Implementing Learning Study to foster Mathematical Knowledge for Teaching: a case in preservice teacher education in the Netherlands

Dédé de Haan[1], Siebrich de Vries[2], Paul Drijvers[1] and Gerrit Roorda[3]

[1]Utrecht University, Freudenthal Institute, the Netherlands; d.dehaan@uu.nl

[2]NHLStenden Hogeschool, Leeuwarden, the Netherlands

[3]University of Groningen, the Netherlands

Keywords: Algebra, Conjecture Mapping, Preservice teacher education, Learning Study, Mathematical Knowledge for Teaching.

Introduction

Teaching mathematics not only requires deep knowledge about the topic taught (Specialized Content Knowledge, SCK), but also knowledge of how students understand the topic (Knowledge of Content and Students, KCS), and knowledge about how to carefully sequence the explanation of the topic (Knowledge of Content and Teaching, KCT). All together this kind of knowledge is called Mathematical Knowledge for Teaching (MKT) (Ball et al., 2008). Although this is taught in Dutch initial teacher education (ITE), most preservice teachers (PSTs) find it hard to apply what they have learned in their education to their teaching practice. In this study, we investigate how participating in a course designed as a Learning Study influences the different aspects of the MKT of PSTs.

Theoretical Framework

Learning Study (LgS) is a method like Lesson Study (LS) in which (preservice) teachers collaborate on the cyclical design of a so-called research lesson, in which learning from their own students is central. The PSTs carry out the research lesson (one performs, the other group members observe the students), reflect on it, adapt the lesson and perform it again. LgS differs from LS through the application of variation theory, a specific pedagogical learning theory. Central in variation theory is the discernment of critical aspects of an object of learning. By varying a critical aspect (for instance, the intercept of a linear function) against an invariant background (slope and variables remain the same), the varied aspect is likely to be discerned by the learner. Prior to designing a research lesson using variation theory as a guiding principle, the PSTs seek to understand how their students understand a particular concept, in order to determine the critical aspects that should be discerned. This is usually done by conducting a pre-test. Skemp (1978) provides the notions to interpret the different ways the concept can be understood: relational and instrumental understanding. Instrumental understanding refers to knowing what to do; relational understanding adds how and why. Applying variation theory in designing the research lesson provides the opportunity for students to achieve relational understanding of the topic. A prerequisite for this to happen is that the PSTs themselves develop relational understanding of the topic (Marton, 2015). We designed a LgS-course that would trigger experiences leading to PSTs' fostering of SCK, KCS and KCT. Several studies on LgS in ITE suggest these conjectures, for example Royea & Nicol (2018). However, we do not know which elements in the design trigger the mechanisms that lead to SCK, KCS and KCT outcomes, and whether and to what extent SCK, KCS and KCT will be fostered. Our research question therefore is:

how and to what extent does participating in a Learning Study in mathematics teacher education in the Netherlands influence preservice teachers' SCK, KCS and KCT?

Methods

We used conjecture mapping (Sandoval, 2014) to structure the embodiment of our LgS design, the mechanisms we expected to take place and the outcomes that we expected based on literature. Six PSTs (two groups, in their last year of ITE) participated in the LgS, on topics within algebra, from October 2021-May 2022, with 15 meetings at the ITE institute. The PSTs went through all LgS phases. In June 2022, all PSTs were interviewed from two perspectives: first, on what the elements of the LgS initiated for them, and second, on if and how their SCK, KCS and KCT were fostered. This allowed us to capture the relations between embodiment, mechanisms and outcomes.

Results

Findings show slightly different results for each of the PSTs. Common for all PSTs is that analyzing the pre-test, together with observing the research lesson leads to understanding in what way students (mis)understand the Object of Learning (OL). This leads to more awareness of how students come to understand the OL the way they do (KCS), but also to more awareness of how to teach the OL (KCT). The PSTs' own knowledge of the OL increases as well (SCK). We will present the results on the poster in a visual way, using graphics.

Conclusion

The analysis of the relation between the embodiment, the mechanisms and the outcomes shows that the awareness of the PSTs of their students' thinking (KCS) and the related teaching (KCT) has increased, and that the increase of their own relational understanding of the mathematical topic (SCK) is a prerequisite for that. It is a modest strengthening, and in most cases limited to the OL of the LgS.

Acknowledgment

This presentation is part of a PhD-trajectory (with project number 023.016.040) of the Doctoral Grant for Teachers programme, which is (partly) financed by the Dutch Research Council (NWO).

References

Ball, D., Thames, M., & Phelps, G. (2008). Content Knowledge for Teaching. What makes it special? *Journal of Teacher Education, 59*(5), 389–407. https://doi.org/10.1177/0022487108324554

Marton, F. (2015). *Necessary Conditions of Learning*. Taylor & Francis. https://doi.org/10.4324/9781315816876

Royea, D.A. & Nicol, C. (2018). Pre-service teachers' experiences of learning study: Learning with and using variation theory. *Educational Action Research, 27*(4), 564–580. https://doi.org/10.1080/09650792.2018.1515094

Sandoval, W. (2014). Conjecture mapping: An approach to systematic educational design research. *Journal of the Learning Sciences, 23*(1), 18–36. https://doi.org/10.1080/10508406.2013.778204

Skemp, R. (1978). Relational understanding and instrumental understanding. *The Arithmetic Teacher*, *26*(3), 9–15. https://doi.org/10.5951/AT.26.3.0009