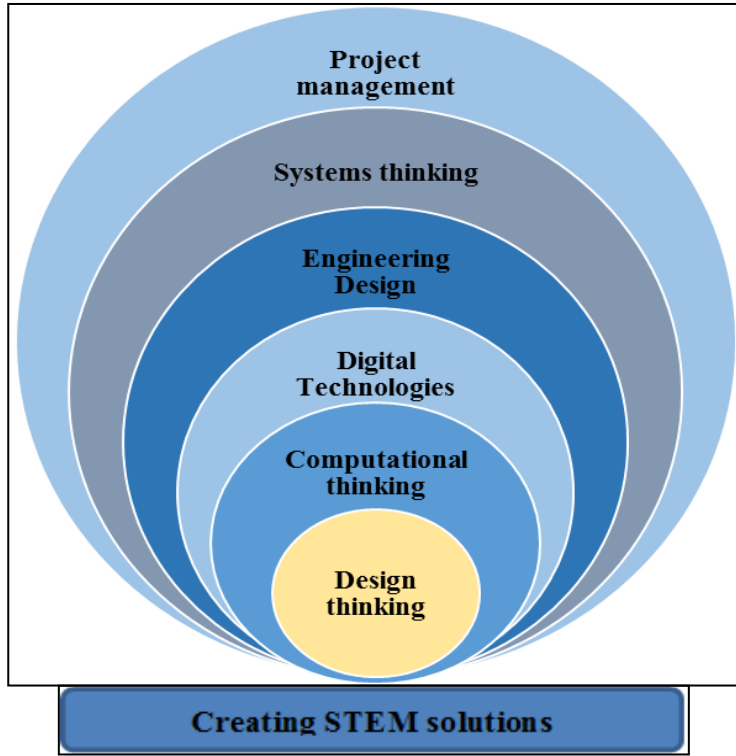
Figure 4. **Technologies for solving problems in STEM-projects**
Source: Own work

CONCLUSION

An overview of the state of STEM-education allows you to make some general conclusions. First, the intensity and diverse-plan of STEM-search can be seen as a vivid symptom of exigent transformations in education. It signals the inconsistency of the existing education system with either the innovation process or the challenges facing the individual in her individual development. Today, the STEM-approach is an area of active search, experimentation and innovation in education.

Secondly, in spite of the concentration on natural sciences, engineering and technology, the issue of STEM-education is a matter and problem of humanities–and social sciences, but first of all of methodology, management, organization of activities.

Third, STEM is the place for everyone. For the development of STEM-education, it is important to include a wide range of participants, each of which finds its own niche and its interest.

In the course of the study, the transformation model of education for the implementation of the STEM-approach in TNPU was approved, which included: increasing the intensity of communication on the topic of STEM-education, promoting the conceptions of STEM-education among the wide public, creating a scientific and research STEM-centre, conceptual and methodological developments of the transformation model of education in the direction of STEM, the training and retraining of educators and practitioners involved in education.

The main indicators of the transformation results of STEM-education at the university are: active participation of pupils, students, teachers in STEM-learning opportunities, interest in themes, concepts and practices of STEM, ability to participate productively in STEM-research processes, ability to apply relevant life and career skills, awareness of the STEM-professions, understanding the value of STEM in society.

In the future, the experience of educators in conducting research and development, the inclusion in the educational STEM-programmes of practitioners who possess these skills and have their own experience, going beyond the traditional teaching practices are relevant for the Ukrainian situation.

REFERENCES

Asunda, P. A., & Mativo, J. (2016). Integrated STEM: A new primer for teaching technology education. *Technology and Engineering Teacher, 75*(4), 8–13.

Balyk, N., Shmyger, G. (2018). Development of Digital Competences of Future Teachers In E. Smyrnova-Trybulska (Ed.), *E-learning and Smart Learning Environment for the Preparation of New Generation Specialists* Vol. 10 (pp. 487–501). Katowice-Cieszyn: Studio Noa for University of Silesia. ISSN: 2451-3644 (print edition) ISSN 2451-3652 (digital edition) ISBN: 978-83-66055-05-6.

Bouwma-Gearhart, J., Perry, K.H., Presley, J.B. (2014). Improving postsecondary STEM education: Strategies for successful interdisciplinary collaborations and brokering engagement with education research and theory. *Journal of College Science Teaching*, *44*(1), 40–47.

Breiner, J., Harkness, M., Johnson, C. C., & Koehler, C. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics*, *112*(1), 3–11. doi: http://dx.doi.org/10.1111/j.1949- 8594.2011.00109.x

Burrows, A., & Slater, T. (2015). A proposed integrated STEM framework for contemporary teacher preparation. *Teacher Education and Practice*, *28*(2/3), 318–330.

Dalimonte, C. (2013). Global STEM Navigators. *Science and Children*, *051*(02), 56–63. doi:10.2505/4/sc13_051_02_56

Encouraging STEM studies. Labour Market Situation and Comparison of Practices Targeted at Young People in Different Member States (2015). Retrieved from http://www.europarl.europa.eu/RegData/etudes/STUD/ 2015/542199/IPOL_STU(2015)542199_EN.pdf (accessed 21 May 2019).

English, L. D. (2016). STEM education K-12: Perspectives on integration. *International Journal of STEM Education*, *3*(3), 1–11. doi: 10.1186/s40594-016-0036-1.

Estapa, A. T., & Tank, K. M. (2017). Supporting integrated STEM in the elementary classroom: a professional development approach centered on an engineering design challenge. *International Journal of STEM education*, *4*(6), 1–16. doi: 10.1186/s40594-017-0058-3.

GoStem (2019). Retrieved from https://www.go-stem.org (accessed 11 June 2019).

Guzey, S. S., Moore, T. J., & Harwell, M. (2016). Building up STEM: An analysis of teacher developed engineering design-based STEM integration curricular materials. *Journal of Pre-College Engineering Education Research (J-PEER)*, *6*(1), 11–29. doi: https://doi.org/10.7771/2157-9288.1129

Honey, M., Pearson, G., & Schweingruber, A. (2014*). STEM integration in K-12 education: Status, prospects, and an agenda for research.* Washington: National Academies Press.EM.

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(11), 1–11. doi: 10.1186/s40594-016-0046-z.

Kennedy, T. J., & Odell, M. R. (2014). Engaging students in STEM education. *Science Education International*, *25*(3), 246–258.

LaForce, M., Noble, E., King, H., Century, J., Blackwell, C., Holt, S., Ibrahim, A., Loo, S. (2016). The eight essential elements of inclusive STEM high schools. *International Journal of STEM Education*, *3*(1), 1–11. doi: 10.1186/s40594-016-0054-z

Lund, T. & Stains, M. (2015). The importance of context: an exploration of factors influencing the adoption of student-centered teaching among chemistry, biology, and physics faculty. *International Journal of STEM Education*, *2*(1), 1–21. doi: https://doi.org/10.1186/s40594-015-0026-8

Moore, T., & Smith, K. (2014). Advancing the state of the art of STEM integration. *Journal of STEM Education*, *15*(1), 5–9.

Morze, N., Smyrnova-Trybulska, E., Gladun, M. (2018) Selected aspects of IBL in STEM-education In E. Smyrnova-Trybulska (Ed.), *E-learning and*

Smart Learning Environment for the Preparation of New Generation Specialists, "E-Learning". Vol. 10 (pp. 361–381). Katowice-Cieszyn: Studio Noa for University of Silesia ISSN: 2451-3644 (print edition) ISSN 2451-3652 (digital edition) ISBN: 978-83-66055-05-6.

Pittinsky, T. L., & Diamante, N. (2015). Going beyond fun in STEM. *The Phi Delta Kappan, 97*(2), 47–51. doi: https://doi.org/10.1177/0031721715610091

Roberts, A. (2013). STEM is here. Now what? *Technology and Engineering Teacher*, *73*(1), 22–27.

Smyrnova-Trybulska, E., Morze, N., Zuziak, W., Gladun, M. (2017) Robots in elementary school: some educational, legal and technical aspects. In E.Smyrnova-Trybulska (ed.), *E-learning Methodology – Implementation and Evaluation* Vol. 8 (pp. 321–343). Katowice-Cieszyn: Studio Noa for University of Silesia ISSN: 2451-3644 (print edition) ISSN 2451-3652 (digital edition) ISBN 978-83-60071-86-1.

Shmyger, G., Balyk, N. (2017). Approaches and features of modern STEM-education. *Physical-mathematical education*, *2*(12), 26–30 [in Ukrainian].

Stanford, C., Cole, R., Froyd, J., Friedrichsen, D., Khatri, R. & Henderson, C. (2016). Supporting sustained adoption of education innovations: The designing for sustained adoption assessment instrument. *International Journal of STEM Education*, *3*(1), 1–13.

STEM center (2019). Retrieved from http://stem.tnpu.edu.ua/ (accessed 21 May 2019)

Stohlmann, M., Moore, T., & Roehrig, G. (2012). Considerations for teaching integrated STEM education. *Journal of Pre-College Engineering Education Research.*, *2*(1), 28–34. doi:10.5703/1288284314653

Thorsteinsson, G., Olafsson, B., & Autio, O. (2012). Student's attitudes towards craft and technology in Iceland and Finland. *I-manager's Journal of Education Technology*, *9*(2), 40–48. doi: https://doi.org/10.26634/jet.9.2.1949

Williams, C., Walter, E., Henderson, C. & Beach, A. (2015). Describing undergraduate STEM teaching practices: a comparison of instructor self-report instruments. *International Journal of STEM Education*, *2*(1), 1–14. doi: https://doi.org/10.1186/s40594-015-0031-y