

# Forming research competence and engineering thinking of school students by means of educational robotics

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## Abstract

© 2018 by the authors. The relevance of this research is defined by a possibility of increase in efficiency of school students' research competence formation by means of robotics within fixed and extracurricular activities and additional education. The problem of a research is defined by a contradiction between widespread introduction of robotics in modern society life and insufficient techniques of studying robotics in order to key competences formation. The objective of this research is studying the didactic potential of robotics for school students' research competence formation and to offer the methodical approach to the organization of classes in robotics on the basis of research tasks and research projects. The article presents methods of studying robotics, the use of which helps to form the skills of independent research activities, as well as the ability to apply modern technology in solving practical problems. The article can be used by teachers of educational organizations and the organizations of additional education in preparation for robotics classes (in fixed and in extracurricular activities, in additional education); in analysis of teaching robotics methods, teachers of pedagogical universities to present the methodology of teaching robotics to the students, teaching staff of institutions of additional professional education in preparation for training courses.

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## Keywords

Metasubject competences, Research competence, Robotics, System and activity approach, Universal educational actions

## References

- [1] Akishina, E. M., Sudakova, Y. E., Prokopyev, A. I., Yakubenko, K. Y., Solovyeva, N. A., & Korzhuev, A. V. (2017). System of cultural experience development of humanities students in modern information media conditions. *Man in India*, 97(14), 115-127
- [2] Alexandrov, A. P. (2015). Modern Robotics: Position and Prospects. *Current trends in the development of science and technology*, 8(2), 9-12
- [3] Alimisis, D. (2013). Educational robotics: Open questions and new challenges. *Themes in Science & Technology Education*, 6(1), 63-71
- [4] Apacheva, V. V. (2014). Introduction of the course "Educational Robotics and 3D Modeling" during after-hour activities. *Scientific-methodical electronic journal Concept*, 25, 176-180
- [5] Artsev, M. N. (2005). Educational and research work of students: methodical recommendations for students and teachers. *Zavuch*, 6, 4-29

- [6] Baltser, E. P. (2015). Educational robotics as a means of developing technical thinking of pupils of grades 7-8. Propaedeutics of the Forming of students' engineering culture in the context of modernization of Russian education: a collection of articles. Moscow: BINOM
- [7] Belenov, N. V. (2015). Robotics in after-hour activity as a factor in the development of technical abilities in students. *International Scientific Review*, 4(5), 11-15
- [8] Bers, M., Ponte, I., Juelich, K., Viera, A., & Schenker, J. (2002). Teachers as Designers: Integrating Robotics in early Childhood education. *InForming Technology in Childhood Education*. Retrieved from [http://makepuppet.org/stem/research/item1\\_earlychildhood\\_designcourse\\_BersITCE.pdf](http://makepuppet.org/stem/research/item1_earlychildhood_designcourse_BersITCE.pdf)
- [9] Beshenkov, S. A. (2017). *Technology*. Moscow: Binom
- [10] Bolotov, V. A. (2003). Competence model: from idea to educational program. *Pedagogy*, 10, 8-4
- [11] Borisov, P. P. (2002). Competent activity approach and modernization of the content of education. *Standards and monitoring in education*, 1, 58-61
- [12] Boyarkina, Yu. A. (2013). *Educational Robotics*. Tyumen: TOGIRRO
- [13] Bukina, E. Ya. (2014). Fundamentals of Integrative Thinking in Technical Education. *Modern Science: Actual Problems and Ways to Solve them*, 12, 116-119
- [14] Chudov, V. (2005). Design and research activity of schoolchildren. *Public education*, 1, 133-140
- [15] Dakhin, A. N. (2004). Competence and competence: how many do they have from a Russian schoolchild? *Public education*, 4, 136-137
- [16] Dakhin, A. N. (2015). *Pedagogy and Robotics*. *Pedagogy*, 6, 65-69
- [17] Davidson, Z. E., & Palermo, C. (2017). Developing Research Competence in Undergraduate Students through Hands on Learning. <https://doi.org/10.1155/2015/306380>
- [18] Dontsova, T. V. (2014). Forming of engineering thinking in the process of project activity. *Engineering education*, 16, 70-72
- [19] Dyakova, N. A. (2013). Educational robotics after-hour activity "Fundamentals of Robotics". *Pedagogical education in Altai*, 1, 327-335
- [20] Ershov, M. G. (2013). Implementation of educational standards of the new generation: educational robotics in the school. *Technological education and sustainable development of the region*, 1(10), 138-149
- [21] Filippov, S. A. (2013). *Robotics for Learners and Parents*. St. Petersburg: Science
- [22] Firsova, M. M. (2003). Research activity of pupils of a grammar school. *Pedagogics*, 8, 26-31
- [23] Galushkin, A. A. (2018). The use of information and communications technology to foster the competitiveness of the entrepreneurial organizations within the Education and Science sector. *International Journal of Engineering and Technology (UAE)*, 7(3.14-Special Issue 14), 323-326
- [24] Gertsberg, R. J. (1994). Cognitive conceptions of expertise. *International Journal of Expert Systems: Research and Applications*, 1, 1-12
- [25] Gimaliev, V. G., Prokopev, A. I., Makarova, E. V., Abdulhakova, K. R., Kozin, M. N., & Fazylyyanova, G. I. (2018). Personality features and values orientations of university students with manipulative behavior. *Espacios*, 39(20), 14
- [26] Goloborodko, E. N. (2013). Robotics as a resource for the Forming of key competencies of students. *Pedagogical education in Al-tae*, 1, 342-345
- [27] Hamada, M., & Hassan, M. (2017). An Interactive Learning Environment for InForming and Communication Theory. *EURASIA Journal of Mathematics Science and Technology Education*, 13(1), 35-59. <https://doi.org/10.12973/eurasia.2017.00603a>
- [28] Hudin, A. N. (2006). Project and research activity in profile teaching. *Management of modern school*, 6, 116-124
- [29] Hutmacher, W. (1996). Key competencies for Europe. Report of the Symposium Bern. Switzerland, 3, 27-30
- [30] Hyusen, T., & Tuyman, A. (1991). The contribution of formal schooling to the increase in intellectual capital. *Educational Researcher*, 20(7), 17-25. <https://doi.org/10.3102/0013189X020007017>
- [31] Ivanova, T. V. (2004). Competence approach. *The best pages of the pedagogical press*, 3, 28-32
- [32] Khutorskoy, A. V. (2003). Key Competencies as a Component of the Personally Oriented Education Paradigm. *Public Education*, 2, 58-64
- [33] Koposov, D. (2013). Educational robotics-the teacher's methodical tool. *Quality of education*, 9, 53-55
- [34] Korcher, E. (2014). Schulklasse testet neue EV3 Physik-Experimente-Eine Entwicklung der htw saar und des Fraunhofer Instituts im Auftrag von LEGO® Education. Retrieved from <http://emrolab.htw-saarland.de/index.php/news/154-ev3physikexperimente>
- [35] Kryukova, N. I., Zakharova, A. N., Dulina, G. S., Yusupova, Z. F., Belonovskaya, I. D., & Bogdanova, J. N. (2017). Didactic features of pedagogical interaction as the basis of university education. *Man in India*, 97(3), 29-41

- [36] Kuzmina, M. V. (2016). Educational robotics: an educational-methodical manual for educators on the development of educational robotics in the conditions of the implementation of the Federal State Educational Standards. Kirov: Open Company "Printing house" Old Vyatka "
- [37] Leontovich, A. V. (1999). Educational activity of schoolchildren as a model of pedagogical technology. *School technology*, 1, 132-135
- [38] Leontovich, A. V. (2006). Modeling research activities of students: practical aspects. *School technology*, 6, 89-98
- [39] Maksimov, V. V. (2011). Organization of additional education for students of educational robotics. *Modern InForming Technologies and IT Education*, 7, 881-886
- [40] McVey, M. (2013). Changing spaces of education: New perspectives on the nature of learning. *International Review of Education*, 59(6), 805-807. <https://doi.org/10.1007/s11159-013-9394-9>
- [41] Mukhina, B. C. (2006). The psychological meaning of research for personal development. *School Technology*, 2, 19-31
- [42] Mulder, M. (2012). Competence Theory and Research. Retrieved from <https://www.wur.nl/en/show/Competence-Theory-and-Research.htm>
- [43] Mutavchi, E. P., Prokopyev, A. I., Kostyleva, G. V., Blinov, L. V., Fedorov, V. V., & Polichka, A. E. (2018). Scientific-methodical resource of student training and vocational motivation development in university. *Espacios*, 39(20), 15
- [44] Natalevich, A. N. (2014). Fundamentals of design and research activities in training programs on robotics. *Scientific and methodical electronic magazine "Concept"*, 25, 56-60
- [45] Novogorodova, A. S. (2013). Development of skills of initial design and modeling on the basis of designers of Lego. Chelyabinsk: Vzgl'yad
- [46] Obukhov, A. S. (1999). Research as a way of forming a world outlook. *Public Education*, 10, 74-81
- [47] Obukhov, A. S. (2006). Efficiency of application of design and research activity in teaching. *School technologies*, 5, 86-90
- [48] Osmolovskaya, I. M. (2006). Key competences in education: their meaning, meaning and ways of Forming. *Director of the school*, 8, 64-69
- [49] Papert, S. (1980). *Children, Computers, and Powerful Ideas*. Retrieved from <http://worrydream.com/refs/Pap-ert20-20Mindstorms201st20ed.pdf>
- [50] Petunin, O. V. (2003). Forming of cognitive independence of senior schoolchildren in the process of in-depth study of subjects of the natural-science cycle Text. Kemerovo: Kuzbassvuzizdat
- [51] Pivovarov, A. A. (2014). Who goes to what? *Journal of the head of the department of education*, 7, 63-67
- [52] Potapova, S. V., Danilova, I. Y., Prasolov, V. I., Makarova, E. V., & Kryukova, N. I. (2018). Mythological foundations of ontology. *XLinguae*, 11(2), 672-685. <https://doi.org/10.18355/XL.2018.11.02.53>
- [53] Raven, J. (2002). *Competence in modern society: identification, development and implementation*. Moscow: Kogito Center
- [54] Ryzhakov, M. V. (1999). Key Competencies in the Standard: Implementation Opportunities. *Standards and Monitoring in Education*, 4, 20-23
- [55] Savenkov, A. (2004). Aspects of competence. *Director of the school*, 6, 40-48
- [56] Sazonova, Z. S., & Chechetkina, N. V. (2007). *The development of engineering thinking is the basis for improving the quality of education*. Moscow: MADI
- [57] Scanlon, E. (2010). Technology enhanced learning in science: interactions, affordances and design based research. *Journal of Interactive Media in Education*, 2, 8-15. <https://doi.org/10.5334/2010-8>
- [58] Shumakova, N. B. (2006). The research position of the child as a factor in the development of giftedness. *First-hand*, 10, 2-7
- [59] Sitnikov, P. L. (2014). Robotics in a modern school. *Pedagogical experience: theory, methodology, practice*, 1(1), 192-194
- [60] Skorokhodova, G. G. (2014). Robotics and lego-design. *Scientific and methodical electronic journal Concept-Nr*, 12, 226-230
- [61] Skurikhina, Yu. A. (2014). Informatization of the educational organization: problems and prospects. *Education in the Kirov region*, 1(29), 4-5
- [62] Skurikhina, Yu. A. (2015). Research activity in the lesson. Co-temporary lesson: traditions and innovations. A collection of materials of the All-Russian Scientific and Practical Conference. Kirov: IRO, pp. 175-177
- [63] Skurikhina, Yu. A. (2016). Designing a program for the development of universal learning activities: methodical recommendations. Kirov: KOGOAU DPO «IRO of the Kirov region»
- [64] Skurikhina, Yu. A. (2017a). Simulation of the process for the implementation of the inForming management system. *Scientific and InForming Publishing Center "Institute for Strategic Studies"*, pp. 127-132

- [65] Skurikhina, Yu. A. (2017b). Approaches to the development of inForming technologies in the organizations of the city of Kirov. *Modern education: growth strategies and effective educational practices*. Conference proceedings. Omutninsk, pp. 428-434
- [66] Spencer, L. M. (2003a). *Competence at work: models for superior performance*. New York: Rutledge
- [67] Spencer, L. M. (2003b). *Soft Skill Competencies*. Edinburgh: The Scottish Council for Research in Education
- [68] Staroverova, M. I. (2007). Forming of educational research activity of schoolchildren in the context of informatization of the learning process (Abstract. dis. doc. ped. sciences). Biysk
- [69] Startseva, E. A. (2016). Robotics in the educational process. *Vocational education and society*, 1(17), 44-46
- [70] Stepkina, I. E. (2013). Educational robotics in the educational process as a factor in the preparation for choosing a technical specialty. *Pedagogical education in the Altai*, 1, 308-311
- [71] Stoycheva, K. (1998). Ambiguity tolerance: Adolescents' responses to uncertainty in life. Johann Jacobs Foundation of Switzerland. Retrieved from <http://www.eric.ed.gov/PDFS/ED422547.pdf>
- [72] Surmann, H., Nuchter, A., & Hertzberg, J. (2003). An autonomous mobile robot with a 3D laser range finder for 3D exploration and digitalization of indoor environments. *Robotics and Autonomous Systems*, 45(3), 181-198. <https://doi.org/10.1016/j.robot.2003.09.004>
- [73] Ustinova, N. N. (2015). Development of technical creativity of schoolchildren on a circle on robotics. Forming of engineering thinking in the learning process: Materials of the international scientific and practical conference, pp. 243-247
- [74] Van den Berg, N. (2017). Boundary-crossing competences of educators and researchers in working on educational issues. Retrieved from <https://uasjournal.fi/tag/research-competence/>
- [75] Velde, C. (1997). Crossing borders: an alternative conception of competence. 27 Annual SCUTREA conference, pp. 27-35
- [76] Vorobyeva, A. V. (2013). Research competences of a modern schoolboy. Retrieved from <http://www.journal-discussion.ru/publication.php?id=157>
- [77] Vtorina, E. A. (2003). The problem of the teacher's professional competence. *The best pages of the pedagogical press*, 2, 28-31
- [78] Zaprudsky, N. I. (2016). Experimental studies of students: relevance, problems, and solutions. Retrieved from <http://olxovka.en>
- [79] Zimnyaya, I. A. (2003). Key competences: a new paradigm of the result of education. *Higher education today*, 5, 54-59
- [80] Zimnyaya, I. A. (2006). Competence approach. What is his place in the system of modern approaches to the problems of education? *Higher education today*, 8, 20-26
- [81] Zinovkina, M. M. (1996). *Engineering thinking (Theory and innovative pedagogical technologies)*. Moscow: MGIU
- [82] Zlakazov, A. S. (2013). *Lessons of LEGO-design in the school*. Moscow: Binom
- [83] Znamenskaya, O. (2006). The dynamics of the development of research and mathematical competencies of senior pupils. *The director of the school*, 5, 60-65