

The occurrence and distribution of programming and computational thinking in mathematics education research

Martyna K. Fojcik^{1, 2}

¹Volda University College, Faculty of Humanities and Education, Norway;
martyna.fojcik@hivolda.no

²University of Agder, Faculty of Engineering and Science, Norway

Keywords: Programming, computational thinking, mathematics education research.

Introduction and background

There is an ongoing debate in the mathematics education community about the relation between programming and mathematics education (Refvik & Opsal, 2023). When looking retrospectively at the development and integration of programming in school, there can be noticed two rather distinct waves (Dolonen et al., 2019). The ‘first wave’ started with Papert around 1980 and his idea of learning through Logo programming in close relation with mathematics. While the ‘second wave’ is both characterized by Wing’s in 2006 popularization of the general skill ‘computational thinking’ (CT) and the many new developments in both computer science and programming, in software, hardware and approaches to these, all of which have influenced and changed the programming process (Armoni, 2016). Lodi and Martini (2021) argue that the original intentions of both Papert and Wing have been misinterpreted, and the today’s popularization of this topic do not understand the meaning behind these terms. The aim of this study is to look at the occurrence and distribution of the terms ‘programming’ (central in first wave) and ‘computational thinking’ (central in second wave) in prominent mathematics education journals.

Method

This research design is based on a two-phase bibliometric study. In the first phase, prominent mathematics education journals are characterized and selected by using the SCImago Journal Rank Indicator, based on the Scopus database (SJR, 2022). This search analysed the ‘Mathematics (miscellaneous)’ category and looked for educational journals, while second (control) search analysed the ‘Education’ category and looked for mathematics journals. The first 5 journals the occurred in both searches were chosen as the prominent journals for this study, see Table 1. The second phase involved using search engines in each of the selected prominent journals to find articles with the keywords ‘programming’ and ‘computational thinking’, characterized from the first and second wave of introducing programming in schools. The search was conducted in January and February 2023 and found 573 possible articles in these journals. An additional search in each article showed that only 107 articles actually used one of the keywords in their original form (e.g., ‘programming’ rather than ‘program’, or ‘computational thinking’ rather than ‘computation’ or ‘computational’).

Results and concluding remarks

All 107 articles mentioning at least one of the keywords have been grouped and distributed over different decades, presented in Table 1. The selected prominent journals have different numbers of

volumes and different number of issues in volumes, making them inadequate for direct comparisons. However, some differences are apparent.

Table 1: Distribution of the 107 articles during different decades.

Prominent mathematics education journals	First issue	1970-1979	1980-1989	1990-1999	2000-2009	2010-2019	2020-2023
International Journal of Research in Undergraduate Mathematics Education	2015					2	6
Educational Studies in Mathematics	1968	2	6	14	7+2	5	8
ZDM - International Journal on Mathematics Education	1997				2+2	17	10
Journal of Mathematics Teacher Education	1998						1
International Journal of Science and Mathematics Education	2003					12	11
		total	31		total	76	

The total number of articles, at the bottom of Table 1, shows that it doubled during ‘second wave’ (blue numbers) compared to the ‘first wave’ (red numbers). It can also be seen that the same number of articles were published between 2010 and 2019 as in the three years and two months between 2020 and 2023. This may suggest that the topic of programming and computational thinking have increased in recent studies.

The results show a wide variety of different proportions that prominent journals have published on programming and computational thinking. A pattern is also presented that may suggest that there is a growing body of research on studying programming and/or computational thinking in mathematics education, but some findings may suggest that many articles do not combine computational thinking and programming in relation to each other in mathematics education research.

References

- Armoni, M. (2016). Computing in schools. Computer science, computational thinking, programming, coding: the anomalies of transitivity in K-12 computer science education. *ACM Inroads*, 7(4), 24–27. <http://doi.org/10.1145/3011071>
- Dolonen, J. A., Kluge, A., Litherland, K. & Mørch, A. I. (2019). *Litteraturgjennomgang av programmering i skolen [Literature review of programming in school]*. <http://urn.nb.no/URN:NBN:no-79405>
- Lodi, M., & Martini, S. (2021). Computational thinking, between Papert and Wing. *Science & Education* 30(4), 883–908. <https://doi.org/10.1007/s11191-021-00202-5>
- Refvik, K. A. S. & Opsal, H. (2023). Do Optional Programming Courses Affect Eighth-Grade Students’ Mathematical Problem Solving? *Computers in the Schools*. <https://doi.org/10.1080/07380569.2023.2175634>
- SJR (2022). Scimago Journal & Country Rank. <https://www.scimagojr.com/journalrank.php?category=3304>