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# STEM Education:
## Key Challenges in the Common Practice

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### ABSTRACT

The purpose of the study is to analyze the key challenges in the implementation of STEM education in Russia and the largest economies in terms of employment promotion and increasing student competitiveness. The research is based on the system analysis aimed at assessing the current status of STEM education in Russia and highlighting its key problems, and the comparative analysis is focused on comparing the approaches to STEM education implementation in Russia and other countries. It has been shown that STEM approach is being most actively implemented in the American system of education, which attracts young people to STEM careers through state and non-formal STEM education programs. The research describes a scheme of cooperation and partnership between stakeholders and the federal coordinating body of the Russian Federation providing support for the STEM education and aimed at the interaction between state and public institutions.

### KEYWORDS

Engineering Education, Key Challenges in the STEM Approach Implementation, Principle of Integration, Stakeholders, STEM Education

### INTRODUCTION

The transition to a new technological order will lead to the emergence of completely new large markets in the next 10-20 years that will offer consumers advanced technological solutions and innovative products and services (Kulbyatskaya, 2017; Zhang & Niederman, 2017). Accordingly, the Fourth Industrial Revolution will soon require new quality and personnel qualifications, as well as staff retraining (Zhang & Niederman, 2017). Therefore, today the focus is being placed on STEM education in Russia and around the world. To sustain competition in the scientific and technological sphere, the Russian Federation should introduce engineering education and at the same time enhance the professional development of graduates. To accomplish this task, the Ministry of Science and Higher Education of the Russian Federation decided to introduce changes in the educational process. The active introduction of STEM education in educational institutions can be one of the ways to increase the interest of engineering students in learning and scientific activities (Sabirova et al., 2020).

STEM is an acronym used to describe scientific and technical areas in education and production. Thus, S stands for *science*, T – *technology*, E – *engineering*, M – *mathematics* (Grigoriev & Kurnosenko, 2018). The concept refers to the features of the didactics reflected in a combination

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of interdisciplinary practice-oriented approaches to the study of natural sciences and mathematical disciplines (Noor et al., 2021). Even though in modern science there are different approaches to STEM education, researchers agree that it is an innovative educational phenomenon that implies a new process of acquisition and assimilation of knowledge related to scientific, technological, engineering, and mathematical fields. Its purpose is to prepare graduates for professional activities, in particular, for performing professional tasks and solving problems through the acquisition of scientific thinking skills and the development of STEM competencies.

Today STEM education is a priority in many countries. In Russia, the trend is getting widespread within the framework of the National Technological Initiative (NTI) with the support of the Council for Economic Modernization and Innovative Development, the Ministry of Science and Higher Education of the Russian Federation, the Institute of Pedagogy and Psychology of Education, as well as the representatives of leading high-tech Russian and foreign companies and large business associations of Russia. Due to the versatility and complexity of the phenomenon, it takes a certain amount of time to solve the problems associated with the introduction of new curricula in educational institutions, as well as with the creation of conditions for STEM projects implementation. A significant advantage of STEM education is the interdisciplinary approach to teaching, which makes it possible to acquire knowledge from various sciences and use them in the study of other disciplines of the humanities, sciences or technology (Shukshina et al., 2021).

The key problems of introducing STEM education in the top countries of the world and the prospects for its development in Russia are highlighted in foreign (Kanadlı, 2019; Martin-Hansen, 2018) and Russian research (Frolov, 2010; Kulbyatskaya, 2017; Rudskoy et al., 2017b). Separate studies are devoted to STEM education with the elements of problem-based learning aimed at the improvement of student research skills (Duda et al., 2019; Grigoriev & Kurnosenko, 2018; Hadiati et al., 2019). The relevance of STEM education in terms of employment opportunities in the context of high-tech industries development is considered by both Russian scientists (Repin, 2017; Vodolazhskaya et al., 2018) and foreign researchers and practitioners (Kim & Keyhani, 2019; Jamaludin & Hung, 2017). The studies on the involvement of women in STEM careers, their appropriate training, employment and the problems that arise during these processes are also relevant from the perspective of gender parity (Mansfield et al., 2014; Pelch, 2018).

STEM education can be defined as a holistic approach which allows students to transform the knowledge and skills acquired through science and mathematics into an engineering product with the help of technology (Kanadlı, 2019). At the same time, STEM education programs include practical tasks aimed at balancing theory and practice with an emphasis on the practical component in the study of academic disciplines (Nepeina et al., 2020). STEM education programs provide an opportunity to develop technical skills in the use of modern technologies, including online educational platforms with online courses and functionality for classes (Chirikov et al., 2020). When exploring the compatibility of the new STEM approach with the old traditional one, it should be noted that the problem is not only the decision to rebuild the education system but also the readiness of the conceptual and institutional grounds for this, namely the development of new curricula and subjects, new organizational structure and standards (Vodolazhskaya et al., 2018). The use of one of the methods of STEM education – problem-oriented laboratory work – allows students to most effectively improve their research skills (Hadiati et al., 2019). Tinnell et al. (2019) determine the study of the ways to improve the teaching of STEM disciplines in the educational institution as a priority approach to the development and improvement of professional STEM competencies. The leadership of engineering institutes with the support of their faculties creates centers aimed at improving the quality of engineering education. These centers contribute to the professional development of teachers, the formation of skills to properly teach STEM disciplines to engineering students. In addition, the Accreditation Board for Engineering and Technology (ABET) located in the United States believes that two out of the seven required student learning outcomes described in the engineering curriculum ensure an effective collaboration of graduates with stakeholder employers. The two outcomes directly related to the student willingness to