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► **To cite this version:**

Eirini Kouvela, Irene Biza, Theodossios Zachariades. Tackling the difficulties of the transition from school to university mathematics. CERME 9 - Ninth Congress of the European Society for Research in Mathematics Education, Charles University in Prague, Faculty of Education; ERME, Feb 2015, Prague, Czech Republic. pp.2287-2288. hal-01288658

HAL Id: hal-01288658

<https://hal.archives-ouvertes.fr/hal-01288658>

Submitted on 15 Mar 2016

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Tackling the difficulties of the transition from school to university mathematics

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This paper reports on a study that investigates the difficulties encountered by first year undergraduate mathematics students during their transition from school to university mathematics. The research is a case study of five students who were followed regularly from the beginning until the end of the semester through questionnaires and interviews while they were attending a Calculus course. The results of the research revealed difficulties faced by undergraduate students regarding the content of the module and the social and academic context. In addition, the research suggests a categorization according to the approaches that students adopted in order to tackle these problems.

Key words: *Transition, university mathematics, first year undergraduates, calculus.*

This paper reports on a study that investigates the difficulties first year undergraduate students of a Greek department of Mathematics who attend a Calculus course face in their transition from secondary to tertiary education and how these students deal with these difficulties. The main research questions are: (a) Which difficulties do first year mathematics students face in their learning of Calculus during their transition from school to university? (b) To what extent do the social and academic environment affect the transition? (c) How do students deal with these difficulties? The results we report in this paper regard mainly the third question.

Transition problems from secondary school to university mathematics have been a recurrent issue which varies across different educational systems. Researchers note that there is a gap between school and university mathematics. School students study mathematics in a different way than the one required

in university and as Clark and Lovric (2008) have indicated, mathematics courses at university focus on conceptual understanding whereas school mathematics tends to have more procedural characteristics. Advanced mathematical thinking requires students to develop working techniques that are necessary to understand and apply mathematical notions, definitions, theorems and proofs and this is a challenge for first-year students entering tertiary education (Hoffkamp, Schnieder, & Paravicini, 2013). Apart from factors related to mathematical content, other factors are also important when students are entering university. These include their mathematical background, the academic and social environment, and their study habits (Pongboriboon, 1992).

In the department of mathematics where this study was conducted, Calculus is offered in the autumn semester of the first year with four hours of lectures and two hours of tutorials. Attendance is not obligatory and students have the option to sit the exams just after the end of the teaching period in January and resit in July or September, if they fail, or transfer their assessment to the resit periods directly. Also, students have the option to drop out of the module and register in it again the following year.

The research is a case study of five students who were followed from the beginning until the end of the semester. Data collection was separated in two phases. In the first phase a questionnaire was handed out in a Calculus course consisting of general questions about students' profile (e.g., gender, grades in secondary school, etc.) and some mathematical tasks. Then five students were selected according to the criteria of gender, grades and responses to the tasks and were interviewed. The second phase of the research included three successive interviews that were spread across

the first semester and were conducted by the first author. During the first two interviews students talked about their experience in the university, responded to a set of mathematical tasks and commented on their responses to these tasks. In the last interview students were asked about their overall experience in the Calculus module and their new life in university.

The results of this research revealed that students face various difficulties during their transition from secondary to tertiary education. Some of these difficulties concern the content of the taught module, in our case Calculus, and some others to the new social and academic environment that students have to adjust to. Analysis suggested three categories of students in terms of the approaches they used to tackle these difficulties. In all categories students begin their studies with great interest in mathematics. In the first category, students face difficulties mainly with the mathematical content. They consider the Calculus module very difficult. They become disappointed in the first weeks and they decide to transfer the module to the following year and pay attention to other modules which are easier to them: “It is not going very well because I am left behind, I said I would study on my own because I could not understand the first things we have done and then I just quitted and I thought of studying another module.” In the second category students realize from the beginning of the semester the differences between school and university, such as the new environment, the content of the module, the way the course is taught and the study habits. Despite the difficulties, they study hard: “[...] I started dealing with it [module] more seriously, studying more and considering the whole situation in a more mature way”. However this is not always effective due to their lack of mathematical understanding. In the third category, similarly to the second one, students face difficulties but mostly to the social and academic environment of university. The autonomy of university work challenges them mostly but gradually they adopt a new way of thinking. In the end they find a way to adjust to the new institution: “There are differences [from school] that make you feel insecure, it is a new environment that you have to integrate into, find your own path [...] in the beginning you feel like you are lost, but once you find your way everything works better.”

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