

Methodological teaching system of mathematical foundations of formal languages as a means of fundamentalization of education

Bushmeleva N., Baklashova T.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2017 Authors. The purpose of the study is to develop content and identify appropriate methods, forms and means of studying formal languages that take into account the specific character of professional development of the future specialist. The methodological basis of the study is the system approach and the methodology for selecting the content of education, which allows to generalize and systematize the process of constructing the content of teaching formal languages, and to improve the content of training to specific formal languages. The article suggests a system for studying mathematical foundations of formal languages as a system-forming element in the training of specialists in the field of computer science, programming, and IT-technologies. It gives reasons for the inclusion of elements of the theory of formal languages in the learning process, defines the structure and content of learning tasks and objectives, develops the system of end-to-end concepts and the logical structure of the course program, suggests the order of presenting the training material, the system of training assignments for a laboratory course on a computer. The developed system allows graduates to get the opportunity to develop a high-level understanding of systems in general, which contributes to a common understanding of the structure of computer systems, and the processes of their creation and analysis.

<http://dx.doi.org/10.12973/eurasia.2017.00989a>

Keywords

Computer science and programming, Content of education, Formal languages, Fundamentalization, Mathematical foundations

References

- [1] Aleksandrov, A. V., Kazakov, S. V., & Sergushichev, A. A. (2013). The use of evolutionary programming based on training examples for the generation of finite state machines for controlling objects with complex behavior. *Journal of Computer and Systems Sciences International*, 52, 410-425. doi:10.1134/S1064230713020020
- [2] Armoni, M., & Ben-Ari, M. (2009). The Concept of Nondeterminism: Its Development and Implications for Teaching. *Science & Education*, 18(8), 1005-1030. doi:10.1007/s11191-008-9147-5
- [3] Beloshapka, V. K. (1992). Computer science as a science of letters. *Informatics and Education*, 1, 6-12

- [4] Beshenkov, S. A., Mindzaeva, E. V., Beshenkova, E. V., Shutikova, M. I., & Trubina I. I. (2016). Information Education in Russia. In V. Uskov, R. Howlett, & L. Jain, (eds.), *Smart Education and e-Learning 2016. Smart Innovation, Systems and Technologies*, 59, 563-571. doi:10.1007/978-3-319-39690-3_50
- [5] Bilgaeva, N.Ts. (2000). *Theory of algorithms, formal languages, grammars and automata: Teaching guide*. Ulan-Ude: ESSUTM
- [6] Broy, M. (1996). *Informatics?. Fundamental introduction*. In 4 pt. 4.1. Moscow: Dialogue-MEPHl
- [7] Bulanova-Toporkova, M. V. (2002). *Pedagogy and psychology of the higher school*. Rostov-on-Don: Phoenix
- [8] Chalmers, C., Carter, M., & Cooper, T. (2017). Implementing "Big Ideas" to Advance the Teaching and Learning of Science, Technology, Engineering, and Mathematics (STEM) *International Journal of Science and Mathematics Education*, 15(Suppl 1), 25-43. doi:10.1007/s10763-017-9799-1
- [9] Chapman, O., & An, S. (2017). A survey of university-based programs that support in-service and pre-service mathematics teachers' change. *ZDM Mathematics Education*, 49(2), 171-185. doi:10.1007/s11858-017-0852-x
- [10] *Computer Science Curricula (2013). Curriculum Guidelines for Undergraduate Degree Programs in Computer Science*. New York, NY, USA: ACM
- [11] Devedzic, V., & Debenham, J. (1998). An Intelligent Tutoring System for Teaching Formal Languages. In B. P. Goettl, H. M. Half, C. L. Redfield, & V. J. Shute, (eds.), *Intelligent Tutoring Systems. ITS 1998. Lecture Notes in Computer Science*, 1452, 514-523. Springer, Berlin, Heidelberg. doi:10.1007/3-540-68716-5_57
- [12] Ershov, A. P. (1994). *Selected works*. Novosibirsk: Nauka
- [13] Fejer, P. A., Dan, A. & Simovici, D. A. (1991). *Mathematical Foundations of Computer Science. Sets, Relations, and Induction*, 1. doi:10.1007/978-1-4612-3086-1
- [14] Fomina, A. A. (2003). *Method of training future teachers of computer science in formal languages (PhD Thesis)*. Russian State Pedagogical University named after Herzen, St. Petersburg
- [15] Gravemeijer, K., Stephan, M. & Julie, C. (2017). What Mathematics Education May Prepare Students for the Society of the Future? *International Journal of Science and Mathematics Education*, 15(Suppl 1), 105-123. doi:10.1007/s10763-017-9814-6
- [16] Hausser, R. (2014). *Foundations of Computational Linguistics*. Berlin, Heidelberg: Springer-Verlag. doi:10.1007/978-3-642-41431-2
- [17] Il'in, V. P. (2015). Computational mathematics and informatics: Global challenges and Russia's roadmap. *Herald of the Russian Academy of Sciences*, 85(1), 8-14. doi:10.1134/S1019331615010098
- [18] Karpov, Y. G. (2012). *Theory and technology of programming. Fundamentals of building compilers*. Moscow: BHV
- [19] Kinelev, V. G. (1996). Education and civilization. *Informatics and Education*, 5, 21-28
- [20] Kirillova, G. I. (2001). *Optimization of the content of information and computer training in the secondary vocational school (PhD Thesis)*. Kazan State Pedagogical institute, Kazan
- [21] Knuth, D. (1976). *Art of computer programming. V.1: Basic algorithms*. Moscow: Mir publ
- [22] Knuth, D. (1977). *Art of computer programming. V.2: Seminumerical algorithms*. Moscow: Mir publ
- [23] Knuth, D. (1978). *Art of computer programming. V.3: Sorting and searching*. Moscow: Mir publ
- [24] Kuznetsov, A. A. (2010). *Fundamentals of general theory and methods of teaching computer science: Teaching guide*. Moscow: BINOM. Knowledge Laboratory
- [25] Kuznetsova, V. A. (1995). *Theory and practice of multilevel university pedagogical education*. Yaroslavl: YarSU
- [26] Laptev, V. V., & Ryzhova, N. I. (2002). The concept of fundamentalization of education in the field of computer science and its implementation in a pedagogical university. *Izvestia: Herzen University Journal of Humanities & Sciences*, 3, 124-135
- [27] Marchuk, A. G., Tikhonova, T. I., & Gorodnyaya, L. V. (2011). Novosibirsk Young Programmers' School: A Way to Success and Future Development. In J. Impagliazzo, & E. Proydakov, (eds.), *Perspectives on Soviet and Russian Computing*, 228-234. *IFIP Advances in Information and Communication Technology*, 357. Berlin, Heidelberg: Springer. doi:10.1007/978-3-642-22816-2_27
- [28] Maróti, G. (2003). Didactic approach for teaching nondeterminism in automata theory. *Zentralblatt für Didaktik der Mathematik*, 35(2), 48-55. doi:10.1007/BF02652772
- [29] Moiseev, N. N. (2001). *Universe. Information. Society*. Moscow: Ustoichiviy mir
- [30] Moshchensky, A. V., & Moshchensky, V. A. (2008). *Mathematical foundations of computer science*. Minsk: BSU
- [31] Myasnikov, V., & Voskresenskaya, N. (2005). Compare, study, critically evaluate. *Uchitel*, 2, 6-10
- [32] Nakamura, K., & Imada, K. (2010). Incremental Learning of Cellular Automata for Parallel Recognition of Formal Languages. *International Conference on Discovery Science*, 117-131. doi: 10.1007/978-3-642-16184-1_9
- [33] Pentus, A. E., & Pentus, M. P. (2004). *Theory of formal languages*. Moscow: Publishing house of MSU Centralized Institute of Mechanics and Mathematics

- [34] Pobedonostseva, M. G. (2016). Requirements for education at the present stage of society. In collection: Actual problems of the methods of teaching computer science in a modern school. International scientific and practical Internet conference
- [35] Pobedonostseva, M. G., & Shutikova, M. I. (2007). Intersubject communications of computer science. *TSU Journal, Tambov: Derzhavin Tambov State University*, 12(5), 621-622
- [36] Ryzhova, N. I. (2000). Development of the methodical system of fundamental training of future computer science teachers in the subject area (PhD Thesis). St. Petersburg: RSEU Publishing House
- [37] Ryzhova, N. I. (2000). Elements of theoretical computer science: Exercises on the mathematical foundations of computer science: formal semantics of programming languages: Teaching guide for students. St. Petersburg: RSEU Publishing House
- [38] Ryzhova, N. I. (2011). Mathematical foundations of computer science as an element of mathematical training of computer science teacher. *World of Science, Culture & Education*, 5, 158-163
- [39] Sadovnikov, N. V. (2011). Fundamentalization of contemporary education. *Izv. Penz. gos. pedagog. univ. im. i V. G. Belinskogo*. 24, 782-786
- [40] Semenyuk, E. P. (2016). Informatics in the context of the differentiation and integration of science. *Scientific and Technical Information Processing*, 43(1), 8-19. doi:10.3103/S0147688216010044
- [41] Shvetsky, M. V. (1994). Methodical system of fundamental training of future teachers of computer science in a pedagogical university in conditions of two-level education (PhD Thesis). St. Petersburg: Russian Pedagogical Institute
- [42] Stefanova, N. L., & Shubina, N. L. (2001). Fundamental science and fundamental education: the problem of correlation and interaction. *Academic readings*, 2, 27-30
- [43] Stepin, V. S. (2000). Theoretical knowledge. Moscow: Progress-Traditsiya
- [44] Subetto, A. I. (1995). Problems of fundamentalization and sources of the content of higher education: Facets of public policy. Kostroma: Kostroma ped. un
- [45] Valeeva, R. A., & Bushmeleva, N. A. (2016). Forming analytical competency of higher school students. *IEJME-Mathematics Education*, 11(8), 3137-3148. doi:10.12973/mathedu.2015.109a
- [46] Van der Wal, N. J., Bakker, A., & Drijvers, P. (2017). Which Techno-mathematical Literacies Are Essential for Future Engineers? *International Journal of Science and Mathematics Education*, 15(Suppl 1), 87. doi:10.1007/s10763-017-9810-x
- [47] Volkova, I. A., Vylitok, A. A., & Rudenko, T. V. (2009). Formal grammars and languages. Elements of translation theory. Moscow: Publishing Department of the Faculty of Computational Mathematics and Cybernetics, Lomonosov Moscow State University
- [48] Yarullin, I. F., Bushmeleva, N. A., & Tsyrukun, I. I. (2015). The research competence development of students trained in mathematical direction. *IEJME-Mathematics Education*, 10(3), 137-146. doi:10.12973/mathedu.2015.109a