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**Capturing Student Beliefs At, During, and Because of the Transition from School to University  
Mathematics: Evidence of Influence of the Historical Development of Geometry**

**Abstract**

In 2015, we began work on the design, development, and implementation of a seminar for undergraduate mathematics students who were preparing to teach mathematics. The theoretical underpinning of the seminar included our hypothesis that:

The change from an empirical-object oriented to a formal-abstract belief system of mathematics constitutes a crucial obstacle for the transition from school to university. And, on epistemological grounds, similar changes regarding different natures of mathematics can be described for the history of mathematics. The explicit analysis of the historical genesis provides support for students dealing with their individual transition processes.

From this hypothesis we also highlight our notion of the two extremities of the belief system continuum. As we previously asserted (Witzke, Struve, Clark, & Stoffels, 2016), “an empirical belief system on the one hand describes a set of beliefs in which mathematics is understood as an experimental natural science, which includes deductive reasoning about empirical objects” (p. 71); whereas, a formalistic belief system “describes a set of beliefs in which mathematics is understood as a system of un-interpreted concepts and their connections in propositional functions ..., which can be established using axioms, (implicit) definitions, and proofs” (p. 72).

Thus, driven by the stated hypothesis, the aim of the seminar was to promote students’ awareness of the changes regarding the nature of mathematics from school to university. We used geometry as the topic of the seminar’s mathematical content and the seminar activities included engaging students in reading and discussing excerpts, task transcripts, textbooks, standards, and historical resources, as well as working on various tasks prompted by historical sources and content. The seminar, “Addressing the Transition Problem from School to University Mathematics” (which we refer to as the ÜberPro Seminar, from the German, ÜbergangsProblematik, and in English, “transition problem”) was first implemented as a three-day intensive seminar in Spring 2015. In relation to literature focused on the transition from school to university mathematics contexts, Gueudet and colleagues (2017) have described certain boundary objects which may play a significant role in helping students to “make this transition.”<sup>1</sup> In particular, Bosch noted, “in the case of the transition between secondary and tertiary education, an interesting boundary object can be the so-called bridging courses organized in different universities to smooth the gap between upper-secondary school and university” (p. 109). In this way, ÜberPro may be considered in this classification of such bridging

courses; however, the unique attribute of our course is in the potential of utilizing the case of the historical development of geometry. We have described the first implementation of ÜberPro elsewhere (Witzke et al., 2016), as well as the modifications to extend the initial intensive seminar into a semester-long seminar experience (Witzke, Clark, Struve, & Stoffels, in press). Furthermore, we propose that in light of the instructional materials (e.g., textbooks) that students face in school mathematics, they are more likely to acquire an empirical belief system. Yet, at university, students are likely to obtain a formalistic belief system based upon the instructional materials found there. Epistemologically, both of these experiences provide parallels to specific historical understandings of mathematics, which we sought to highlight as the fundamental components for the design of our “transition problem” seminar for students.

In this workshop, we will first provide background and context of the ÜberPro seminars. Then, we will engage participants with sample activities used with students in the seminar. In the time remaining, we will describe one aspect of the research conducted during the third implementation of ÜberPro in Summer 2017. In our research on the implementation and impact of the ÜberPro seminar, we sought to address the question: In what ways do ÜberPro Seminar students, confronted with the historical development of mathematics, recognize their own transition? Data sources included recordings of and field notes from 12 class sessions, seminar materials, and “reflection learning diaries” (RLDs) from approximately 15 seminar students. We conjectured that the RLDs would provide important evidence about whether the explicit analysis of the historical genesis addressed in the seminar supported students in dealing with their individual transition processes. In our analysis of the students’ seminar experience – especially with a focus on the way in which the seminar served to promote students’ awareness of changes in the nature of mathematics – we searched for evidence of the ways in which students responded to weekly research diary questions. In particular, we sought to (1) determine whether the RLD questions were addressed or not by the student, and (2) classify whether there was explicit attention to an emotional, content, or opinion orientation within their responses. Since a key outcome of the seminar was to understand how students were recognizing and dealing with their own transition process, the first author was particularly interested in the emotionality expressed as students were confronted by elements of the transition from school to university mathematics as presented during the seminar. In the workshop, we will present data from cases that represent students at different points of recognition and awareness of their own transition as prompted by an examination of the historical development of geometry. Consequently, we hope to engage workshop participants in discussion about both methodological and conceptual questions regarding the research we are conducting, as well as the application of the research in other contexts.

## References

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<sup>1</sup> To clarify, we are concerned more with working with students to recognize and address said transition, and less on “making the transition” in the research on the design and implementation of ÜberPro.