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ORIGINAL ARTICLE

"This is what you need to be learning": an analysis of messages received by first-year mathematics students during their transition to university

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Abstract This paper explores the messages that first-year mathematics students receive in the context of their academic studies during their transition from school to university mathematics. Through observations of lectures and discussions with first-year mathematics undergraduates in an English university, we identified and analysed the messages that two of their lecturers transmitted to them during this transitional phase. The results suggest that strongly framed messages are more easily perceived by students and affect them during their transition. Additionally, messages that have been received in the school context continue to have control over students' thinking and on many occasions can impede adjustment to the new setting.

Keywords Transition · University mathematics · Messages

Introduction

The secondary-tertiary transition has been a recurrent issue in the research field of mathematics education. Many studies have been implemented, mainly with a focus on the difficulties that students face when they leave the school context for the university one. The transition to university is still a hot topic in the mathematics education research community because, despite it being researched extensively and despite many attempts to address and alleviate these difficulties (bridging courses, support centres, etc.), problems persist.

When students come from school to university to study mathematics, they make a life-changing move. They are expected to be more "independent" and "responsible" and

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embrace the feeling of "freedom" that university provides. They move from a safety bubble created throughout their previous years of education by their school teachers and their parents to an environment that requires the development of critical thinking, creation of consistent arguments and independent ways of thinking and working.

Compounding the existing problem are some UK government policies which aim to recruit yet more mathematics graduates equipping them with the skills required for science-based occupations which, it is claimed, contribute more to the economy (Roberts 2002). For this reason, the UK government funded various projects (e.g. More Maths Grads) to increase students' participation in STEM disciplines. Despite being well meaning, this tactic of encouraging more students into an already problematic situation has the potential for serious consequences. Some students select their degree programme according to the exchange value that this will offer them later in the job market and not necessarily through any intrinsic interest in the programme itself. This eventually makes their transition harder. Therefore, as Black and Hernandez-Martinez (2016) argue, there is a necessity to leave behind the "institutional practices which emphasize arbitrary forms of exchange value" (p. 141).

This paper aims to shed more light on the issue of transition to university mathematics by focusing on the discourses taking place during teaching-learning interactions, specifically on the messages that lecturers transmit to their students and on the potential influences that these can have during the transitional phase. Additionally, we are interested in how these influences affect the ways that students position themselves as learners in the new context.

Background

The existent literature recognizes a gap between school and university mathematics (Luk 2005; Brandell et al. 2008; Winslow 2013). This gap refers to the differences in the nature of the mathematics taught at school and that taught at university (Daskalogianni and Simpson 2002; Luk 2005; Solomon and Croft 2016); the differences in the ways that students must think, work and communicate mathematics (Tall 1991; Hoffkamp et al. 2013; Breen and O'Shea 2015); and the institutional differences between secondary and tertiary education (Artigue 2004). De Guzmán et al. (1998) classified the difficulties that students face during the transitional phase in three distinct categories: epistemological/cognitive, sociological/cultural, and didactical. This classification has been expanded and enriched by Gueudet (2008) who reviewed several studies and distinguished them in three categories according to the approaches used to investigate the issue: thinking mode and organization of knowledge, proofs and mathematical communication, and didactical transposition and the didactical contract. Her categorization begins from the individual and expands to the institution. Drawing on De Guzmán et al.'s (1998) classification, in the following, we explore in more detail those studies, which focus on the didactical and sociological/cultural aspects of the transition, which are more relevant to this paper.

Changes in the didactical and sociological/cultural aspects

Several authors have investigated differences between typical school and university teaching practices. Thomas and Klymchuk (2012) refer to a high percentage of students

who participated in their study (77.8%) reporting differences in teaching style and/or the emphasis in university mathematics courses. This includes changes in the way resources are provided, the assessment practices, the pace that is followed and, the level of interaction.

Various researchers refer to the differences in the way learning resources are used in the two educational settings (De Guzmán et al. 1998; Pampaka et al. 2012; Thomas and Klymchuk 2012). For instance, a common issue is that some students do not know how to take notes when they come to university, because in high school, they were used to having a specified textbook (De Guzmán et al. 1998). Another issue that arises when students enter university is the different level of interaction they have with their lecturers compared to the level of interaction they used to have with their teachers. Scholars describe the extent to which the teaching is impersonal (Pampaka et al. 2012; Thomas and Klymchuk 2012) and the opportunities that students have to discuss ideas and problems (Pampaka et al. 2012) as differences in the new context. Finally, the assessment procedures and the way feedback is provided at university change. Jablonka et al. (2016) make the distinction between "formative feedback" that students receive in the school classroom and the "summative assessment" which takes the form of an examination at the end of the semester often in undergraduate courses. Interestingly, the difference in teachers' control over students' work (Pampaka et al. 2012) is not always problematic as students adjust to the new context; the authors argue that the students in their study were not concerned with the low level of control that the lecturers had over their work. Thomas and Klymchuk (2012) report that the students in their study recognized that lecturers have greater flexibility than teachers in how, when, and how often they assess students.

The social and cultural aspects of the transition have been at the epicentre of various studies in the area. Researchers recognize issues such as the change in the cohort size, the classroom climate at university, the new social setting, independence, and new academic requirements as some of the most important features of the transitional experience.

The cohort size at university is almost always bigger than that at school and this change usually troubles freshmen (De Guzmán et al. 1998; Thomas and Klymchuk 2012). The size of the group can make them often feel too intimidated to raise questions about the things that they do not understand. Additionally, De Guzmán et al. (1998) refer to the competitiveness that is created occasionally among students in the lecture theatres and which can create a feeling of discomfort. Furthermore, when students enter university, they are unaware of numerous aspects of university life and the ways in which academic requirements will change from those they were used to at school (Clark and Lovric 2008). Thomas and Klymchuk (2012) argue that one of the biggest problems that students encounter with the move to university is the freedom that they acquire. A contributing factor to the independence required at this level of studying is the extent to which students are treated as adults, and this is also a big change for first-year students (Pampaka et al. 2012).

The TRANSMATHS project (www.transmaths.org) investigated, with the use of socio-cultural theories, the transitions to post-compulsory education in England, i.e. from school to sixth form college and from sixth form college to university. For instance, Hernandez-Martinez et al. (2011) examine the ways in which the identities of students develop while they engage in different activities during the transition from school to college. They argue that students during this phase construct their identities

through different social interactions and consequently they position themselves in the new institution in different ways. The troubles that these students encountered during their transition were seen as an opportunity for stepping up and not as an obstacle.

Similarly, Solomon and Croft (2016) use the concept of alienation to explore the reasons why students disengage from university mathematics. The authors focus on the relationships with mathematics that students bring with them from school and on the changes that these relationships undergo at university. They argue that students who favoured more transmissionist teaching at school might feel less confident at university; these students alienated themselves from the activity of mathematics at university because they focused primarily on memorizing rules and on the exchange value of mathematics. At the same time, students who tried to build new relationships within the new context and invest in their participation in the community of mathematics, became frustrated because they felt that they were not supported enough by the institution.

Using elements of Bernstein's (2000) theory, Jablonka et al. (2016) investigated whether engineering students were able to recognize the change in criteria associated with mathematical rigour required at university. They concluded that the students pay attention to a variety of aspects in mathematics texts by which they "(mis)recognize" the precision of the mathematics pedagogic discourse. This (mis)recognition can hamper their eventual academic success.

Hourigan and O'Donoghue (2007) employed Brousseau's concept of didactical contract to study the pre-tertiary mathematics experience of entering students, in the Irish educational context. The authors investigated the didactical contracts of two distinct mathematics classrooms and identified many common features in the two. The "national obsession with the state examination" (p.473) led the teachers to follow examination-driven practices. These practices narrowed students' future potentials and did not promote skills that are necessary in tertiary level mathematics courses, such as problem-solving abilities, self-confidence in working with challenging problems, and more flexible ways of thinking.

Introducing a new perspective to approach the issue

Our focus in this paper is on didactical and sociological/cultural aspects of the transition that have been proven problematic by previous researchers, but here, we adopt a different approach.

Starting with the shift that occurs in the teaching-learning practices between school and university we aim to explain how the discourses that frame this shift affect the transition. We pinpoint not only the differences in the practices, but we analyse the messages that are transmitted to the students through them and how students interpret and enact them back. In this way, we aim to describe the student transition in a relational way. We aim to emphasize the agency of students in interpreting and enacting such messages, something that the literature tends to understate.

Theoretical framework

Bernstein's (1971, 1996, 2000) work focuses on educational transmissions and explains how knowledge is reproduced by controlling what is taught, and how, by those in

power. The educational knowledge is transformed into pedagogic discourse through the conceptual instruments of classification and framing. These concepts describe the power and control relations between agents, discourses, and spaces during the teaching-learning interactions. Herein, we use them to demonstrate how the messages transmitted by lecturers transform the knowledge that they possess about mathematics (referring to both the content of the subject and the learning practices) into discourse. Classification characterizes the power relations between discourses and thus sets the limits of any discourse; when classification is strong, the discourse is well insulated with strong boundaries. A strong classificatory message carries a lot of power (Bernstein 1971). In the context of our study, a strong classificatory message is an explicit message transmitted by the lecturer through which students can recognize the specific context of the discourse. Whether or not they can distinguish this message from other messages depends on them as individual learners as we will see in the following. Framing reveals the control relations that a transmitted message can carry and shows the form of realization of a discourse. The control is over the selection, sequencing, pacing, and evaluation of the communicated knowledge. When a message is strongly framed, there are reduced options and the control is with the transmitter (Bernstein 1971). In our study, a strongly framed message gives all the control to the lecturer and regulates explicitly students' thinking over something that is discussed or practiced.

Several researchers have used Bernstein's work in instructional contexts to explain various educational issues through the concepts of classification and framing. For example, Morais et al. (2004) argued that to promote scientific development in school children with different social backgrounds, the pedagogic practice should be mixed, among other things, with weak boundaries between teachers' and students' spaces, weak pacing over learning, and strong intra-disciplinary relations. Similarly, Bourne (2004) exemplified how changes in the degree of framing of the pedagogic discourse can help students dig deeper into the meanings that are expected to be learned.

Senninger's (2000) model illustrates in what ways learning situations can be created and consists of three zones: the comfort zone, the learning zone, and the panic zone. The comfort zone consists of those things that are familiar to an individual; it provides safety but does not provide new learning opportunities. In order to learn, an individual needs to move from the comfort zone to the learning zone where growth and learning takes place. In the learning zone, people can discover new things, explore their limits, and expand their comfort zone by becoming familiar with more material to be learned. Beyond the learning zone lies the panic zone; in this zone, the individual has a sense of fear, everything seems rather too difficult to approach and consequently there is no opportunity for learning. To achieve learning, an individual should move from the comfort zone to the learning zone with awareness of the existence of the panic zone. Should the individual step into the panic zone, this produces stress which is difficult to control and it is not easy then to move back into the learning zone. Each person's learning zone system is unique as are the boundaries of every zone (Senninger 2000).

In this study, using Senninger's model, we decompose students' movement from school to university and see clearly the route that they follow. It is a useful tool that describes how the power and control carried through the discourses influence students' adjustment during their transition to university, by observing their movements between the zones. Additionally, given that each learning zone system is unique, we can depict how students are affected differently by the same message. This gives us the

opportunity to account for each student as an individual learner; this is important because we argue that if we attempt to alleviate the difficulties that students face in this phase, we need to pay attention to students' agency.

Bernstein (1996: 6) argued that individual enhancement is the "experiencing of boundaries… not as prisons… but as tension points condensing the past and opening possible futures." Grasping this idea and combining it with Senninger's (2000) learning zone model, we show how students position themselves as mathematics learners during their transition by crossing (or not) boundaries among the zones. This positioning is triggered by the degree of power and control carried through the transmitted messages.

In this study, those things that students know already from school regarding the learning of mathematics are found in the comfort zone. It is important to clarify that during the transitional experience, students meet both new knowledge and new pedagogical approaches that they might find challenging. On many occasions, as we will see shortly, these two blend together. We will describe new ways of thinking and studying mathematics at university level that can push students outside their comfort zone and broaden their mathematical knowledge. For example, if at school the students were used to forming study groups for mathematics assignments, then at university, they will feel comfortable if they are asked to work in groups with their peers. Both power and control in the comfort zone are high; mathematics as content and the practices regarding the learning of mathematics are recognized and fixed in students' minds because of their school experiences. In this model's adaptation, we will refer to the panic zone as the discomfort zone; this zone includes the things that students find completely different in the university context from those experienced at school. For instance, proof construction is required when studying university level mathematics. Some students feel uncomfortable when asked to produce proofs (Gueudet 2008); the procedure makes them feel anxious; the anxiety and fear create a feeling of discouragement and consequently they quit trying. Between the comfort and discomfort zones lies the transitional zone, the one that Senninger refers to as the learning zone. In the transitional and the discomfort zone the power is high—well distinguished content with clear boundaries—but the control depends on the ways the transmitter gives out the message. In the transitional zone, students can grasp new meanings, adjust to the new context and expand their ways of learning mathematics. They do this based on their experiences in the comfort zone and are thus able to achieve things that were formerly out of reach in the discomfort zone. This movement between the zones describes a smooth transitional experience. We hypothesize that the boundaries between the zones can be pushed by transmitting messages that prompt changes in students' actions and thinking.

Data and methodology

The research was conducted in a UK research intensive university among first-year honours degree mathematics students attending two modules referred to hereafter as A and B. Module A is an introductory module in analysis and module B an introductory module in the thinking and reasoning required at university level (e.g. proof by induction, proof by contradiction, etc.). We observed 27 lectures of module A and 17 lectures of module B from weeks 1–10 of the 12 weeks of semester one. During the lectures observations, we focused our attention on messages conveyed through the

various features of the teaching-learning interactions that could possibly differ from the ones prevailing in the school context and that were likely to affect students' learning of mathematics at university. For instance, these include the different ways, between school and university, of providing the learning resources. Some lecturers might provide handouts of the notes to the students; others might expect students to copy the notes from the board, etc. On the contrary, teachers at school might use specified mathematics textbooks for their lessons. These different approaches transmit different messages which every individual student interprets in a unique way. Through our work, we aim to see how these interpretations can be influential on students' adjustment to the new setting.

The observations were highly focused on the interactions between students and lecturers and the unit of observation was the transmitted message. The researcher/observer kept a list of messages that, according to the degree of power and control that they were carrying, could influence students' thinking about the learning of mathematics at this level. Both implicitly and explicitly transmitted messages, and verbal and non-verbal messages (hand gestures, practices etc.) were of interest. The verbal messages were carried through words that the lecturers articulated; the non-verbal ones were carried through teaching practices with the use of various means. We see later how the selection of these means played an important role in the transmission of the messages. Further information was collected from the university's internal webpage where the lecturers posted information and learning material.

The participants were chosen from an initial cohort of 56 students who completed a questionnaire during week 2 of the semester. This included items regarding students' profile and background, the expectations they had of their degree, and about the messages they had received concerning mathematical study up until that time. Based upon their responses, 18 students were selected to participate in focus groups which met between weeks 5 and 6. From the focus groups' responses, we selected ten students for individual interviews which took place between weeks 9 and 11. Our main interest during the selection process was to include students that had different interpretations of the same received messages, had received different messages from their lecturers, and had been influenced differently by the transmitted messages. In the focus groups, and later in the interviews, the students had the opportunity to comment on some of the messages that referred to general practices (e.g. assessment methods, provision of lecture notes, etc.) and which were identified and considered important through the observations (either because the lecturer was particularly emphatic, or because they were influential on students' learning). The interviewer asked the students which were the messages they had comprehended through these practices (not all the messages were comprehended by all students, and some of the messages might have been considered important by the observer but not by the students) and then they expressed their thinking about them. Moreover, students had the opportunity to refer to messages that were not in the observation list; none of the participants referred to non-observed messages. They described ways in which the messages prompted them—or not—to take action in furtherance of their learning. In this way, we gained an in-depth understanding of the interpretations of the messages received and of the possible influences that these had on their transition.

Additionally, we conducted interviews with the two lecturers, hereafter A and B. They talked about their teaching plan, the reasons behind their choices and the

expectations they had of the students. The interviews, the focus groups, and the observations were audio-recorded and transcribed. All names used are pseudonyms. Ethical clearance was obtained and followed BERA's ethical procedures.

The messages collected from observations and recordings were identified and classified into categories. We focused on messages that were important for students' understanding of the new content and the new learning practices (our decision was informed by the literature on the transition and from the lecturers' interviews) and carried a certain level of power and control. For the categorization of the messages, we used open and axial coding (Strauss and Corbin 2008). Open coding was used for the identification and initial classification of the messages identified in the observations and the interviews with the lecturers. Throughout this process, we paid attention to the details of the transcripts from the audio-recordings. Axial coding was used for the re-examination of the identified messages and their final classification in categories and more specified subcategories. The codes that we used included, for example, study habits, notes, problem sheets, feeling stuck, mathematical conversations, mathematics support centre, and tutorial. The six categories that arose concerned:

- things that students should do during lectures
- things that students should do outside lectures
- assessment
- general study habits
- things that students should do when they feel stuck
- lecturers' intrinsic enthusiasm for university mathematics

Here, because of space limitation, we discuss the first four. We consider these four significant as they offer an account of the teaching-learning interactions and show how students are impacted (both during classes and in their own time while they process the received messages and develop their study routine). Each one consisted of subcategories which focused more precisely on the transmitted message. For instance, in the category of assessment, we have two subcategories: coursework and class test, because the lecturers used different kinds of assessment and therefore sent different kinds of messages. In the next step of the analysis, the messages were analysed according to the degree of power (classification) and control (framing) that they carried. Based on Bernstein's (1971) theory, the level of classification was identified through the ways that the lecturers set the limits of the discourse and made the specialty of the context they were talking about easily recognizable to the students. The level of framing (Bernstein 1971) was identified through the selection, sequencing, pacing, and evaluation of the communicated knowledge carried through each message. Specifically, we explored who controlled the knowledge that would be communicated (selection); who controlled how this knowledge was ordered, e.g., what came first and second (sequencing); who controlled the rate of the expected acquisition of a concept/practice (pacing); and, lastly, who controlled the evaluative criteria (evaluation). The transcripts of the focus groups and interviews were scrutinized to explore how each message was interpreted. We examined which were the messages that each student talked about. We linked each received message with each student's interpretation of it. Then, we explored what were the actions (if any) that the individual student took from this message in order to enhance her/his learning. Following this, we identified in

which zone students positioned themselves after having received and interpreted each particular message that they talked about. Finally, according to the interpretations, we linked the level of power and control of the transmitted messages to the specific positioning (in the three zones) in order to explain the influences in the transitional experience. For instance, a message (carrying a certain level of power and control) given by a lecturer could motivate the student to take action upon her/his learning and therefore to move from the comfort zone to the transitional zone where new experiences challenge the thinking and create opportunities for learning. The same message might have been received and interpreted differently by various students. Consequently, the influence of each message may vary from student to student as discussed in the following sections.

Results

The messages that the lecturers transmitted to their students were analysed using concepts of classification and framing (Bernstein 2000). These help us to decompose each message and identify, through the underlying structures of power and control, in what ways the message can be influential on students' transition. We used an adaptation of the learning zone model (Senninger 2000) to identify how the impact of particular messages affects students' positioning in the university mathematics context.

We will now present how each message was communicated by the lecturers, the means of transmission, and in what ways the students interpreted it. We comment on how the influences of each message positioned students in the new setting.

Things that students should do during lectures

During observations, the two lecturers used different teaching practices. For this message, we will refer to lecturer A who employed "gappy notes". These printed notes include gaps that students have to complete while she is teaching and have several activities for the students to do. They include a weekly reading section and problems for practice. The lecturer uses gappy notes because she wants to give students the opportunity to develop certain types of thinking and be able to communicate mathematics.

> Lecturer A: I think of my lecture notes as sort of a book, just one that is not completed yet, and you will interact as you go along with the lectures and you will end up with this completed book but you are all being part of constructing it, and you have a lot of thought about it, at each stage hopefully, I mean you can't control everybody doing that.

Lecturer A explained that students should treat them as something that they own and to add more notes themselves:

> The set that you have are your notes. You will end up with a version that looks like mine but you should also have lots of extra notes that you've made about things I've said, things that you think that might be useful. So these are your notes you can write on them in any way you want.

Through this approach, students received an explicit message: students should be active members of the lecture, constructing their own notes, and interacting with the lecturer and their peers. Additionally, she wanted to direct their thinking about what they should be studying by including the reading and the problems sections. The power of this message is strong; the lecturer makes clear what topics are to be covered and she sets distinct boundaries regarding the things that they are expected to do. The control of the transmitted message is mixed. On one hand, the lecturer admits that she wants to make the process of taking notes a thinking process for her students and she tries to achieve this by employing this practice. The selection, the specific order that is followed, the required pace, and the evaluative criteria of the activities included in the gappy notes are all defined by her, and the students must follow and engage with them to participate in the lectures. The gappy notes operate as her controlling device; through them, she makes clear when she wants students' input and what form this should take. On the other hand, we observe instances where the lecturer is intentionally weakening the framing to allow students greater independence and control over their learning, for instance when she invites them to treat the notes as their own and to add whatever they consider as useful for their learning.

Eight of the participants commented on lecturer A's lectures and the gappy notes. Some said that by employing these notes, the lectures are more active, the students have time to think and take in, are more attentive, become more responsible for their own understanding, and have a good resource for revising. In the following, we can see that the students recognized the benefits. Specifically, Kenny mentioned that this way of delivering the notes makes him think that lecturer A cares about how they learn compared to other lecturers, and this encouraged him to study more actively.

> Kenny: I think Lecturer A is the one actually who is thinking about how we learn. I feel like she is more into that, I feel like the others are more like: Ok, this is what you need to be learning, learn! … Even if it is harder I am definitely picking up quicker, and also I am more motivated to do homework, whereas with the other ones I am not made to do the work. 'Cause if I don't do the reading between Monday and Wednesday I am not going to understand Wednesday's lecture so I need to do the reading.

Similarly, Owen stated that he prefers this way of having the notes as opposed to ways that other lecturers provide them (e.g. expecting students to copy from the whiteboard). Owen argued that by employing gappy notes, Lecturer A gives students the opportunity to have more time to think and "take it all in" during the lecture instead of trying to keep up with the copying of the notes and then going through everything again later.

The degree of control that lecturer A's message has is evident. Although she used a different way of teaching compared to that experienced by the students at school they seem to feel more comfortable during the lecture because, as they argued, they have time to think and this is important for them considering that the material taught is new and therefore needs more time to be understood. Kenny indicated that the gappy notes make him more motivated for studying and preparing for the next lecture. Here we can see how the strong control exerted by Lecturer A's message through the gappy notes influences students in the ways they position themselves not only during lecture time but also afterwards. This suggests the students expand their comfort zone to the transitional one and become more active in their learning.

Things that students should do outside lectures

Here, we illustrate how students perceived the message given by lecturer B regarding the things that they should do outside lecture time. Both lecturers expected students to work on exercises based on the content that was covered during the lectures. The way though that the exercises were distributed differed. Lecturer B uploaded some exercises to the module's webpage at the end of a set of typed notes for each topic covered. He went through these selectively during the weekly tutorial sessions that students attended in addition to the lectures, and he expected the students to work on the rest of them independently.

Lecturer B described in the interview in what ways he suggests his students should work outside the lectures; he said that he encourages them to work on the exercises and think over the things that, at first, might seem hard to understand in the lectures.

> Lecturer B: Just the usual way, I advise them to spend some time and go over the problem sheets and if they miss something in the lecture come back home think about it again… You have to invest some time into this, just thinking, sitting on your own, thinking about it, so nothing special...

During the lectures, lecturer B did not refer to the exercises. In module B, the students were expected to spend time in tutorial sessions working on them. On the module's webpage, lecturer B wrote that he expects students to try to tackle the exercises and devote three hours of work per week for this module:

> All exercises are to be attempted and solutions written up neatly. You are expected to work at least 3 hours per week outside of lectures and tutorials on this module.

Spending individual time outside the lectures and thinking over the problems in order to understand the concepts is the message that the lecturer transmits. The means used to transmit this message are the problem sheets. The exerted power is strong and the boundaries are clear; by getting a specific number of exercises to practice, students will acquire a better understanding. But the framing here is weak. The students can work on their own pace; they can organize the work in whatever way they want; they can select which exercises they will solve; and there is no evaluation purpose behind this practice. The students have control over their learning.

The students commented on things that their lecturers ask them to do outside lectures. Five of them referred to the exercises or problem sheets. Some of them said that they are not told explicitly to work on the problems, but by being given them, they realize that they have to. Others mentioned the differences that they identify between school and university and the ways they have to work when they are not in the lectures; at school, most of the work was done in the classroom; the students were told to work on the problems and then submit them for marking; the teacher checked that the problems had been completed; there was no assessed coursework and they did not struggle for time. Jeremy, one of the students, said:

> Well, they say like do your work and I usually can't be bothered to so I won't… They don't check really that you do the problem sheets and stuff, I'm just like: I am not doing them.

Elsa noted the difference between how students are monitored at college and less so at university. At university, you are expected "to work out yourself what you need to do" and that it is different from college where you had to "make sure you did it" because you were going to be marked. For her it is more important to prioritize what counts for the degree, like the coursework.

The weak framing in lecturer B's message regarding the work on the problems in combination with the differences that arise between the two educational levels seem to influence students. Lecturer B seems to adopt weak framing in the transmission of this message. When he said "the usual" in the interview, he assumed that the students already know what this "usual" is. Or, when he wrote on the webpage about the "3 hours per week", he assumed that students know that spending three hours outside of lectures is considered good for them. The students come from school to university and they are used to have the work that they need to do structured and indicated by someone else. With the lack of control in lecturer B's message, it is more probable that students will ignore what he said and they will procrastinate until something that counts towards their degree, like an examination or assignment coursework, arises. We note here how the weakly framed message does not prompt the students to take action and practice the exercises. This may result in two outcomes: students will either remain in the comfort zone, like Jeremy who does not pay attention to the message at all, or they will remain in the discomfort zone. In the latter case, they will become distressed and as a consequence will give up trying. Either way, this message does not push the boundaries of their comfort zone to move them in the transitional zone and expand their learning until a mark is at stake.

Assessment

The two modules were assessed differently. Both had an examination at the end of the semester but they also had assessments during the semester. Lecturer A employed three tests which contributed 30% to the overall module mark. Lecturer B employed two courseworks that contributed 50%. In addition to the obvious evaluation purpose, the methods of assessment implemented by the two lecturers transmitted messages that we explore below.

The class tests that Lecturer A distributed to the students comprised two parts. The first had questions that students were not aware of until the day they were examined; the second consisted of questions given in advance in order to think about and prepare. In the interview she said that the motives behind her decision to use the class tests were to provide students with feedback and to make them keep up with the module content and not cram it all in at the end. During the lectures, she emphasized these points and made students understand why having this particular kind of assessment is important.

> Lecturer A: ...the reason I do this kind of thing early is to make sure that everybody is reviewing things regularly and keeping up and doing the small tests. But, if you get like 15 out of 30 I don't much care. What I care about is that you've done the learning, right? And that you review it, and that you think about things afterwards, you look at the solutions and feedback… and learn from that.

The message that lecturer A wanted to transmit to her students by implementing the tests was that they have to review and keep up with the content of the module

throughout the semester. It was strongly classified and set clear boundaries. She made them aware from the beginning what exactly they were supposed to do in these tests and their purpose. The control carried through this message was strong and with the lecturer. The evaluation purpose of the tests was apparent and explicitly defined. The same held for the selection and the ordering of the content of the tests, and for the pacing required of the students. In addition, lecturer A exerted a lot of control through her words and made clear to the students in what ways they have to work for the tests in order to succeed; students have to review, keep up, think about things, consider the feedback and learn from this.

Seven of the participants referred to the message that lecturer A transmitted with the use of the tests. Carin argued that it is important having the tests during the semester. At university, there is no one to advise you to study regularly and it is easier to fall behind. Therefore, the test is a good chance for keeping up with the content.

> Carin: …no-one is on your shoulder all the time, it is very easy for you to get lost in the work and not really know what's going on, and I think the fact that the tests are regular does make you keep up…

Kenny perceived the message that Lecturer A transmitted and recognized the opportunity this afforded for feedback. He compared it to other modules where there was not such opportunity.

> Kenny: This [test] is a little bit of feedback from Lecturer A, whereas the rest you could be doing very well or failing horribly you wouldn't know.

Lastly, Jason appreciated the chance that he had to challenge his thinking and work on the questions that are distributed in advance.

> Jason: I like the challenge; I like to go away and have a think about something.

On the other hand, lecturer B chose to give his students two courseworks. He said that by doing so, students have to spend some time on their own on the given exercises. Lecturer B referred to the courseworks in a lecture at the beginning of the semester where he described the concept and gave students some information. Later in the semester, he referred to them again when they were distributed.

> Lecturer B: … there will be an exam at the end in January, which will be worth 50% of the total mark. And there will be two courseworks… You will be given three weeks to do the coursework. The first coursework is to be done individually, and the second can be done in groups of three… It can be done individually if you prefer but it's advisable to work in groups. Each coursework will be worth 25% ...

The message that lecturer B wanted to transmit with the use of courseworks was that students need to spend individual time and time with their peers to practice and understand in-depth the material taught. He made explicit his expectations and exerted a lot of power over students' learning with this message; if students wanted to succeed,

they had to work on the courseworks in addition to the examination. We cannot say though that the degree of control was at the same level; we notice here an example of mixed framing. The evaluation and the selection of the coursework's content is defined by the lecturer; therefore, the framing is strong and he is the one who has the control over these two components. But the way that students will choose to work on the coursework, how they will organize their study, and the pacing of their work is not defined by the lecturer. Therefore, in this case, the framing is weak and the students have complete control over the ways they choose to work.

Despite the mixed framing by lecturer B, the students received the message and talked about it in the focus groups and interviews. Some recognized that by having the content of the course split up in tests and courseworks, they could prepare all the topics that the end-of-semester examination would contain. They were encouraged to work in groups and some of them considered this beneficial. However, on certain occasions, this approach caused them difficulties because it was completely different from what they were used to. This assessment practice contrasts with previous findings (Jablonka et al. 2016) which suggest that feedback at university is often summative with a final examination at the end-of-semester, while at school, it is formative.

Alex commented on how having assessment during the semester was beneficial for examination preparation for both modules:

> I think is a great idea the way they have laid it out, because the test that you have in the middle that we have done or the courseworks integrate into what the exam is going to be like and you can feel great about the marks you are getting.

Owen admitted how helpful the group work was. By working with peers during the coursework he could adopt this practice in other modules. Moreover, there were students who talked about the differences in the types of assessment between school and university. Eric identified the difference and found it useful.

> Eric: I think… the biggest difference [is] between the coursework and A level, so it was kind of cram it all in, do everything I can, whereas here I have a better understanding of what I need to do…

However, Lesley found the difference troubling.

> Lesley: I didn't expect it to be this much coursework and I am not used to it, 'cause at 6th form we had exams at the end of the year and that was it…

Despite the differences in control that the two lecturers exert through the messages regarding assessment, it seems that students still get influenced by them. The evaluation purpose and the high degree of control that this has in the two different practices is what really affect students. The concept of assessment exists already in their comfort zone. The students seem to have the belief that assessment is what really counts. This belief exists throughout schooling and pervades their whole educational experience. What prompts the students to take action and expand their comfort zone here is not a strongly framed message that the lecturers transmit but the exchange value of the assessment. They take for granted that they will put in effort and work on whatever counts towards

their degree. The strong assessment-driven background makes them pay more attention to the learning opportunities that will be exchanged for a mark at university and is what moves them between the zones.

General study habits (advice: it's ok if you don't understand everything)

During the lectures, lecturer A gave plenty of advice to her students regarding how they should approach their studies. Every participant in the study referred at least once, during the focus group or the interview, to the advice that Lecturer A had communicated. Through axial coding we classified six subcategories which referred to different types of advice:

1. Creation of definitions lists
2. Keep-up/don't fall behind
3. Effective time-management
4. It's ok if you don't understand everything
5. Mind-map (of theorems, definition, etc.)
6. Creation of questions lists

The specific subcategory (*It's ok if you don't understand everything*) explored here was reported by six students. We discuss this one because it was important for students' understanding of university mathematics learning practices and it also addressed affective issues that arise during this phase as we will see below. The students until that point are told by someone else what they need to do; through this advice the lecturer attempted to show them how they could be effective in the university context. She talked about how they should manage their time, how they should be working and organizing their study. Another characteristic of her lectures was attempts to address affective issues such as students' emotional needs. She explained that there will be occasions where they will not take everything in, but that is normal, and not something that should worry them as long as they try to study afterwards and think about the things that have been discussed. By doing that she meant to show them that they are more or less all in the same boat and that not understanding something when it is first introduced is not something that someone should be ashamed of. This level of mathematics requires deep thinking about the concepts and continuous work.

> Lecturer A: Remember, I do not expect you to understand everything in lecture time. I do expect you to re-read and think more, talk to another about maths, and ask your tutor and the mathematics support centre staff about things you don't understand.

The message was explicit and Lecturer A used her own words to transmit it. The classification is strong; she set clear boundaries regarding what she perceives as a legitimate level of understanding while she teaches. She stated her expectations in a straightforward way. Strong control over the students' thinking was carried through this message. The selection and the ordering of the concepts that are meant to be understood are all defined by the lecturer, in addition to the things that they need to do in order to acquire understanding. We noticed though that she also gave some control to the

students; she left them some space to act independently and find their own pace for comprehending what is taught.

The students received the message and commented on it. Emily recognized through this message how different the situation is from A level where students are expected to know everything.

> Emily: I think at the beginning it was Lecturer A, she was like you are not expected to understand everything, like there are going to be things that you do not understand, 'cause like during A Level and at the end of A Level at the exam you just like need to answer everything, everything you need to know, every kind of thing…

Elsa talked further about it, saying that the fact that you do not understand does not make you stupid; with hard work and the help provided eventually everything will work out.

> Elsa: …you are not stupid if you don't understand things, you are not going to understand a lot of things but if you like work hard, different things should come together …

The students seem to be influenced by lecturer A's message. From the above extracts it is obvious that strongly framed messages received in the school context are still influential. The fact that they do not understand everything, like they used to at school, places them in the discomfort zone. Lecturer A's message though, with its strong power and control (over selection and sequencing), has an impact on them. It provides them with emotional encouragement and pushes the boundaries of the discomfort zone to the transitional zone where the "not understanding everything" situation is legitimate, and with adequate effort, there are possibilities for grasping new meanings.

Discussion and conclusions

In this study, we explored one aspect of the transition that has received little attention: the relation between messages transmitted through university practices and the interpretation that different students give to those messages. Hence, we attempted to find out the nature of the impact on students' transition. Bernstein's (2000) concepts of classification and framing helped achieve this by eliciting the underlying structures of power and control. We decomposed each message and identified the power and control conveyed through it and the effect that this had upon individual students. We identified how different values of power and/or control influenced the ways students positioned themselves in the new setting by employing an adaptation of Senninger's (2000) learning zone model.

When Kenny commented on lecturer A's lectures and the message that she transmitted (being active in the lectures) with the use of gappy notes, he reported that by using them, he can "pick up quicker" and he is "more motivated to do homework", in contrast to other lecturers that do not employ them. We noticed that in particular cases, when the control of a transmitted message is strong, students can benefit from it. We

found that the students understood the strongly framed messages that lecturer A transmitted and most of them were influenced to some extent. The high degree of control pushed the boundaries of the students' comfort zone to the transitional one and students had the chance to feel better integrated. Lecturer A admitted that she delivered the lectures in this way because she wanted to affect the way the students are thinking.

On the other hand, the messages that lecturer B gave to his students were not strongly framed. In the case of things that they should do outside lectures, students received the message but because of the low degree of control were not really prompted to take action. For example, lecturer B expected the students to work on the exercises but during the lectures he did not exert strong control regarding this and consequently, also drawing on the fact that they would not been marked or checked, the students did not really engage with the problems. Therefore, they positioned themselves in one of the zones in which learning does not occur, either in the comfort zone, as in Jeremy's case who did not pay attention to the message, or in the discomfort zone.

The students did not seem to be influenced by the level of control that the message regarding assessment carried. Whenever a message referred to something that counts towards the degree this would be easily perceived and would have influence over the students. One explanation might be that students come from a highly assessment-driven context at school or college and these influences are still evident when at university. Students revealed on other occasions as well that messages received during school years were still influential on the ways they think about studying mathematics. For instance, one of the students mentioned that at university there is no-one to urge them to keep up with the work, as was the case at school. Therefore, keeping up with the material at university is harder.

Several students felt more comfortable when they perceived messages that were similar to ones that they had received at school. The transmitted messages that are common between the two educational settings help students to integrate into the new context and can be considered as a comfort zone, for example the message that students perceive through the assessment: the examination at the end of the year at school and respectively at the end of the semester at university. We observed some of the students stepping into the discomfort zone when they encountered messages completely different from the ones transmitted at school. In between the comfort and the discomfort zone there are the messages that can prompt action to be taken by students and can change their thinking. Powerful messages which exert a certain level of control are capable of pushing the boundaries of the comfort zone and transform, eventually, the discomfort zone to a comfort one. The challenge in this situation is to exert that degree of control through a message that can challenge students' thinking and not guide them blindly.

Through this study, we pinpointed the influences that the exerted power and control can have on students' transition to university mathematics. Our data suggest that a transmitted message with weak control gives more independence to the students. But because of the low degree of control that the message conveys, it is more likely that the students will not be influenced by this particular message. On the other hand, a message with strong control takes away the responsibility from the students. In this case, with the high degree of control, it is more likely to influence the students. Similarly, we noticed that strongly framed messages acquired through school years persist in being influential when students come to university. Consequently, we identify that many students during the transitional phase get influenced from the degree of power and

control in the transmitted messages. Although we recognize that it is a complex and challenging task to find a balance of control and independence expected for those who transmit the messages, we claim that if this balance is found, the students can expand the boundaries of their comfort zone, carried from the school years, challenge their thinking, and integrate smoothly.

We suggest therefore that the types of discourse that take place in teaching-learning interactions during the transitional phase should be given upmost importance. We consider that the power and control that is carried through the messages can be of great influence for the positioning of the newcomers as mathematics learners in the new context, i.e. what we say and how we say it really matters. University actors should make a greater effort to consider the kind of control and power they exert through their messages in order to facilitate students' transition to university mathematics.

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