



# Transition from school into university mathematics: experiences across educational contexts

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The term ‘transition’ describes a process of change, which involves discontinuities and often crisis. The ICMI Topic Survey by Gueudet et al. (2016) offers a recent overview on transitions, describing transitions in mathematics education from three distinct perspectives: epistemological, cognitive and socio-cultural. The authors then state that any change in one of the three dimensions can be considered a transition in mathematics education. The volume, a very comprehensive survey of the state of the art in this field, goes on to describe both the theoretical frameworks that have been adopted to understand transitions, and the topics and research questions that scholars have investigated in each of the theoretical perspectives adopted.

Gueudet et al. (2016) observe that much of the research related to the transition from school to university mathematics has addressed predominantly the epistemological and cognitive difficulties students face. Recently, considering what Lerman (2000) calls ‘the social turn’, two perspectives have been added to the study of this transition: the affective (e.g. Di Martino & Gregorio, 2019; Geisler & Rolka, 2021) and the socio-cultural (e.g. Hernandez-Martinez & Williams, 2013) perspective. This shift in focus was the first motivation for the development of this Special Issue of *Educational Studies in Mathematics*. On the one hand, we asked whether and how much the turn to a holistic view of transition—one that considers the socio-cultural and affective as well as the cognitive aspects of this phenomena—had inspired scholars and motivated studies about the transition into university mathematics outside the well-rehearsed consideration of cognitive difficulties that students encounter in mathematics at the start of a STEM degree. On the other, we wanted to contribute to this social turn, involving scholars from a variety of theoretical perspectives.

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According to the cumulative nature of mathematics education (Schoenfeld, 2000), the first step for the development of this Special Issue was to carry out a systematic review of the literature (Di Martino et al., 2022a). From this work, two further motivations came to our consideration. The first was the significance of the transition from school to university mathematics, intended as the transition experienced in mathematics by students who join STEM degrees with a significant mathematics component. This emphasis is justified by the high levels of dropout involving students who were successful in high school (Geisler & Rolka, 2021). Understanding this transition and the worrisome (and in some way unexpected) phenomenon of dropout can help educators and institutions to better support students to be successful in mathematics also in their university experience. The second concerned the geographical distribution of this research and the impact that it may have on the findings of such research. We believe it is particularly relevant to discuss how the cultural, institutional and educational context may impact students' transition to university mathematics. Therefore, the social turn evoked by Lerman (2000) will not be accomplished in tertiary transition research until the variety of higher education systems, institutions and cultures across countries is considered. We developed this Special Issue also with the aim of offering a glimpse of how students and lecturers experienced the transition to university mathematics across a variety of countries and educational contexts.

The Special Issue opens with a systematic review of the literature (Di Martino et al., 2022a) covering the years 2008 (the year of the foundational review of the literature by Gueudet, published in *Educational Studies in Mathematics*) to 2021. The first outcome of this review is an issue of underrepresentation: we know little about research coming from certain geographical areas such as Africa, South America or Asia. This in part reflects the general distribution of mathematics education research, but it is particularly troublesome in the study of transitions as we hypothesise that the educational context shapes students' experiences (socio-cultural perspective on the secondary to tertiary transition). The second outcome concerns the perspectives adopted by studies in this area. Although there has been a diversification in theoretical frameworks used to research the transition into university mathematics since 2008, and that the socio-cultural and affective aspects of this transition are starting to be considered, studies adopting the cognitive/epistemological perspectives are still dominant in this research. In this Special Issue, we therefore choose to investigate affective and socio-cultural perspectives on secondary to tertiary transition.

Included in this Special Issue are empirical studies from Central Europe, Hong Kong, Israel, Korea and New Zealand, employing a variety of theoretical frameworks such as Figured Worlds (Holland et al., 1998), Rite of Passage (Clark & Lovric, 2008), Commognition (Sfard, 2008), Improvement Science (Perla et al., 2013), Three-Dimensional Model for Attitude toward Mathematics (Di Martino & Zan, 2010) and Sociomathematical Norms (Yackel & Cobb, 1996). In line with the aims of the Special Issue, these theoretical frameworks focus on the social and affective rather than the cognitive aspects of the transition.

From the systematic review of the literature (Di Martino et al., 2022a), it appears that there is the need for more research from educational contexts such as East-Asia, and this Special Issue contains two papers that address this gap. The first, by Liang et al. (2022), adopts the construct of figured worlds (Holland et al., 1998) to investigate the effects of the double discontinuity (Klein, 1939) that pre-service mathematics teachers experience during their training in Hong Kong. The authors notice that there can be continuity in the transition from school to university, to teacher education, and that such continuity can be an asset for teachers to understand the problems of transition of the students they will eventually teach. A second paper by Lim et al. (2022) is situated in the Korean context and investigates the effect that a very competitive and exam-focused system such as the

Korean one can have on students' perceptions of learning, guiding them towards an acquisitionist model of learning and hence depriving them of the opportunity to socialise into mathematics.

Two contributions come from Europe—where there is a very strong tradition of research on transition issues. The first, by Di Martino et al. (2022b), sets up a comparison between the affective and socio-cultural experiences of students during the secondary to tertiary transition across three European countries: Switzerland, Italy and the UK. They find that the educational context impacts on the experiences of students during the transition, and that a superficially uniform picture of transition hides significant differences when such transition is considered holistically according to students' social, affective and cognitive experiences. The second, by Geisler et al. (2022), reports on the relation between German students' mathematics interest and dropout from a mathematics degree. The authors conclude that the interest students have for school mathematics has no influence on university dropout, but that interest in university mathematics and students' mathematical self-concept are aligned to a decreasing risk to drop out from university studies. Pinto and Koichu (2022) investigate the secondary to tertiary transition from a different angle and report findings from a survey of mathematics university teachers from 30 countries. They asked participants for their perspectives on the importance of secondary to tertiary transition for students joining degrees with a large component of mathematics. Results reveal that the transition is perceived to be a big problem by most of the university teachers surveyed and that interventions targeted to alleviate this problem and perceived to be the most effective are aligned with the enculturation-oriented approach and include mentoring and tutorials. However, the participants do not perceive that the situation has improved over time. From New Zealand, Kontorovich and Ovadiya (2022) employ the theoretical framework of commognition (Sfard, 2008) to report the experience of undergraduate students who lead tutorials for first year mathematics students. They found that the students' experiences of the secondary to tertiary transition when they themselves were starting the university degree helped them making sense of the realities of their tutees, again indicating that the double discontinuity may have also positive effects on those who are still students and are themselves teachers. The Special Issue concludes with a contribution by Gueudet (2023) that synthesises the lessons learned from the papers included in this Special Issue, discussing the development and advances made since her review in 2008 (Gueudet, 2008).

Based on the contributions included in this volume, it is possible to identify some significant research directions for understanding the secondary to tertiary transition:

1. This research needs to develop studies from under-represented contexts and comparative studies between different educational contexts to better understand the role of socio-cultural aspects and to distinguish between aspects of this transition which depend on the educational contexts and aspects which are common to students from different contexts.
2. This research also needs studies that differentiate between distinct transitions at the university level, for example between transitions of students on mathematics degree and on STEM degrees (e.g., engineering) and of students on teacher education courses.
3. Researchers in the area need to design and evaluate interventions that alleviate the crisis inherent to the transition into university mathematics and that reduce the dropout of students on STEM degrees.

We believe that this Special Issue contributes to our understanding of the transition from school to university mathematics by reporting findings in under-researched areas

such as the role and impact of affect on this transition and by including the experiences of students in often under-represented areas. However, as indicated by the three further directions mentioned above, we see this Special Issue as the beginning of a conversation between researchers: a starting point to develop our understanding of the secondary to tertiary transition rather than an end point of a completed research programme.

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