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STEAM-approach to Teacher Training at the Immanuel Kant Baltic Federal University

Anna O. Budarina* (a), Olesya V. Parakhina (b), Kseniia A. Degtyarenko (c)

(a), (b), (c) The Immanuel Kant Baltic Federal University, 236016, Kaliningrad (Russia), 14, Nevskogo
(a) ABUDARINA@kantiana.ru; (b)OParakhina@kantiana.ru; (c) KDegtyarenko@kantiana.ru

Abstract

The article represents the practices of an innovative teacher training management model implemented by the Institute of Education, the Immanuel Kant Baltic Federal University (Kaliningrad, Russia), within the framework of the pedagogical education development strategy in the Kaliningrad region.

Educational approaches that ensure the development of interdisciplinary integration become the basis for improving the teacher training system. One of the most successful practices of transdisciplinarity concept implementation is STEAM education that integrates five core fields of study. They are S – Science, T – Technology, E – Engineering, A – the Arts, M – Mathematics.

The integrated practice-oriented teacher training approach encompasses modelling educational programmes according to STEAM-approach; modern educational environment design, including final assessment procedure upgrading through introducing demonstration exam framework using WorldSkills techniques and methodology; the development of a new School-University partnership model aimed at implementing new formats of educational practices through international, national, regional, network and inner integration educational projects.

STEAM-approach based on the concepts of interdisciplinarity, metadisciplinarity and integration in education is considered as the conceptual basis of the innovative teacher training models. The existing practices of teacher training models designed according to STEAM-approach prove its effectiveness both at the training stage at the Institute of Education, the Immanuel Kant Baltic Federal University, and at the further professional development stages.

Keywords: STEAM-approach, teacher training, educational environment design, interdisciplinarity, socio-educational ecosystem.

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* Corresponding author. E-mail: ABUDARINA@kantiana.ru

Introduction

Currently, the concepts of interdisciplinarity and metadisciplinarity play a key role in education. The integration occurs at the levels of disciplines, training forms, educational activities management as well as interaction modes of stakeholders in the educational process (Bardige & Russell, 2014; Moore & Smith, 2014; Banks & Barlex, 2014; Berland & Steingut, 2016). These tendencies are due to a number of political, socio-economic and educational factors (Bybee, 2010). The interest in studying general scientific and cultural universals instead of specific phenomena and concepts relating to the field of study of each science stems from such factors as universality and accessibility of the information sector, the tendency towards a universal synthesis of knowledge, humanization and humanitarization of education, self-organization of complex systems and a culture-sensitive approach to education. One of the most successful practices of transdisciplinarity concept implementation is STEAM education that integrates five core fields of study. They are S – Science, T – Technology, E – Engineering, A – the Arts, M – Mathematics (Khine & Areepattamannil, 2019).

The complexity of professional objectives currently facing educators linked to the transformation of the mission of education has resulted in the awareness of the need to revise the existing teacher training models. The basis for improving the teacher training system are educational approaches that ensure the development of interdisciplinary integration (Conradty & Bogner, 2020; Moilanen, 2015). Within the framework of the pedagogical education development strategy in the Kaliningrad region, an innovative teacher training model has been designed in compliance with professional, educational and international standards.

The promotion and implementation of the STEAM-approach in education as a leading approach to teacher training within the social and educational ecosystem of the Kaliningrad region is due to the internal potential of this approach to the integration of all strategies and methods aimed at designing a cutting-edge educational environment. It is the STEAM-approach, based on interdisciplinarity and integration in teaching, that can serve as the conceptual basis for an innovative model for training a new type of teachers.

The concept of STEAM education as the basis for the development strategy at the Institute of Education is also being implemented in international projects. The Erasmus+ project “Integrated Approach to STEM Teacher Training” aims at developing an integrative approach to STEM teacher training, based on interdisciplinary connections and project-based learning. As a result of the implementation of the project in collaboration with partner universities (University of Helsinki, Finland; University of Limerick, Ireland;

Linköping University, Sweden; Hacettepe University, Turkey; M.O. Auezov South Kazakhstan State University, Kazakhstan; L.N. Gumilyov Eurasian National University, Kazakhstan; S. Amanzholov East Kazakhstan State University, Kazakhstan; Southern Federal University, Russia; Belgorod State National Research University, Russia) a unique network international Master's degree programme "STEAM-practices in Education" has been developed and successfully implemented at the Institute for two years.

The programme is aimed at training teachers-to be who are able not only to design basic and additional educational programmes, but also to develop high-tech ways of their implementation, such as the establishment of School Technoparks and Technopolises, STEAM Education Studios and Project Offices. The students mastering the programme get acquainted with the experience and best practices of national and international education systems. They are taught to create special educational environments that allow teachers and trainers of all levels to implement STEAM approaches and interdisciplinarity into teaching, launch high-tech educational start-ups and projects, organize and manage innovative research and project activities of students. This programme allows the graduates to become professionals with the relevant expertise in-demand not only in the context of the national education system, but also on the international labor market.

Within the structure of the Institute of Education, the Center for Natural Science, Technological, Engineering, Artistic-Aesthetic and Mathematical Design "STEAM-PARK" has been established. Its main lines of action are to conduct applied scientific research in the field of theory and practice of shaping, developing and transforming modern approaches in education; to create new and modernize existing training courses and modules related to didactic engineering, methods and techniques of STEAM education, to transfer supplementary education technologies to the educational process of a comprehensive school; to implement educational robotics practices; to coordinate and shape regional innovation platforms.

Purpose and objectives of the study

The aim of the study is to analyze the experience of implementing the designed teacher training model based on STEAM-approach and prove its effectiveness both at the training stage and at the further professional development stages. The article represents the educational practices of the Institute of Education at the Immanuel Kant Baltic Federal University (Kaliningrad, Russia).

To disseminate the experience of implementing a new practice-oriented model of training pre-service teachers, the Institute of Education has developed a project "STEAMTeach: Management of Professional Development of Pre-Service Teachers" (The STEAMTeach Project).

The project was presented for the competitive selection for the Immanuel Kant Baltic Federal University to acquire the status of a national innovation platform in December, 2020.

The conceptual basis of the project is STEAM-approach rested on the concepts of interdisciplinarity and integration in education. The STEAMTeach Project developed by the IKBFU Institute of Education as part of the strategy for the development of teacher training in the Kaliningrad region is focused on managing the professional development of pre-service teachers through the development, testing and implementation of new mechanisms, forms and methods for training teachers of a new type in the context of an innovative practice-oriented STEAM education model based on professional, educational and world standards.

The applied aspect of the STEAMTeach Project is to develop a holistic model for managing the professional development of pre-service teachers.

Literature review

The approach to teaching based on an integrated approach to the study of existing problems or phenomena was first proposed by the American bacteriologist Rita Colwell in the 1990s, who integrated Science, Technology, Engineering and Mathematics in the educational technology STEM. But more active application is associated with the name of biologist Judith Ramali, who, as the head of the US Institute of Natural Sciences, was responsible for the application of new educational programmes (cited in Khine & Areepattamannil, 2019).

The early pioneer for developing the first framework for STEAM-approach is considered to be Yackman (2008) who proposed an integrative framework wherein the last added component, the Arts (as an important component of integration), was introduced to "help students from different perspectives to understand the link between different disciplines to improve their comprehensive use of knowledge to solve practical problems" (Yakman, 2016) and inspired by the concurrent social discourse on education for creativity and a well-rounded citizen in the twenty-first century (Baik et al., 2012). According to Yackman, "STEAM educates students in the fields of science, technology, engineering, art and mathematics with an interdisciplinary approach, leading students to adapt to constantly changing professional knowledge and rapidly changing social life. <…> STEAM education supports students to understand the world in a multi-disciplined way, transforming the world in the form of comprehensive innovation" (Yakman, 2016).

Initiatives for application the integrated approach in education were supported by many countries at every level of education. Currently, there are more variations of the integrated approach.

STREAM technology that is focused on research activities through the development of reading and writing skills with the emphasis on literacy as an important component of science, engineering, and technical education (Yakman, 2016), STEM PhBL (Science, Technology, Engineering, Mathematics through Phenomenon-based learning), STEM PBL (Science, Technology, Engineering, Mathematics through Problem-based learning). The core of the designed approaches is the integrative framework to promote the professional development of teachers and improve the teaching level to meet the demands of the rapidly changing trends in education and the active development of new information and communication technologies.

Methodology

The research methods of the designated issue are theoretical methods including the analysis of the research issue through studying philosophical and psychological and pedagogical scientific sources; the analysis of the research relevant regulating documents on education policy; the analysis of renowned pedagogical practices.

This study examined the STEAM education initiative implemented by the Institute of Education, Immanuel Kant Baltic Federal University (Kaliningrad, Russia), and investigated its risks and potential positive effects of transdisciplinary and intradisciplinary links in the framework of teacher training both at the training stage at IKBFU Institute of Education and at the further professional development stages.

This paper provides a glimpse of what can be achieved through implementing STEAM-approach, and what should be further researched and advanced in organizing the educational process based on the STEAM-approach for improving the quality of education and the professional growth of teachers.

Results

The integrated practice-oriented teacher training approach encompasses designing and modelling educational programmes according to STEAM-approach; modern educational environment design, including final assessment procedure upgrading through introducing demonstration exam framework encompassing WorldSkills techniques and methodology as well as the development of a new School-University partnership model aimed at implementing new formats of educational practices through international, national, regional, network and inner integration educational projects.

Modelling the educational programme in the context of the STEAM-approach project implies the design and development of educational modules for Bachelor's degree programmes in pedagogical areas of training and introduction of such compulsory disciplines as, for example, “The Ecosystem of Project Design”, “Technical Creativity”, “STEAM-Practices in a Modern School”, “STEAM Robotics”, “Pencil Programming”, “Experimental Design”, “Game Programming and Animation”, that enable future teachers to gain competences to implement STEAM education technologies in the educational process, competences to effectively design STEAM environment for obtaining educational results as well as competences to apply methods of organizing research and project activities of learners.

However, the concept of STEAM education requires the restructuring of the educational program both in terms of its content and methods of its implementation in the framework of interdisciplinary integration, including wider use of case and project methods, inventive problem solving technologies and research experiment. It directs the educational process towards the formation of competencies to activate the imagination, creative potential and heuristic activities of learners, towards the creation of individual educational trajectories based on STEAM interdisciplinary and integration links.

The key concept of STEAM education is the design of a modern educational environment, which also implies new requirements for the State Final Certification (the format, the assessment system, etc.). The development and implementation of a demonstration exam in the WorldSkills format for State Final Certification for Bachelor's degree in pedagogical training areas is considered as an effective tool for determining the readiness of graduates to perform professional tasks. The demonstration exam allows to simulate real workplace conditions and, thus, to assess the compliance of the graduate's competencies with the existing requirements for the level of professional training of teaching staff. The introduction of the demonstration exam implies independent expert assessment (including employers) of the level of knowledge, skills and abilities of graduates in compliance with international requirements.

The creation of a new model of network School-University interaction within the educational ecosystem STEAM Community, on the one hand, will significantly strengthen the practice-oriented component in teacher training through introducing new innovative interaction modes of stakeholders in the educational process, creating innovative educational products (according to the standard “Educational Product Life Cycle”) (Rudinskiy, Parakhina, Pugacheva, & Kravets, 2020) and developing modern technologies for pupils’ support (including pupils with special needs) in the field of engineering and technical creativity; on the other hand, it will help to support the professional development of teachers in the context of CPD programmes and obtaining new competencies in the field of STEAM education.

The main participants in the proposed educational network STEAM Community are the Resource Centers of the Institute of Education, that form a wide net for creating an educational and scientific cluster and maintaining the educational ecosystem balance in the region. These are 18 leading institutions of pre-school, primary and secondary education of the region: gymnasiums, lyceums, comprehensive schools and nursery schools, which function as structural subdivisions of the University. Within the framework of the designed project, the Resource Centers act as partner organizations that carry out an expert assessment of the content of the developed STEAM- approach educational modules, the assessment of the compliance of the graduate's competencies with modern requirements within the framework of the demonstration exam and perform the role of agents in introducing and promoting new formats of STEAM education practices.

This model assumes several trajectories within students' internship. They are: introduction of practice-oriented educational events into educational modules, in particular, through a system of professional competitions and qualifying competitions within the framework of the Junior WorldSkills Russia movement where pre-service teachers can act both as participants and as tutors for schoolchildren; development of technologies for pupil's' support in the field of engineering and technical creativity, which can be implemented within the project work of student teachers. To carry out this initiative, the Resource Center of the Institute of Education "Engineering School" was opened in 2020 aiming at supporting after-school club movement through organizing and holding regional festivals of ideas and technologies.

Discussion

As a result of the STEAMTeach Project implementation, a functioning model of professional development of pre-service teachers will be created and implemented, which can be used both at the stage of teacher training through the implementation of the developed educational modules with appropriate educational and methodological support, followed by dissemination at pedagogical institutions of the Russian Federation. Educational modules "STEAM-practices in education" will vary in their content depending on the training profile in basic educational programs (pre-school education, primary education, supplementary education, etc.). State Certification in the framework of a demonstration exam will create conditions for modeling the real workplace professional activity of a teacher in order to assess the compliance of graduate's competencies with the requirements of the labor market.

Thus, the creation and implementation of a network partnership model in the university system will advance STEAM education at various levels, creating conditions for the introduction and promotion of new professional educational practices.

It will contribute to improving the quality of education and the professional growth of teachers through the generalization and dissemination of international experience in organizing the educational process based on the STEAM-approach. The designed programs for professional retraining and continuous professional development of teachers in the field of STEAM education consider modern requirements and standards of the national education system and innovative international experience and can be widely used by educational authorities to improve the quality of education. (Fig. 1)

As for the potential risks, there could be some difficulties in implementing the project. The researchers note that modern teachers are not ready for the transition to STEAM, since they themselves have not been trained according to this approach. Lack of teachers' motivation and initiative to implement STEAM-approach and to organize after-school club activities, in general, may be also caused by the lack of teaching aids and the inconsistency of contemporary curricula and programmes at school with a new approach of interdisciplinary cooperation. Among other risks there could be undeveloped criteria for assessing student achievement, formats of discipline integration within the school, limited space within the school territory, etc. These difficulties can be solved by introducing a new partnership model in the School-University system, which will provide new modes of cooperation within the regional socio-educational ecosystem. Direct collaboration among the university and the schools of the region will allow to provide methodological support for teachers through STEAM education retraining and advanced training programs, to intensify after-school-club movement in educational organizations through preparing and holding regional festivals of ideas and technologies in cooperation with the university, which can act as an educational center and a multiplier of innovative products, and also as a platform for training pupils under highly qualified teaching staff (as mentors) and a resource base with a wide range of methodological and technical support.

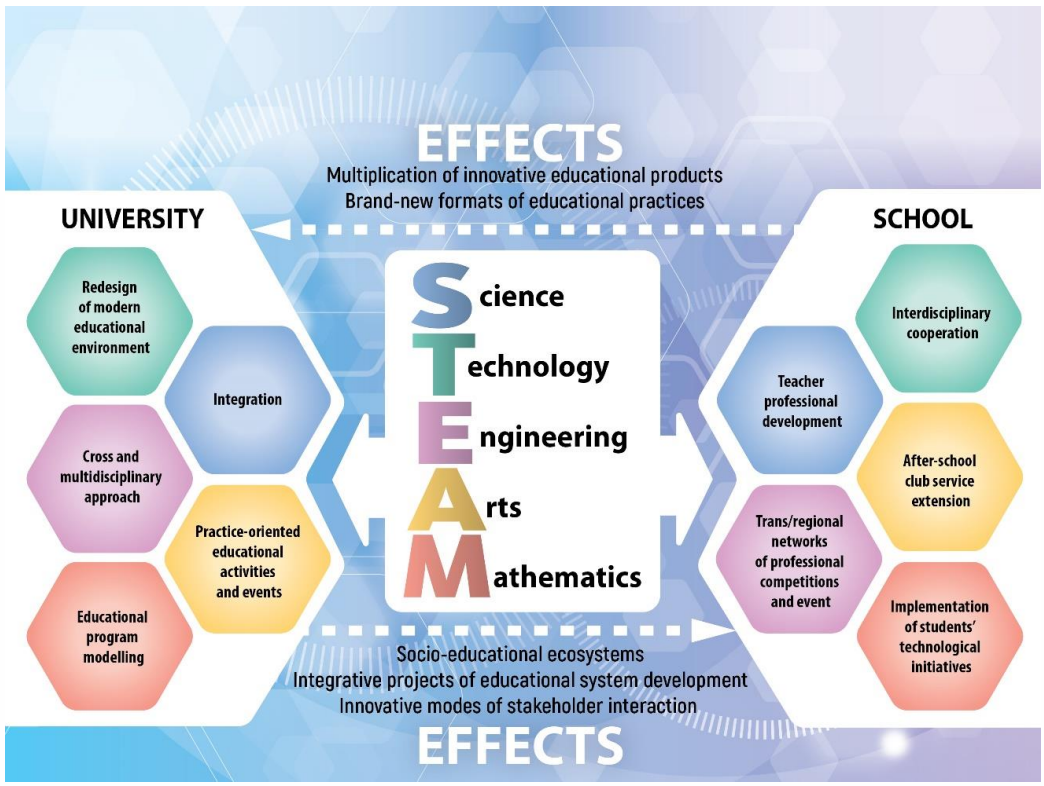

Figure 1. The model of implementing STEAM-approach within the framework of the regional ecosystem

As for the expected positive effects, the implementation of an innovative educational project will raise the prestige of the teaching profession, promote the formation and development of the regional educational ecosystem, innovate the training system for pre-service teachers in terms of optimizing the content of educational programmes and internship as well as bringing the competencies of graduates of pedagogical training fields in line with the modern requirements of the labor market and employers.

Conclusion

Learning environments are changing. Having moved front, STEAM education is implemented at different state (national, regional), educational (school, university, professional development, supplementary, informal education), collaborative (Government-Business-University) levels. Various approaches, like project-based science learning (PBSL), inquiry-based learning (IBL), problem-based learning (PBL) have become an integral part of education systems in various countries (Kang, 2019). Being a foundation of STEAM system, teachers around the world are increasingly likely to develop soft skills and core competencies in their learners.

Teachers introducing STEAM need to receive sufficient and appropriate pre-service and in-service professional development to be equipped with the skills for implementing STEAM-approach and providing cross-disciplinary working environments.

Thus, the research suggests that there is a necessity of design, approbation and implementation of new techniques, formats and methods of teacher training and development. Choosing STEAM-approach as a dominant approach to teacher training in the framework of socio-educational ecosystem of the Kaliningrad region is determined by the inner potential of the approach to integrate all the strategies and methods aimed at modern educational environment design. STEAM-approach based on the concepts of interdisciplinarity and integration in education can become the conceptual basis of the innovative teacher training models. This new educational environment mainstreams the introduction of new partnership models within the educational ecosystems, which will promote new forms of direct collaboration between a University and a School including methodological support for teachers through a line of ongoing CPD programs in the field of STEAM education, development of supplementary education and the club movement with the focus on STEAM, evolving a sustainable system of international events and festivals on technologies and STEAM ideas.

Students, parents, communities, educational institutions and organizations are the pillars on which to build a favourable environment in support of STEAM practices. Key stakeholder groups can be valuable allies but need sufficient information and positive interactions within the paradigm of STEAM education. Dialogue among all parties and a coordinated approach, aligned with national education policies, will result in powerfully transforming all students' access to and engagement in STEAM.

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