

Mathematics Textbooks Related to Algebra Content

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Introduction

Mathematics textbooks as educational resources and artifacts are widely used in classroom teaching and learning. What is presented in a textbook is often taught by teachers in the classroom. Similarly, what is missing from the textbook may not be presented by the teacher. Textbook content reflects pedagogical intention. This study is based on an assumption that pedagogical content knowledge (PCK) (Shulman, 1986) is embedded in the subject content presented in textbooks. Textbooks contain both subject content knowledge (CK) and pedagogical content knowledge (PCK). The embedded PCK in textbooks varies depending on which teaching culture a textbook reflects. Quadratic equations as part of algebra content are taught at Swedish upper-secondary school. This study is about analyzing algebra content concerning different methods, including factorization, for solving quadratic equations presented in Swedish mathematics textbooks, with PCK-CK (Shulman, 1986; Mishra & Koehler, 2006) as analytical framework. The study has been done in the form of a licentiate thesis (Sönnerhed, 2011).

The aims of the study

The primary aim of the study was to explore what pedagogical content knowledge (PCK) regarding solving quadratic equations that is embedded in the mathematics textbooks. The secondary aim was to analyze the algebra content as subject content (CK) from the perspective of mathematics as a discipline related to historical development of algebra.

Research methods

Content analysis with the PCK-CK as theoretical framework has been applied for the study. The analytical criteria were based on the previous research on textbook analysis. Four rounds of analyses were carried out. Twelve Swedish upper-secondary textbooks were involved. One of them was selected for a deep analysis. The results were generated accumulatively in every round of analysis.

The results of the study

The results show that the selected textbooks all presented four methods for solving quadratic equations. There was an accumulative relationship among these methods with a final goal of presenting how to solve quadratic equations by the quadratic formula (often called the pq-formula). It was found that one of the textbooks contained an overall embedded teaching trajectory with five sub-trajectories in the presentation of solving quadratic equations with the four solving methods¹. Instead of factorization, among the four methods the quadratic formula is emphasized as a final goal in the overall trajectory. The five sub-trajectories were organized and connected by four historically related geometrical models according to a part-whole relationship. These four geometrical models of areas for rectangles and squares represent basic algebra rules for building up the four different solving methods. That way, a complete teaching sequence on solving quadratic equations was offered in the textbook. The finding implies that teaching in Swedish classrooms may put focus on solving quadratic equations by the pq-formula. Teaching quadratic expressions has different focuses in different mathematics classroom cultures. In Singapore and China, for example, teaching the factorization method (also called cross-multiplication method) is emphasized (Kemp, 2010; Leong et al., 2010). Consequently, this may lead students to solve quadratic equations with the factorization method in focus. Learning to use the pq-formula may implement an instrumental understanding of quadratic equations while the factorization method may provide students with opportunities for understanding quadratic structures and preparing them for the future study of factorizing polynomials at a higher degree. However, the hypothesis requires further research. The continued study will compare the same algebra content between Chinese textbooks and the analyzed Swedish textbooks.

References

- Kemp, A. (2010). Factorizing quadratics. *Mathematics in School: For Secondary and College Teachers of Mathematics*, 39(4), 44-45.
- Leong, Y. H., Yap, S. F., Yvoone, T. M., Mohd Zaini, I. K. B., Chiew, Q. E., Tan, K. L. K., & Subramaniam, T. (2010). Concretising factorisation of quadratic expressions. *The Australian Mathematics Teacher*, 66(3), 19-24.
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017-1054.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Research*, 15(2), 4-14.
- Sönnerhed, W. W. (2011). *Mathematics textbooks for teaching*. Retrieved from <http://gupea.ub.gu.se/handle/2077/27935>

¹ The four solving methods refer to the square root method; using factorization method to solve simple quadratic equations; completing the square method and a quadratic formula.