

Number sense in the app Vektor: Mathematical progression and use of various modes

Helena Johansson¹, Malin Norberg¹, and Magnus Österholm^{1,2}

¹Mid Sweden University, ²Umeå University

This presentation describes an on-going study that takes a multisemiotic approach to analyse the app Vektor in order to understand how interaction between different modes in digital tools can support students' development of number sense. Preliminary results show that some interactions between modes highlight central aspects of number sense, while the purpose with other interactions are unclear.

Introduction

To learn, understand, and use mathematics, one must be able to make meaning from different modes (e.g., mathematical symbols, writing, and images). Empirical studies show that various combinations of different modes could be challenging for students to interpret (e.g., Dyrvold, 2016; Norberg, 2020). For example, the use of various images can be very demanding for students to handle (Dyrvold, 2016), the mathematical symbolic language, especially in relation to natural language, create complexity in the teaching of mathematics (Johansson & Österholm, 2019), and mathematical texts that include mathematical symbols require another type of reading than mathematical texts without these kinds of symbols (e.g., Österholm, 2006). The integration of digital learning resources in mathematics increases the potential for using more modes to present mathematical content and activities, thus opening for more ways to understand mathematics, but also perhaps even more complex interactions between modes.

This study aims to contribute to the understanding of how digital learning resources can be used to support students' mathematical learning, especially concerning the use of different modes. The focus is delimited to number sense, and a particular app, Vektor, was analysed. Vektor consists of several exercises with different focus, and only the two exercises that address number sense are included in the analyses in this study. These are called Number Pals and Number Line. The research questions are: 1) *How are different modes used to present central aspects of number sense?* 2) *What mathematical progression is made possible in relation to how different modes are used?*

Analysis, results, and conclusion

Based on a literature review, a structure of central perspectives and aspects of number sense (e.g., mental number line and numeric symbolisation) was created. A multisemiotic perspective was used to analyse the present of modes (Kress, 2010) with respect to the created structure, as well as to identify changes in modes between each step when a user only provides the right answer in each exercise.

Preliminary results show that different modes, such as coloured blocks and numbers, interact in such ways that the aspect of *number as a size* is made visible (Figure 1a). Furthermore, the interaction between filled blocks and numbers on a number line (Figure 1b) could help visualising *numbers as a position*, as well as contribute to development of a symbolic *mental number line* (a central aspect of number sense).

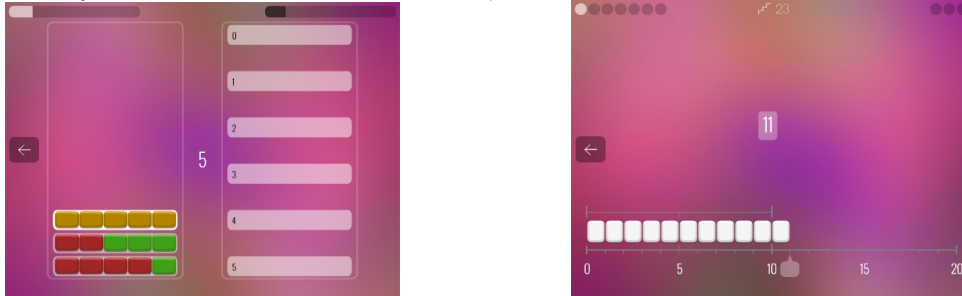


Figure 1. Examples of modes visualising number as a size in Number Pals (1a), as well as modes visualising numbers as positions in Number Line (1b).

Furthermore, preliminary analysis showed that a clear progression emerged in Number Pals, by presenting higher and higher numbers, and also when the modes used for numbers changed from iconic (coloured blocks), to more abstract (only numerical symbols). The progression in Number Line, on the other hand, was not as clear. It could though be seen that number ranges were expanded, as well as expanded number sets, from initially including the natural numbers to later including positive rational numbers. There was also a certain progression within each step in sub-exercises, where first single numbers should be represented on the number line, and later it was the operations addition and subtraction that should be represented using the number line.

Results show that Vektor, as a digital learning resource, can provide opportunities for students to develop their number sense through interactions between different modes in the exercises. Further studies are required to explore if students notice and use these provided opportunities, or what challenges there might be for students with these types of interactions.

References

- Dyrvold, A. (2016). The role of semiotic resources when reading and solving mathematics tasks. *Nordic Studies in Mathematics Education*, 21(3), 51–72.
- Johansson, H. & Österholm, M. (2019). Objectification of upper-secondary teachers' verbal discourse in relation to symbolic expression. *The Journal of Mathematical Behavior*, 56.
- Kress, G. R. (2010). *Multimodality: A social semiotic approach to contemporary communication*. London: Routledge.
- Norberg, M. (2020). *Från design till meningsskapande: En multimodal studie om elevers arbete med matematikläroböcker i årskurs 1* (Mittuniversitetet doktorsavhandling, 317) [Doktorsavhandling]. Mittuniversitetet.
- Österholm, M. (2006). Characterizing reading comprehension of mathematical texts. *Educational Studies in Mathematics*, 63(3), 325–346. <https://doi.org/10.1007/s10649-005-9016-y>