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A socio-cultural analysis of the transition from school to university mathematics

Eirini Kouvela

Doctoral Thesis

Submitted in partial fulfillment of the requirements for the award of Doctor of Philosophy of Loughborough University

Supervisors: Dr Paul Hernandez-Martinez & Prof Tony Croft

Mathematics Education Centre, School of Science

October 2017

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To Martin

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Abstract

This research project investigates first year mathematics students' transition from school to university mathematics. I focussed my attention on the messages that students receive from their lecturers during the teaching and learning of mathematics at this level. By decomposing each transmitted message into the underlying structures of power and control that it carries I investigated in what ways these affect students' adjustment to the new context. In order to examine students' interactions with the messages I took into account their previous experiences while working with mathematics. The results of the study reveal a direct influence of the degree of power and control of the transmitted messages on students' adjustment. This influence is highly dependent on students' interpretations of the messages which are mediated through their identities as mathematics learners. With this work I approached the secondary-tertiary transition as a multifaceted process which accounts for the development of students' identities as mathematics learners while they interact with the transmitted messages and try to position themselves in the new context.

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CHAPTER 1

Introduction

1.1 Transition from school to university mathematics

"[It is] much harder than I expected, even though I did expect it to be difficult..." this is Elsa's view regarding university mathematics at the point when she started studying for a single honours degree in mathematics. The same view was shared by many other of her peers who participated in this study. It is widely known in the research field of mathematics education that students who decide to study for a mathematics degree, or generally for mathematically demanding programmes, face a variety of difficulties in their transition from school to university mathematics (Cherif & Wideen, 1992; De Guzman, Hodgson, Robert, & Villani, 1998; Daskalogianni & Simpson, 2002; Gueudet, 2008; Clark & Lovric, 2009; Brandell, Hemmi, & Thunberg,

2008; Hernandez-Martinez, 2016). Regardless of the different educational systems, students around the world encounter similar troubles while trying to adjust to the new context. My own transitional experience as a first year mathematics undergraduate was also hard and daunting, and that is why I was initially interested in researching this topic.

Background studies have classified the difficulties that students encounter as epistemological/cognitive (e.g. a shift from elementary to advanced mathematical thinking, a move from the use of informal language to formal language, working with proofs and abstract mathematical concepts, etc.), sociological/cultural (e.g. a change in the cohort size, a change in the academic requirements, a change in the level of autonomy, etc.) and didactical (e.g. different teaching style, different resources, different level of interaction between lecturers and teachers, etc.) (De Guzman et al., 1998). Other studies in the field, which have focussed on the sociological/cultural aspects of the transition, emphasise the importance of students' socio-economic background, educational background, gender and ethnicity background in this phase (Hernandez-Martinez & Williams, 2013; Black & Hernandez-Martinez, 2016). The work presented by Gueudet (2008) has expanded the previous categorisation and classified students' difficulties with respect to the new thinking modes and knowledge's organisation, proofs and mathematical communication and, didactical transposition and didactical contract.

A variety of theoretical lenses have been chosen by different scholars in order to investigate in depth the issue. The literature is rich in studies that use socio-cultural theories in their attempt to understand and explain students' transitional experience. Among them, the concept of identity is widely used. For instance, Hernandez-Martinez et al. (2011b) use identity in order to examine its contribution to students' development through their

engagement in different activities during this phase. Holmegaard, Madsen, and Ulriksen (2013) investigate how students negotiate their identities in the transitional process and the impact of this negotiation in their adjustment to the new context. Other scholars move their attention from the individual to the institutional aspects of the transition. For example, Jooganah and Williams (2016) who use activity theory to bring to the fore the contradictions that arise between the two educational systems during the transitional phase. In this way they explain the extent to which these contradictions influence students' experiences in the learning of mathematics.

The literature offers also a great variety of initiatives suggested by various researchers in order to alleviate students' difficulties during this phase. Many scholars (such as Kajander and Lovric (2005); Leviatan (2008); Pyke (2012); Hoffkamp, Paravicini, and Schnieder (2013), etc.) introduced the use of bridging courses which attempt to bridge the gap between school and university mathematics. In these courses students are given the opportunity to revise previously taught concepts, address mathematics skills deficiencies, familiarise themselves with the mathematical notation and language used at university level, with the concept of proof, etc.

Despite being so extensively researched and from various theoretical perspectives the transition from school to university mathematics is still a persistent issue in the field of mathematics education. With this study, I am trying to approach the transition from a different perspective, that to the best of my knowledge has not been used so far, and that can shed light on the root causes of the issue. In the following, I will introduce this different approach.

1.2 A different approach

A lot of significant work has been implemented over the past 30 years for the investigation of the secondary-tertiary transition. The majority of this work has focussed on the difficulties that students encounter when they move between the two educational settings. With this study I attempt to show a broader picture of the transitional experience. Through students' narrations I capture the whole trajectory that they follow from the moment they leave school until the moment they come to university to study for a mathematics degree.

In this trajectory I consider of major importance the role of the messages that students receive regarding the studying of mathematics (both the content and the learning practices) transmitted through the discourses and practices in the teaching-learning interactions. My aim is to examine to what extent these messages are influential on students' transitional experience and particularly, if they are facilitating it or hindering it.

In the interaction with these messages students bring to the fore elements of their identities as mathematics learners. These are shaped during the school years through their engagement with mathematics. The previous experiences mediate the interpretation of the messages. Once the message is interpreted, according to the extent that it will affect each student, their mathematical identity can be reformed. This reform can be a crucial element of students' adjustment to the new context.

By using this approach I discuss three different stages in students' trajectory: their previous experiences with mathematics while being at school, the ways they react to the teaching-learning interactions with their lecturers (through the messages that the latter convey), and the changes they are willing to make, or not (inspired by the transmitted messages) in order to

settle in better at university.

To account for all this I designed a theoretical framework which is based on three different theoretical concepts. For the analysis of the transmitted messages I use the concepts of classification and framing introduced by Bernstein (1971, 1980, 1996, 2000). With these concepts we can see the underlying structures of power and control that each transmitted message carries and hence examine in what ways it influences students. In the interaction with the messages students use aspects of their identities, formed through their previous experiences and individual backgrounds, in order to interpret the messages and eventually take (or not) some kind of action for the enhancement of their learning and the facilitation of their transition. For this reason I used Holland, Lachicotte Jr., Skinner, and Cain's (1998) concept of positional identity which shows how individuals position themselves, and are positioned, in a certain context according to the ways that make them feel comfortable or constrained. Likewise, in this study with the use of this concept I examine in what ways students position themselves in the context of university mathematics. This positioning comes as a result of students' interaction with the transmitted messages which make them feel either comfortable or constrained.

The final part of my theoretical framework is based on an adaptation of Senninger's (2000) learning zone model. This model considers that learning is achieved when students move from their comfort zone (which consists of the things familiar to the individual) to their learning zone (where individuals can explore new things and expand their knowledge). A third zone that lies beyond these two, is the panic zone. There is no opportunity for learning in this zone, as fear and panic are prevailing. In the adaptation of this model, I use the comfort zone (which consists of the things that students

know regarding the learning of mathematics from school), the transitional zone (where students grasp new meanings and adjust to the new context of university) and the discomfort zone (which consists of the things that refer to the learning of mathematics and are completely different from what students have experienced at school and which make them panic and "bury their heads in the sand"). As students get involved in the teaching-learning interactions at university, by receiving various messages from their lecturers, they can move between these three zones. Their final positioning in one of the zones contributes to our understanding of whether students' transition has been facilitated or hindered. Hence, my research questions are the following:

1. How do students interpret the different messages they receive within the university community?
2. How are these interpretations shaped by their individual backgrounds and previous experiences?
3. How do they facilitate or hinder students' transition?

By implementing this study I attempted to give voice to both students and lecturers. In this way I wanted to understand and explain how the power and control conveyed through their interactions can impact students during their transition to university mathematics. Moreover, I wanted to stress the importance of accounting for students' identities in this process which is fundamental to the ways that they process the various information their lecturers are transmitting. Finally, by capturing a wider picture of the transitional experience I am bringing to the fore aspects that have not been considered by previous works in the field. For instance, monitoring the impact that a message exerted through a practice can have on a student in

this phase, based on their previous experiences and on the degree of power and control that it is carrying.

In the following subsection I will present an outline of the thesis.

1.3 Outline of the thesis

1.3.1 Chapter 2: Literature review

In Chapter 2 I present the literature review that has been implemented over recent years for the investigation of the secondary-tertiary transition. This chapter consists of three sections. In Section 2.1 I introduce the different kinds of studies with a different focus on the difficulties that students encounter during the transitional phase (Section 2.1.1). Then I describe the vast variety of theoretical approaches that have been used to examine the issue (Section 2.1.2) and the initiatives that have been suggested and implemented by various researchers and institutions in order to tackle students' difficulties (Section 2.1.3). In Section 2.2 I summarise the previous work in the field and finally in Section 2.3 I comment on the gap in the existing literature that my study addresses.

1.3.2 Chapter 3: Theory

The third chapter of my thesis is concerned with the theories that I used. It consists of four subsections; three of them refer to the three different theories that I employed in order to design my theoretical framework and in the last subsection I introduce the theoretical framework. In Section 3.1 I develop Bernstein's theoretical concepts of classification and framing. I start this part of the chapter with the general preoccupations that Bernstein had in

his research work (Section 3.1.1), then I explain the concept of pedagogic device which I intended to use initially as the theoretical framework (Section 3.1.2) and why this was not eventually appropriate (Section 3.1.2.1). Lastly, I talk about the use of the concepts of classification and framing in my work.

In the second part of this chapter (Section 3.2), I describe Holland et al.'s (1998) work on positional identities. Initially, I talk generally about the use of the concept of identity in the field of mathematics education (Section 3.2.1). Then I refer more specifically to the positional identities and in what ways I used them in the design of the theoretical framework (Section 3.2.2).

In Section 3.3 I introduce Senninger's (2000) learning zone model and how I adapted it in order to comprise a part of my theory.

At the end of this chapter, I present in detail the theoretical framework. In Section 3.4.1 I include a table with all the core concepts that I use.

1.3.3 Chapter 4: Methodology

The Methodology chapter consists of four parts. It starts with the pilot study that I implemented during the first year of my doctoral degree and its results. Section 4.2 is concerned with the data collection. I start by explaining why I chose to observe the lectures of these two specific modules (Section 4.2.1). Following this, I refer in detail to the collection methods that I used (Section 4.2.2). Then I describe how I implemented the data analysis of the study (Section 4.3). I talk about the messages categorisation (Section 4.3.1) and the analytical methods that I used in order to analyse the collected data (Section 4.3.2).

At the end of this chapter, Section 4.4, I present a summary of the methodology that was followed for the implementation of my study.

1.3.4 Chapter 5: Results

The Results chapter is divided into two main parts. In Section 5.1 I present all the transmitted messages that I observed during the lectures and to which students referred during the interviews. The messages presented here follow the categorisation as this arose from the data analysis and are also presented in this way (Section 5.1.1-5.1.6). Each category of messages is divided into more specific subcategories which refer in detail to every transmitted message. At the end of this part, Section 5.1.7, I include a summarising figure which represents all the messages and their degree of classification and framing.

The second part of this chapter, Section 5.2, is concerned with students' narratives which I used as a way to explore the students' identities, and their zone positioning. Here I include only narratives from five students (the remaining five narratives can be found in Appendix A). In each student's story I have included information about their backgrounds, in what ways they experienced university mathematics through the lens of the messages transmitted during the teaching-learning interaction, and an overall impact on their transition. This last part is accompanied by a table with a summary of the messages, their level of classification and framing, and their impact on each student.

1.3.5 Chapter 6: Discussion

In this chapter I discuss the results of the study. It consists of six subsections, as many as the categories of the transmitted messages. The messages are presented according to the ways that are represented in Figure 5.1, in Section 5.1.7. In Section 6.1 I start with the message transmitted through Lecturer

B's [1] enthusiasm for mathematics M_6 [2] which was strongly classified and framed, and I end with Section 6.6 where I discuss the message transmitted through lecturers' suggestions regarding the recommended sources of help at university $M_{3.1}$&$M_{3.2}$, which were strongly classified and weakly framed.

1.3.6 Chapter 7: Conclusions

This last chapter of my thesis answers my initially posed research questions. It is comprised of three sections (7.1, 7.2, 7.3) where in each one of them I give answers to the research questions based on the results of the study. In Section 7.4 I present some summarising final remarks of my study and some recommendations for policy and practice.

1.3.7 Appendix

In Appendix A the reader can find the stories of the five students that I did not include in the main body of the thesis.

In Appendix B, I include the two questionnaires that I used for the data collection at the beginning and at the end of the first semester.

In Appendix C I present extracts from the interview transcript with Lecturer A (C.1) and from the observation of the first lecture of Module A (C.2). With these extracts I intend to give an example and explain how I identified and interpreted the various messages from the transcripts (C.3).

Finally, Appendix D includes a full transcript of the interview with one of the students (D.1). Following the transcript I explain how I constructed the student's narrative (D.2) and I comment on the utterances that suggest his mathematical identity (D.3).

[1] fully defined in 4.2.2.1

[2] fully defined in 4.3.1

CHAPTER 2

Literature Review

The transition from school to university mathematics has been and still is a persistent and often problematic issue in the field of mathematics education. The existent literature recognises a gap between school and university mathematics (Luk, 2005; Kajander & Lovric, 2005; Brandell et al., 2008; Winslow, 2013) and points to several factors as the root cause. These factors refer mainly to the difficulties that students face due to changes in the content of mathematics taught at university (Brandell et al., 2008), changes in the ways of thinking and communicating mathematics (Engelbrecht, 2010), changes in the way of teaching (Thomas & Klymchuk, 2012) and changes in the social and cultural context of the new institution (Holmegaard et al., 2013).

The literature that focuses on the investigation of the secondary-tertiary transition in mathematics is extensive and rich in approaches for examining

the issue. The time-spectrum within which various scholars research students' transitional experiences at this level of education is broad; it may start before the end of school and reach until the second-year at university. For instance, Clark and Lovric (2009) borrow a concept used widely in anthropology, the "rite of passage", and they suggest a theoretical model for investigating the transitional phase (described in more detail in Section 2.1.2.9). The authors argue that the three phases that students go through during their transitional experience include the time when they are still in high school, the time in between high school and university and the first year of their studies. Hernandez-Martinez et al. (2011b) investigate students' transitional experience as an issue of identity in an earlier phase. They examine the transition of students from school (compulsory education) to college (post-compulsory education). On the other hand, Duah, Croft, and Inglis (2014), investigate how second-year students can be influenced and a potential loss of motivation and interest in mathematics can be avoided at this phase by engaging in Peer Assisting Learning (PAL) sessions. Hence, although the literature offers a broad time frame for the examination of students' transition from school to university mathematics, the literature that I present here focusses mostly on the transitional phase that takes place during the first year of students' studies. This is consistent with the research design of the study; due to time restrictions I was able to collect data only from first year mathematics undergraduates during the first semester of their studies.

In the following I will draw on some of the previous studies that have been implemented on the secondary-tertiary transition. The first section is divided into three parts. The first part consists of background studies on the topic; these studies follow the classification that De Guzman et al. (1998) introduced (epistemological/cognitive, sociological/cultural, didactical) with

an additional category, studies that describe how students' previous perceptions about mathematics are influential on their transitional experience. The second part describes the various theoretical approaches used in recent years to investigate this topic. And finally, I present a number of initiatives suggested and implemented by different institutions and researchers around the world for the alleviation of students' difficulties during this phase.

2.1 Background studies on the secondary-tertiary transition

In this part I organised the studies according to their focus. I present studies which focus on the cognitive/epistemological issues that arise with students' move to university, studies that focus on the sociological and cultural changes which accompany the entrance to university, the work that focuses on the didactical aspects of the transition, and lastly the influence that students' perceptions about mathematics have in the shift between the two educational levels.

2.1.1 Different foci according to the difficulties that arise due to the changes

2.1.1.1 Epistemological/Cognitive

One of the most important changes that happens with the move from school to university mathematics is the change in the content of mathematics itself and in the ways of thinking, manipulating and communicating this content. I will explore these changes in more detail in the following.

There is a difference in the ways mathematics is approached between

school and university. A study implemented by Oikkonen (2009) on the teaching of mathematics to beginning mathematics students in the University of Helsinki shows that the majority of first year students considered school mathematics rather algorithmic; as a set of rules that needs to be taught and applied. On the other hand, university mathematics consist of definitions, abstract thinking and rigorous language. Similarly, Breen, Shea, and Pfeiffer (2013) conducted a study in a tertiary level institution in Ireland among students who followed a first year calculus course. The students stated that they recognized a change in the emphasis between school and university; from instrumental understanding to conceptual understanding. All the participants mentioned the importance attributed to procedures in high school mathematics. When the same students were asked about mathematics in university they talked about emphasis on conceptual understanding and connections between mathematical topics.

Another shift comes with the use of rigorous language in university mathematics and the transition from intuitive assumptions to mathematical argumentation (Farmaki & Paschos, 2007). This is considered as a frequent cognitive problem experienced by students; the passage from informal to formal language in first year university courses (Clark & Lovric, 2008). Formalism is an essential element of university mathematics; the concepts need to be precisely formulated, the deductions need to be structured in a strict way and the results are codified usually in formulas. This is not easy for students; it needs time, patience and concentration in order to learn it (Luk, 2005). Along similar lines, Nardi (1996) comments on the gap between school and university mathematics as a jump from the informal to the formal, from the empirical mathematics taught in school to the abstract mathematics taught in university. This entails that students, in order to succeed, need to adopt

a new way of thinking (Hoyles, Newman, & Noss, 2001). When students arrive at university they think that mathematics is a continuation of what they learnt in school. Therefore they are not prepared for the rigour of university mathematics, the need to make links among the concepts and not just memorise formulae (Hoyles et al., 2001). A characteristic example of the difference in the rigour of mathematical language between school and university mathematics is the notorious epsilon-delta gap between calculus and analysis. It is probably the first time a student learns to use words in this way, exactly as defined. In university when they say 'for all' or 'for some' they must mean exactly what is stated; when they write the conditions for a conclusion they need to be clear and precise and to make statements that can stand 'for all' tests (Luk, 2005).

The way of thinking required at this level has been studied extensively by Tall (1991) who argues that the shift from the elementary way of thinking used at school to the Advanced Mathematical Thinking (AMT) involves an important transition: "that from describing to defining, from convincing to proving in a logical manner based on those definitions" (Tall, 1991, p. 20). He reports that this is a challenge for students who once they enter university are required to work with theorems, understand what the theorem actually says, grasp the implication of the statement, apply the theorem and eventually deal with the proof. Proof construction is another important shift during the transition to university mathematics.

All this leads us to the work of many researchers in the field who have focused on the difficulties that first year students face when they deal with proofs at university level, and they suggested various ways to ease students' engagement with proofs (see for example Section 2.1.3.1 bridging course on mathematical reasoning, argumentation and proof). Gueudet (2008) reports

that university is seen by students as a new world, with new laws and language that make freshmen feel as foreigners. These laws and language are the ones used by the mathematicians and focus on the ways they build and communicate proofs. Likewise, Jooganah and Williams (2010) argue that it is the nature of proof in university mathematics that poses an epistemological shift in the character of mathematical knowledge at this level. The sources of students' difficulties when engaging with proofs have been classified by Moore (1994) in the following seven categories:

- The students did not know the definitions, that is, they were unable to state the definitions.
- The students had little intuitive understanding of the concepts.
- The students' concept images were inadequate for doing the proofs.
- The students were unable, or unwilling, to generate and use their own examples.
- The students did not know how to use definitions to obtain the overall structure of proofs.
- The students were unable to understand and use mathematical language and notation.
- The students did not know how to begin proofs.

According to Moore another important aspect which can influence the proof writing performance is students' perceptions of mathematics and proofs.

All the points included in this classification focus on students' skills deficiencies. The categorisation can be complemented by another feature reported by Jablonka, Ashjari, and Bergsten (2016) which involves lecturers'

input in proof construction; "the lack of explicitness of what counts as legitimate accomplishment" when working with proofs (Jablonka et al., 2016, p. 74). This aspect refers to the times that it is not made clear to the students what needs to be proven and what is taken as obvious in a proof, the shift between inductive and deductive arguments, and lastly the status of informal and formal reasoning in oral and written communication.

2.1.1.2 Didactical

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 can include changes in the way of providing the resources, the assessment practices, the pace that is followed and, the level of interaction.

The move from school to university mathematics is characterised by Gueudet (2008) as a shift between two different didactical contracts. Brousseau (1997) describes the concept of didactical contract as a set of rules, some explicit but the majority of them implicit, which frame the mathematical practices between teachers and students, and can be considered as a set of mutual responsibilities between the two parties (teacher(s)-student(s)). With the entrance to university these rules change and this can cause difficulties in students' learning.

In a more recent work, Gueudet and Pepin (2016) shed light on the resources that are used at university and argue that there is a link between the new didactical contract and the use of the new resources: "the use of the resources is shaped by the contract; and at the same time the available resources shape the mathematics taught" (p1). Several authors refer to the

importance of the resources used at university (De Guzman et al., 1998; Pampaka, Williams, & Hutcheson, 2012; Thomas & Klymchuk, 2012). For instance, a very common issue is that 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 Guzman et al., 1998).

Another issue that arises when students enter university is the different level of interaction they have with their lecturers as opposed to the level of interaction they used to have with their teachers. Various researchers refer to this change. For instance, Cherif and Wideen (1992) describe that many of the professors who participated in their study admitted that they were not able or were too busy to spend time communicating with their students. Other scholars refer to the extent to which the teaching is impersonal (Pampaka et al., 2012; Thomas & Klymchuk, 2012) and to the opportunities that students have to discuss ideas and problems (Pampaka et al., 2012) as a difference in the new context.

The assessment procedures and the way feedback is provided at university changes also. Jablonka et al. (2016) make the distinction between "formative feedback" that students receive in the school classroom and the "summative assessment" with examination at the end of the semester 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. Thomas and Klymchuk (2012) report that the students in their study recognised that lecturers have greater flexibility than teachers in how, when, and how often they assess students.

2.1.1.3 Sociological/Cultural

The social and cultural aspects of the transition have been at the epicentre of various studies in the area. Scholars recognise issues like the change in the cohort size, the classroom climate at university, the new social setting, the independence and the 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 Guzman et al., 1998; Thomas & Klymchuk, 2012). The size of the group can make them often feel intimidated to raise questions about the things that they do not understand. Additionally, De Guzman et al. (1998) refer to the competitiveness that is created occasionally in the lecture theatres among students which can create a feeling of discomfort.

When students enter university they are not aware about the numerous aspects of university life and the changes in academic requirements (Clark & Lovric, 2008). Thomas and Klymchuk (2012) argue that one of the biggest problems that students encounter with the move to university is the unlimited 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 freshmen (Pampaka et al., 2012).

Similar results are reported by Breen et al. (2013) where students recognise the independence required at university level among the most important differences between the two educational settings. The participants in Breen et al.'s study found unusual the fact that they had to plan their own study timetables without the framework of daily homework assignments. This confirms also previous studies in the field. Pongboriboon (1989) reports that both students and lecturers in his study on the secondary-tertiary transition

at Khon Kaen University (Thailand) argued that mathematics deficiencies between school and university resulted from:

1. Differences in study habits between the two educational settings: "acting skills and dispositions necessary for autonomous study; and a shift from superficial to productive study practices" (p.444)

2. Undesirable study habits developed at university: "do not attend class and tutorial consistently; allocate insufficient time to study and review content; not enough practice on mathematics exercises" (p.444)

Building on this, the change from a parent-disciplined life can be troublesome for first year students. Cherif and Wideen (1992) report that the majority of the students that participated in their study agreed that by leaving behind the school and home environment they entered a completely new world, with all the consequences this entails. Likewise, students moving from school to college in Hernandez-Martinez et al. (2011b) study characterised entering university as the entrance into a new social setting and the expansion of their social life, and as an opportunity to grow up, individually and academically.

2.1.1.4 Students' perceptions

The last category that I will refer to has to do with students' perceptions about mathematics. According to various researchers (Crawford, Gordon, Nicholas, & Prosser, 1994; Ulriksen, Holmegaard, & Madsen, 2013; Harris et al., 2014) the perceptions that students have about the content of mathematics and the study of mathematics at this level seem to be influential during the transitional phase. Here I will make a distinction between the perceptions that concern the content of mathematics (including the ways of working with

mathematics, i.e. study habits) and the self-conception of students regarding their academic competence when they work with mathematics.

Research in the field recognises a link between students' conceptions about mathematics when they enter university and the approaches they will choose for working with mathematics (Crawford et al., 1994). The students arrive at university with a set of pre-existing experiences regarding the subject of mathematics. These experiences are shaped during the previous years of schooling through their engagement with various mathematical activities. It is argued that this set of experiences will influence the ways that students will approach mathematics at university level. For instance, if students believe that the assessment methods measure their ability to reproduce procedures that they have been taught, then it is more likely that they will adopt a surface learning approach. Therefore, as Crawford et al. (1994) suggest, the lecturers need to take into account students' conceptions of the content of mathematics because these will shape their learning approaches.

Building on that, Harris et al. (2014) emphasize how the perceptions about mathematics change with the move to tertiary education. In their study of first year engineering students the authors recognise a change in students' perceptions; mathematics at school is about an "exchange value" and mathematics at university has to do mostly with a "use value" (this might be different though for mathematics students). This means that when studying mathematics at school good grades and qualifications can be exchanged for a place at university. On the other hand, when studying at university, mathematics becomes a subject which has a use value and supports their engineering studies. The study stresses the importance of the use-value of mathematics in engineering courses and how this can enhance students' learning.

Finally, a change in students' self-conception about competence in doing mathematics may arise with the move to the new context. It was shown in the previous sections how changes in the content of mathematics, or changes in the teaching practices (lectures, level of interaction, independence, etc.) can influence students during this phase. Adding to this, Ulriksen et al. (2013) in their study of first year STEM students, recognise a gap between students' expectations and experiences regarding mathematics. For a number of students this gap refers to their self-conception about how competent they are to cope with mathematics at this level. These students reported that this was linked to their difficulties in passing examinations and also to the level of competitiveness among students. The authors argue that students' expectations may differ to a great extent from their experiences, from their sense of identity, or from what students imagined would happen at university before starting their degree.

2.1.2 Different approaches applied to study the secondary-tertiary transition

In this section I will demonstrate some of the various theoretical approaches that have been used to investigate the secondary-tertiary transition. Considerable work was undertaken by the TRANSMATHS project (www.transmaths.org) which investigated, with the use of socio-cultural theories, the transitions to post-compulsory education, i.e. from school to college and from college to university. Their theoretical approaches include Activity Theory perspective on the concept of identity, a Marxist perspective on the concept of alienation, Bourdieu's theory and also the creation of measures to understand students' perceptions of the transition. Other scholars in the field have used parts of Brousseau's, Bernstein's, Chevallard's work and other theories

which I will explore in the following.

2.1.2.1 Identity

Identity is a topic which has "enjoyed an explosion" (Darragh, 2016, p. 19) in the field of mathematics education during the last 20 years. Unsurprisingly, this explosion has had an impact upon research into the transition. Indeed, many scholars in recent years have used the concept of identity as a theoretical approach to investigate the issue. Hernandez-Martinez et al. (2011b) 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. Interestingly, the troubles that these students encountered during their transition were seen as an opportunity for stepping-up and not as an obstacle.

In a later work, Black and Hernandez-Martinez (2016) emphasise the role of identity in accessing science capital while studying mathematically demanding courses. The authors use the concept of science capital as developed by Archer, Dawson, Dewitt, Seakins, and Wong (2015) and this consists of: "scientific forms of cultural capital (scientific literacy; dispositions towards science, symbolic forms of knowledge about the transferability of science qualifications), science-related behaviours and practices (e.g. consumption of science media; visiting informal science learning environments, such as science museums), science-related forms of social capital (e.g. parental scientific knowledge; talking to others about science)" (p.3). Some students will access science capital for its exchange value, but others will recognise its use value. The choice is influenced by students' identities and the difference in approach

will produce different forms of engagement with mathematics. Therefore, a promotion and alignment of the use value with the exchange value will be influential on students' dispositions towards mathematics and will prevent a possible alienation from the subject (Black & Hernandez-Martinez, 2016).

Along similar lines, Holmegaard et al. (2013) suggest that in order to understand the transition we need to understand how people work on their identities while they move from one cultural context (the school) to another (the university). The authors investigate students' transition as a process and a negotiation of identity. They focus on how students narrate the negotiation of their identities in the new context and how they develop an understanding of what it means to belong in this new context. The results suggest that the students renegotiate their narratives of why they chose this degree; what is it like to study for this degree; what kind of students they consider themselves to be in order to construct a new type of narrative which will include their experiences at university and their identity.

2.1.2.2 Alienation

Another concept that has been used in the transition research is the concept of alienation. Hernandez-Martinez (2016) uses the concept to explore drop-out of previously engaged students from mathematical study during their transition to university. Despite their considerable efforts to integrate and the support provided by the university (e.g. mathematics support centres) the students in this study were not able to negotiate their learning. The way they saw themselves as learners (for instance, engineering students who recognise themselves as more "practical") prevented them from aligning with the academic practices employed at university.

Similarly Solomon and Croft (2015) use the concept of alienation to ex-

plore 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. 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 were not supported enough by the institution. Their results suggest that the majority of the students who participated in their study were in favour of the change in the nature of mathematics taught at university and they expressed a sense of ownership (which is the opposite of alienation) over their mathematical knowledge, as opposed to a number of students who "remained in 'school mode' " (p.273).

2.1.2.3 Cooling-off phenomenon

The developing loss of interest in mathematics, also known as the "cooling-off" phenomenon, was also approached with a different focus (from the one we saw above, which uses the concept of alienation). Daskalogianni and Simpson (2002) investigate students' attitudes regarding mathematics before and while being at university during the first semester of their studies. They find that before entering university students' attitudes are very positive and are mostly shaped by their beliefs about the nature of mathematics and the teaching-learning approaches employed at school. When they come to university for some of these students there is a mismatch between the previously shaped beliefs (about learning processes, nature of mathematics, assessment methods, etc.) and the actual university practices which can cause difficulties in the adjustment to the new setting. The students who experience such

a mismatch of their beliefs develop a negative attitude towards university mathematics which eventually entails a loss of interest in mathematics. The authors suggest that at this point two possible outcomes can happen; the students may recover and re-engage with their studies or they may lose interest in mathematics, lose interest in the course and then develop a "cooling-out" behaviour (some characteristic signs of this behaviour are no sign of interest in engaging with mathematical activities and denial of engaging because of the fear of failure).

2.1.2.4 Activity theory

Jooganah and Williams (2016) use activity theory to explain first year undergraduate students' experiences in the learning of advanced mathematics. They focus on the contradictions that arise between the two activity systems (school and university) and they claim that these contradictions play an important role in explaining the difficulties that students face while studying mathematics at this level. The results of the study suggest that when students move from one activity system to another, the contradictions arising between the two systems can create conflicts in students' mathematical identities which influence the motivation and understanding of advanced mathematics.

2.1.2.5 Creation of measures

Statistical measures have been developed in an attempt to quantify the issue of the transition. Pampaka et al. (2012) created two measures of students' perceptions of their transition to university, within the Rasch measurement framework, namely:

1. "perception of the transitional gap/jump"

2. “degree of positive feeling about the transition”

These two measures allowed the researchers to track students’ disposition to complete their degree and their dispositions to study more mathematics. The authors suggest that the measures can be easily adopted by lecturers who want to get feedback regarding the practices they use during the transitional period. The results of their study suggest that there are significant differences in the transitional experience between subgroups of students and that these contribute to the prediction of the development of positive dispositions. Moreover, they argue that mathematics self-efficacy has a similar effect size to the “positive feeling about transition” (Pampaka et al., 2012, p. 1066).

2.1.2.6 Pedagogic discourse

In their study of first year engineering students at two Swedish universities Jablonka et al. (2016) investigate whether students were able to recognise the change in criteria regarding the mathematical rigour required at this level. The researchers presented to the students extracts from various mathematics textbooks and asked them which ones they considered more or less mathematical and why. Their theoretical framework was based on Bernstein’s (2000) work in pedagogic discourse, and more specifically on his ideas of knowledge classification and recognition rules, on features of Halliday and Hasan’s (1989) work on social semiotics, and on Eco’s (1979) concept of the model reader. The results of the study suggest that the students pay attention to a variety of aspects in the mathematics texts by which they “(mis)recognise” the precision of the mathematics pedagogic discourse. This (mis)recognition is eventually linked to their academic success.

2.1.2.7 Didactical Contract

Hourigan and O'Donoghue (2007) employ Brousseau's concept of didactical contract to study the pre-tertiary mathematics experience of entering students, in the Irish educational context. The authors investigate the didactical contracts of two distinct mathematics classrooms and identify 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.

2.1.2.8 Anthropological Theory of Didactics (ATD)

In her review paper on the secondary-tertiary transition Gueudet (2008) gives an insight into studies in the French (Gueudet, 2006), Spanish (Bosch, Fonseca, & Gascón, 2004) and Danish (Gronbaek & Winslow, 2007) educational context, which use the ATD (Chevallard, 1992) as an analytical tool for the investigation of the issue. According to the ATD a given institution proposes mathematical organisations (or praxeologies): "A mathematical organization $[T, \tau, \theta, \Theta]$ has four components: a type of tasks, T, associated techniques, τ , a technology, θ , which is a discourse explaining and justifying the technique, and a theory, Θ , which is itself a discourse justifying the technology. These organizations can be observed in the official curriculum text, or in the textbooks provided by the institutions." (Gueudet, 2008, p. 245, 246). The results of the aforementioned studies suggest that a focus on the mathematical organisations can provide us with information regarding how an institution presents specific mathematical content and what can be the effect

of this particular choice on students' transitional experience.

2.1.2.9 Rite of passage

A concept from anthropology - the rite of passage - is used by Clark and Lovric (2008) to build a theoretical model in order to explain the transition. The three phases of the rite of passage - separation (when a person encounters a life crisis and isolates her/himself from the rest of the community), liminal phase (events that help the person to achieve the required changes and eventually bring her/him back to the community) and incorporation (at the end of the rite the person learns about the community that she/he will belong to and, supported by the members of the community, she/he will find eventually a place in this new community) - can all be identified as constituent stages of the transitional experience. The separation phase refers to students' separation from the school context: "takes place while students are still in high school, and includes anticipation of forthcoming university life" (p.35). The liminal phase (from school to university) includes the end of school, the time between school and university and the beginning of university. Lastly, the incorporation phase refers to the first year at university. The exploration between the dynamics of these three stages offers a way to understand the difficulties arising during the transition.

2.1.3 Initiatives to alleviate the issue

2.1.3.1 University programmes designed to bridge the gap between the two educational levels

Taking into account the issues that arise from the secondary-tertiary transition, many universities around the world designed various programmes to

support and help first year undergraduates. These programmes aim to address students' skills deficiencies and re-introduce mathematical topics taught at school, introduce the mathematical language used at this level, introduce the notion of proof and familiarise students with its construction, build confidence and trust among students, encourage good study habits that will be required at university, etc.

Leviatan (2008) describes a two-stage transition programme implemented in Beit Berl Academic College in Israel, for prospective mathematics teachers. The first stage of the programme is a Pre-Calculus course consisting of three components ("Introduction to advanced mathematics", "Reading, writing and reasoning in mathematics" and "Number systems"). The second stage is a Post-Calculus course of two parts ("Definition and proofs in mathematics" and "Topics in advanced mathematics"). With the application of innovative teaching and assessment methods (questionnaire based instruction, project based learning, self study, group study, etc) the programme seeks to introduce the students to the basic concepts and tools of mathematics, enhance their reasoning skills, enable them to construct proofs, work individually and in groups, and experiment further with mathematical topics. Students' feedback at the end of the year showed that the course boosted the students' self-confidence, helped them significantly with the other courses of their mathematics curriculum, and they benefited from the use of non-routine mathematical tasks. Similarly, Hoffkamp et al. (2013) designed a bridging course for first semester students majoring in mathematics and for future mathematics teachers in the German educational context. The course was focused on the teaching and learning of mathematical reasoning, argumentation and proof. It consisted of three phases: Information, Cognition and Metacognition. In the first phase the students are presented with the basic

concepts of logic and the method of proof by contradiction. In the second part of this phase, which is more interactive, the students are called upon to analyse and compare two examples of proof by contradiction. And in the last part there is a discussion and reflection on the previous, which eventually unveils the legitimacy of deductive reasoning. At the end of the course some of the students reported that they grasped new ways of approaching mathematics.

The aforementioned courses are just examples of the many bridging courses functioning in universities all over the world. Another initiative employed by universities which aims to help students during the first year of their studies is peer support. Cheng and Walters (2009) implemented a study of 534 first semester freshmen in order to estimate the effectiveness of a "peer assisted learning" (PAL) session, at the University of Minessota. The PAL session was complementary to one mathematics course upon which the students were enrolled (College Algebra and Probability or Precalculus I). In these sessions second year students who had completed the course successfully the previous year ("the facilitators" as the authors call them) were trained before the beginning of the semester, but also during, in peer cooperative learning strategies. In the 50-minute sessions, which took place once per week for a period of 13 weeks, the facilitators encouraged the students to get involved in the engaging activities that they have planned. The agenda was decided by the facilitators, and included worksheets, activities and material which promoted the cooperative learning among peers, but it was also open to changes giving the students the opportunity to develop it collaboratively, based mostly on the things that could trouble them. In this way the responsibility was shared among facilitators and freshmen. The authors found that the attendance at PAL sessions was linked to success in the completion of

the course; students who attended all the sessions had ten times higher odds of succeeding compared to those who did not attend them.

McMaster University in Canada, administered a Mathematics Review Manual for students' voluntary preparation before entering university (Kajander & Lovric, 2005) as a part of its three stage transition programme. This is a 70-page brochure which aims to assist students during the summer months as they prepare for their mathematics courses. Students can find the Manual online and a paper copy is sent via post to all incoming students in science, engineering, and arts programmes. It consists of two parts. The first part contains information about university and the mathematics courses. The second part includes a revision of basic mathematics concepts required for the university mathematics courses (basic algebra, geometry, functions and transcendental functions). Kajander and Lovric's (2005) study suggests that the Mathematics Review Manual did not serve eventually the purpose for which it was designed. Students considered it a "great" idea but admitted that they had not read it. Nevertheless, they usually used it for review purposes while being at university.

Bardelle and Di Martino (2012) piloted an e-learning platform available to 169 science freshmen, in the university of Piemonte Orientale in Italy. This web based platform consisted of interactive activities and resources (quizzes, lessons, tasks) which provided the opportunity to the students to work independently at different levels. In this course the students could submit any activity they worked on and receive individual feedback from their instructors, but they could also work on the activities without submitting them. The course had a non compulsory character and it was made clear to the students that it was used for practice purposes. Additionally, a forum was developed where students were able to exchange ideas and pose questions.

At the end of the year the researchers found a positive correlation between the marks of the students who used the platform and the time they spent on using it. Nevertheless, a low level of participation was observed. Only 40% of the students accessed the platform. As the authors argue, more work should be put in from people that design such initiatives in order to get students engaged.

Simon Fraser University in Canada has developed numerous strategies to address the issues that arise with the transition to university mathematics (Pyke, 2012). These include initiatives that begin when students are still at high school and continue during the first year at university. For instance, the university hosts regular weekend lectures on various mathematical topics which high school students and their teachers can attend. Every summer the department of Mathematics organises a mathematics camp activity for students with a range of mathematical activities to engage with. Additionally, to give an idea of what university will look like, first year university students visit high schools as "Math Ambassadors" and share their experiences and impressions of university with the high school students. When students arrive at university they are also supported in different ways. The department offers entry-level mathematics courses, there is a wide use of technology in lectures which seeks to enhance students' learning, dedicated spaces are provided where students can meet with tutors and/or instructors and can discuss possible misunderstandings or questions on the material covered during lectures, etc.

2.1.3.2 Theoretical suggestions for alleviating the difficulties

Other scholars in the field had suggested different approaches to tackle students' difficulties during the transitional period. In this section I will refer to

the approaches that I consider more relevant to this study. All the following suggestions approach the issue from different perspectives.

Furinghetti (2000) proposes the use of the history of mathematics in first year courses to connect the gap between the two educational levels. The author in collaboration with two experts in computer science created computer based activities on the "classical problems of geometry" (squaring the circle, duplication of the cube, trisection of an angle). Through these problems the students had the chance to witness how the "birth" of algebra arose through the solution of a problem that had involved many mathematicians over many years. The author reports that the history of mathematics worked as a "magnifying glass" for the students which helped them identify difficult concepts of a theory and analyse them through the words that previous mathematicians have used. In this way the students were not presented with a ready-made theory but they had the chance to construct it, following the way of previous mathematicians who encountered difficulties with the mathematical problems underlying this specific theory. The activity emphasised the role of history in the understanding of mathematics.

A completely different approach is suggested by Wood and Solomonides (2008). The two researchers report on two studies of graduates' transition into the workplace which focused on the things that could be improved in tertiary education to enhance students' learning. The participants of the first study had degrees in mathematical sciences and the participants of the second study studied mathematics as part of their degrees. The authors suggest that the graduates needed a better understanding of the purpose of what they were taught at university. Taking this into account they claim that more employment-focused tasks would assist students in their transition to university. University actors should focus on where students are heading

to and inspire them with deeper engagement with the mathematical ideas. They argue that this can be succeeded through the link of students' knowledge with professional work, integration of technology-based activities in the learning process, integration of discipline-specific discourse and creation of a professional identity.

The last suggestions I will refer to concern a more straightforward and practical way to deal with the issue. Firstly, Engelbrecht (2010) inspired by his personal experience of teaching mathematics to undergraduate students and by his research work in the field of mathematics education suggests a model that is adding structure to the transition process. Engelbrecht argues that in order to assist students in the development of the new ways of thinking required at this level he employs the following strategy:
"For each new concept (definition) or result (theorem) students have to be able to understand/explain the concept or result using eight different representations.

1. Verbal, hand-waving, informal explanation in English (or whatever language they speak)
2. Visually (drawing a picture)
3. Formal mathematical symbolism
4. How would you begin proving that this concept is valid, or that the result is true?

The same four representations should be done for the negation of the concept or converse of the result." (p.150).

The first two representations would contribute to the concept image that students have and would contribute to the development of a mental model.

The next two would contribute to the concept definition and would help build on students' logical thinking skills. The negation of the concepts would contribute to students' logical skills and would develop a deeper understanding.

Similarly, Breen et al. (2013) suggest the use of unfamiliar tasks as a way of promoting conceptual understanding during the transition to university mathematics. The authors developed a set of tasks for first year Calculus students in the Irish context. This included both unfamiliar non-procedural tasks as well as some more procedural tasks that the students were more familiar with. The students reported that despite their struggle with the unfamiliar tasks they were beneficial in the development of their conceptual understanding and led them to make links between ideas that they have encountered previously.

2.2 Synopsis of the previous work in the field

Over the past 30 years the literature has offered many significant works in the research of the secondary-tertiary transition. The different aspects of the issue that have been studied shed light on the various kinds of difficulties that students encounter with the study of mathematics when they enter university. Based on these difficulties De Guzman et al. (1998) and Gueudet (2008) presented two different categorisations of the previous studies. For my work I employed an expanded version of the first categorisation created by De Guzman et al. (1998) which I introduced at the beginning of this section. Gueudet's (2008) categorisation on the other hand, begins from the individual - from the thinking modes and knowledge's organisation to proofs and mathematical communication - and expands to the institutional context - didactical transposition and didactical contract.

The engagement with proofs is one of the major shifts that characterises the mathematical knowledge at this level (Jooganah & Williams, 2010) and has been researched extensively. Scholars in the field talked about the change that comes with the use of rigorous language (Hoyles et al., 2001; Luk, 2005; Farmaki & Paschos, 2007; Clark & Lovric, 2008) and the new way of thinking (Tall, 1991) when working with and communicating proofs. A classification of the difficulties encountered by students has been offered, as we saw earlier, by Moore (1994) which although rich focuses only on students and does not take into account the lecturers' agency in this process. This was complemented to an extent years later by the study of Jablonka et al. (2016) which considers also lectures' involvement in the issues arising with proof construction.

Researchers often bring to the fore differences in the teaching practices employed between the two educational contexts which might be the root cause of problems that students have in adjusting to the new context (Gueudet, 2008; Thomas & Klymchuk, 2012). Among other things these differences include the shift in the provision of the resources (De Guzman et al., 1998; Pampaka et al., 2012; Thomas & Klymchuk, 2012; Gueudet & Pepin, 2016) and the level of one-to-one interaction between students and lecturers (Cherif & Wideen, 1992; Pampaka et al., 2012; Thomas & Klymchuk, 2012).

Moreover, the changes in the assessment and feedback procedures have been at the epicentre of various studies in the field (Pampaka et al., 2012; Thomas & Klymchuk, 2012; Jablonka et al., 2016). These changes can be added to the new academic requirements that the study of mathematics at university poses to first year undergraduates. Various scholars have investigated in what ways the new study habits and the level of independence that is expected to be adopted by freshmen can influence their transitional experience (Pongboriboon, 1989; Clark & Lovric, 2008; Pampaka et al., 2012;

Thomas & Klymchuk, 2012; Breen et al., 2013).

Finally, a body of research has focused on students' perceptions about mathematics and on the ways in which these can be influential during the move between the two educational settings (Crawford et al., 1994; Ulriksen et al., 2013; Harris et al., 2014). Here, I included studies in which the perceptions refer either to the content of mathematics and its use/exchange value, or to what students perceive as being mathematically competent.

Accompanying the research which investigated the troubles that students encounter when they enter mathematically demanding courses, is a number of studies which explore various ways to tackle the issue and alleviate students' troubles. The majority of these studies refer to the initiatives that various institutions have taken towards this direction (Kajander & Lovric, 2005; Leviatan, 2008; Bardelle & Di Martino, 2012; Pyke, 2012; Duah et al., 2014) but also suggest projects/ideas (Furinghetti, 2000; Wood & Solomonides, 2008; Engelbrecht, 2010; Breen et al., 2013) that could be implemented in order to support students during this phase. What is missing though from these studies, is in the first case a reflective voice evaluating whether the initiatives taken by universities are effective and in what ways, and in the second case substantial results from testing these projects/ideas in order to see if they are adequate for introducing them to the students.

Another issue that emerges by reviewing the literature is that many of the studies focus on undergraduate courses that include in the curriculum a number of mathematics modules (e.g. engineering or science courses) and there are not many studies that investigate pure mathematics courses. This focus changes the direction of the research to some extent because there can be issues that a mathematics student might face which will not be faced by an engineering student and vice versa. For instance, on many occasions an

engineering student will have to succeed in a specific number of mathematics modules which will eventually be used as a tool for the engineering modules. A mathematics student will have only mathematics modules and this entails a different approach to studying.

Moreover, as we saw previously, the vast amount of research directs its attention to the difficulties that freshmen encounter when they study mathematics at university level. On many occasions the researchers focus on one aspect (like Moore (1994) where he focused on the troubles that students face when they engage with proofs) and by leaving other (equally important) aspects untouched (for instance, in Moore's case the lecturers' role during students' engagement with proofs, or the resources' role) do not show the whole picture. Therefore, we only know partially what happens. Of course, it is not feasible to investigate the issue by focusing on all of its aspects at the same time. But we should always bare in mind that in some cases the elements are interconnected and by shedding light only on one of them we do not gain an understanding of the situation. Based on this view, I will explain in the following section how my work tries to connect different aspects of the issue and bridge a gap in the secondary-tertiary transition literature.

2.3 What is missing?

Due to all the aforementioned changes students encounter a number of difficulties while engaging with university mathematics. I focus my attention on aspects of the transition that have been proven problematic by previous researchers but with a different approach which aims to delve more deeply into the issue.

Following a thorough research of the literature I identified some breaches

(like the ones mentioned above) which I want to address with my work. The aspects of the transition that my work is based on (as those were introduced earlier in this section) include the didactical, sociological/cultural and students' perceptions.

Starting with the shift that happens in the teaching-learning practices between school and university I aim to explain how the discourse that frames this shift affects the transition. I do not pinpoint only the differences in the practices but, I analyse the messages that are transmitted through them. In this way we can gain an understanding of the meanings that students receive from the teaching-learning interactions. Following this, I explore how students interpret the messages according to their identities. The interpretation will eventually lead us to the influence that this sort of information has on students' transition. Let me give an example to make it more clear.

A big change in the didactical aspects of university mathematics lies in the ways the assessment and feedback procedures are implemented. In some university programmes the lecturers choose to employ regular assessment methods throughout the semester, as opposed to the school teachers who use mostly a final examination at the end of the year. The implementation of the assessment method (either it is a test, or a coursework, etc.) in addition to the information that the lecturer transmits about the assessment during lecture time, will give out a message regarding the content of the module and the ways of studying for it, but also for the degree in general. The interpretation of this message, mediated through students' identities, will make the students feel either comfortable and take action from it or uncomfortable and struggle. Therefore, in this example we have a clear view of the whole picture by taking into account what the lecturer transmits (didactical aspects), under what circumstances (sociological/cultural context), how the students interpret it

(perceptions), and what kind of action they take - or not - from it (i.e. how they influence students' transition). In this way I try at the same time to capture the whole interaction and understand what can facilitate or hinder students' adjustment to the new context.

Furthermore, if we consider the new academic requirements that students are expected to follow, I am trying to see how the messages, either implicit or explicit, accompanied through these requirements can help or make students struggle. For instance, how students react to all the information transmitted with the new study habits at university. The independence that prevails in this level of studying can be stressed to a greater extent with the use of specific practices by some lecturers - they might not specify what they expect their students to study and assume that is students' responsibility to find out - and less by others - they might say explicitly what they expect their students to know for the next lecture, recommend books to read from, etc. The different practices that the lecturers adopt, transmit different messages regarding the nature of learning mathematics at this level. Different students interpret these messages differently, according to their identities. For example, in the first case some students might feel comfortable having control over their study time and material and some others might feel constrained by not having designated by the lecturers what to do. Hence, students' adjustment to the new context will be influenced. With my work I am exploring what lies beyond these influences by analysing the transmitted messages and the ways that students interact with them.

Also, perceptions are an important part of students' identities and play an important role in this process. The messages can enhance, undermine or even change entirely these perceptions which will eventually have an effect on the transitional experience.

In conclusion, we have seen that the transition to university mathematics has many different aspects and one cannot just focus at the same time on all of them. But, it is important to understand that some aspects cannot be studied disconnected from some other ones. For instance, when we say that the students struggle because of the new academic requirements, we cannot leave out of this the discourse that accompanies this change. For example, do the academic requirements change because the lecturers do not say something about it and the students realise that they need to be responsible (no message is a big message)? Or do the lecturers provide tasks that enhance students' responsibility? And at the same time we need to take into account how different students will react in these different hypothetical scenarios. This leads us to the identities that students bring with them to university. Therefore, what I am saying is that because of the complexity of the issue we need to build a framework for analysing the problems that arise, which will have a more broad perspective and will account for more aspects of the phenomenon. And this is what I am trying to do with my work.

The theoretical approach that I use builds on the socio-cultural tradition (see Chapter 3). I employ concepts from Bernstein's (2000) work to analyse the power and control of the transmitted messages, concepts from Holland et al.'s (1998) work on positional identity to account students' identities and Senninger's (2000) learning zone model to demonstrate students' moving during the trajectory from school to university mathematics.

Behind the practices/discourses the lecturers intend to transmit messages which have to do either with the content of mathematics or with the learning of mathematics. The analysis of every message to the level of its classification and framing shows the power and control relations in the teaching-learning interactions. The analysis of the messages is not, of itself, enough to demon-

strate in what ways they are influential on students' transitional experience. And this is because each individual student according to her/his previous experiences (through schooling, family and friends environment) has already formed a mathematics learner identity which responds differently to different messages. This explains the use of the concept of identity. Finally, the adaptation of the learning zone model, allows us to see in a clear way how the students are influenced (or not) by messages. This is achieved by observing in what ways the students move between the zones and how they eventually position themselves in the new context. In the next chapter I describe in detail these three theoretical perspectives.

CHAPTER 3

Theory

In this chapter I introduce the theoretical concepts that I used for the design of the theoretical framework. I draw on elements from three different theories:

1. Classification and Framing (Bernstein, 2000)
2. Positional Identity (Holland et al., 1998)
3. Learning Zone Model (Senninger, 2000)

I will present now the three different concepts separately and subsequently I will describe how by bringing them all together I constructed the theoretical framework.

3.1 Classification and Framing

In this section I will present features of Bernstein's theory included in the theoretical framework. Firstly, I will talk about his main preoccupations for developing the theory of pedagogic device. Then, I will explain how the pedagogic device works. Although I am not using the pedagogic device as my main theoretical framework I intended to do so when I started out on this research project. My initial plan was to use the whole device for the data analysis, but for particular reasons - which I will explain in more detail in the following - I chose to employ only a part of the device, the recontextualising rules, which include the concepts of classification and framing. I consider that by explaining how the whole pedagogic device functions it is easier for the reader to comprehend the concepts of classification and framing. In the final part of this section, I will go into more detail and explain classification and framing.

3.1.1 Bernstein's preoccupations

Bernstein's (2000) work focuses on educational transmissions and explores how knowledge is reproduced by controlling what is taught, and how, by those in power. In the following I will talk about the development of his theory.

According to Bernstein the discourses of education frequently reproduce relations of social class, gender and racial inequality which are external to the actual discourse of education - which he calls "pedagogic discourse". With his work he attempted to develop an understanding of the voice of pedagogic discourse by examining the relations within the pedagogic communication (Ashwin, 2009).

The analysis of the voice of pedagogic discourse offers a way of understanding the relations between disciplinary knowledge practices (a set of structural agentic processes; whether an individual acts as a free agent or in a manner dictated by social structure (Ashwin, 2009)) and teaching learning interactions. This analysis has two aspects:

1. It offers conceptual tools to discover the production of disciplinary knowledge and its transformation into curriculum.

2. It reveals in what ways the curriculum and the teaching learning interactions influence the consciousness of academics and students.

Therefore, Bernstein tried to find the connection between the knowledge production and the teaching-learning interactions. This attempt resulted in the creation of the concept of pedagogic device which as Ashwin (2009, p. 91) puts it, "is an area of struggle over how academics' and students' ways of thinking will be structured through pedagogic discourse and whose interests will be served through this structuring."

3.1.2 Pedagogic device

The concept of pedagogic device was introduced by Bernstein in order to explore whether there are any principles underlying the transformation of knowledge into pedagogic communication. I will explain now in more detail how the pedagogic device works.

There is a potential discourse outside the device, which Bernstein called the meaning potential, that needs to be transformed into pedagogic communication. This meaning potential is the one that activates the device and as a result we have communication. The device itself has some internal rules which regulate this communication (Bernstein, 2000). The communication

produced by the device has a feedback in the meaning potential. This feedback can act selectively upon the meaning potential. Therefore the device regulates the pedagogic meanings either in a restrictive or enhancing way of their realisations. In simpler words, outside the device there is some knowledge that needs to be transmitted, this knowledge carries some meanings and these activate the device. Going through the device the knowledge will be transformed into discourse and afterwards this discourse will be transformed into practice which is subjected to evaluation. This process will be achieved with the aid of the rules of the device. The rules of the pedagogic device are the distributive, recontextualising and evaluative. They are hierarchically related and there is an interrelationship and power relationships between them. In the following I describe each set of rules.

Distributive rules

The distributive rules distinguish between two different classes of knowledge, the thinkable and the unthinkable. Bernstein (2000) argued that these two classes are necessarily available in all societies. The thinkable refers to the knowledge of the possible (for example, in the context of university mathematics the knowledge of the possible would be mathematical concepts that first year students already know from school and are able to work with) and the unthinkable to the possibility of the impossible (for example, the mathematical concepts which are used by professional mathematicians but students are not yet familiar with and will learn at university). Between the thinkable and the unthinkable there is gap and any distribution of power will try to regulate this gap in its own interest (for instance, in what ways the lecturer will try to regulate the gap between the things that students already know from school and the things that they need to learn at university in order to

become professional mathematicians). Thus the power relations are the ones that distribute the thinkable and the unthinkable.

Recontextualising rules

With the recontextualising rules the knowledge is transformed into pedagogic discourse. There are two elements in the recontextualisation of knowledge into discourse; these are the classification and the framing. These two concepts refer to the translation of power and control relations.

Classification and Framing

According to Bernstein (2000) classification refers to "a defining attribute not of a category but of the relations between categories". Hence, classification is not concerned with what is classified but with the relations between the categories and it shows the differences in degrees of insulation between contents (e.g. subjects/courses). When the classification is strong it means that the insulation between the categories is strong and each category has its own identity. Thus, there are strong boundaries between them. When the classification is weak we have weak insulation and boundaries, and less specialised identities. For instance, the subject of mathematics has stronger boundaries than the subject of politics and science. This can be explained because the contents of the discipline of politics interrelate with the contents of the discipline of science; hence the boundaries between the two disciplines are weak. But in the case of mathematics there is no interrelation with another discipline, therefore the boundaries are strong from the rest of the subjects.

The way I use the concept in this study, which I will explain in more detail in the following, differs from how Bernstein initially used it, in the school

context. For him classification is concerned with the boundaries between the different knowledge contents taught at school. For instance, when there is a relation of the contents of one discipline with the contents of another discipline of the curriculum, hence in the interdisciplinary level, the boundaries between them are weak and so it is the classification. On the other hand, when there is no interrelation between the disciplines, the boundaries are strong and similarly the classification.

In the context of this study a strong classificatory message puts clear boundaries and makes explicit the things that students are expected to do by their lecturers. For example, if we have three different approaches used by a lecturer during teaching assuming as approach A: the lecturer asks the students to just listen what s/he says, approach B: the lecturer asks the students to just copy from the board what s/he writes, and approach C: the lecturer asks the students to listen and copy from the board at the same time. Approach A can only be approach A if there is no relationship between it and the rest of the categories, hence if it is effectively insulated from approach B and approach C.

Framing on the other hand is concerned with "the controls on communications in local, interactional pedagogic relations" (Bernstein, 2000).

With the classification an individual can recognize the specialty of the context. With the framing the individual has the necessary means for the acquisition of the legitimate "text". This would mean whether students have understood specific aspects of the curriculum (for instance, when a lecturer recommends that their students adopt a specific approach for constructing proofs, this approach would be the legitimate text). Hence, classification sets the limits of the discourse and framing sets the form of realisation of the discourse. Classification refers to what meanings are going to be put together

and framing refers to how these meanings are going to be put together.

Framing concerns who can control what. This control is over the selection of communication, its sequencing, its pacing, the criteria and the social base that make this transmission possible. As Bernstein argued: "When framing is strong, the transmitter has explicit control over selection, sequence, pacing, criteria and social base. When framing is weak, the acquirer has more apparent control over the communication and its social base."

Evaluative rules

These rules focus on the transformation of pedagogic discourse to pedagogic practice. Bernstein (2000) suggested that continuous evaluation is the key to pedagogic practice and this is what the pedagogic device is all about. The evaluative rules summarise the whole meaning of the device. This evaluation concerns the texts that should be created by the students from the pedagogic discourse. These texts are forms of evidence that can show us if the students have acquired the expected aspects of the curriculum. Therefore, the evaluative rules set the standards that must be reached by students (Ashwin, 2009).

3.1.2.1 Why the whole of the pedagogic device was not an appropriate theoretical framework?

In the data analysis of the study I was not able to apply all parts of the pedagogic device but only the recontextualising rules. This made me reconsider my initial decision to use the pedagogic device as the main theoretical framework. I will explain now why the distributive and the evaluative rules were not appropriate in this context and why only the recontextualising rules were.

As I described earlier the distributive rules show who holds the power for distributing the knowledge, hence bridging the gap between what is already known (the thinkable) and what is going to be learnt (the unthinkable). In this study I was not able to recognise, or access, those holding the power of the distribution of knowledge. For instance, on the occasion that the lecturer chooses to give the students a particular set of notes, is it the institution's rules that drive this choice or is it the lecturer her/himself, or both? In that sense, behind each choice there is a different motive and a different level of power transmitted. Looking at this in more detail was beyond the scope of this study.

Moreover, I was not able to use the evaluative rules for two reasons. Firstly, each message received by the students did not always result in some kind of action or practice. Therefore, I could not evaluate how the discourse was transformed into practice, which is the main function of the evaluative rules. Secondly, on the occasions that the discourse was transformed into practice, this practice was not always subjected to evaluation. For example, the actions that students might take when they receive messages regarding becoming more independent in the university context (e.g. managing their study time, looking for more resources to facilitate their study, etc.) cannot be reliably evaluated.

However, the recontextualising rules provided me with the appropriate tools to analyse the transmitted messages during the teaching-learning interactions. Using the concepts of classification and framing I could identify how powerful a transmitted message was and the level of control that it carried. The variation in the degree of power and control affected the ways students perceived and interpreted the messages and therefore whether they were prompted to take action in furtherance of their studies. In the following

I will describe further how I used these concepts.

3.1.3 Classification and Framing of the Transmitted Messages

Knowledge (in this case, mathematical knowledge but also knowledge about how university works) 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. In this study, I 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. In this context, a strong classificatory message is an explicit message transmitted by the lecturer through which students can recognize the specific context of the discourse. Therefore, I took the idea of classification and I use it to differentiate messages given to the students. I use the concept in order to identify how clear the boundaries are between the transmitted messages and the clarity of each conveyed message. Bernstein argued that with the use of the concept of classification the expectations of a particular context can be made clear. The concept helps to identify what kind of meanings are going to be put together during the transformation of knowledge into communication. Therefore, by employing it I examine whether or not the lecturers, through the conveyed messages, make their expectations clear regarding the ways that they expect students to

learn mathematics at this stage. According to the degree of power that each message carries I aim to examine to what extent it is recognizable (or not) by the students. The stronger the power of a particular message the better the insulation from the rest of the messages and the easier to be recognized by the students. Whether or not a student can distinguish a particular message from other messages depends on them as individual learners as we will see in Section 5.2. Hence, in the forthcoming analysis I also use the concept of identity which considers individuals as having agency in their learning. For instance, some students might be familiar with having mathematical conversations. Therefore, when the lecturer invites the students to engage in this sort of discussion they would be keen on getting involved and they would recognise easily the message behind the use of such practice. On the other hand, students that are unfamiliar with having mathematical discussions might disregard the practice and the message that it conveys.

Framing reveals the control relations that a transmitted message carries and shows the form of realisation that the discourse can take. The control is over the selection, sequencing, pacing and evaluation of the communicated knowledge. When a message is strongly framed, there are reduced options for the recipients and the control is with the transmitter (Bernstein, 1971). In this study a strongly framed message arises when all the control rests with the lecturer and regulates explicitly students' thinking over something that is discussed or practiced. A weakly framed message gives space to the students to control and be responsible for their learning. For example, a lecturer who suggests to their students to study only from specific kinds of resources for the examination, e.g only from the lecture notes that s/he provides, directs entirely students' thinking about how they should be studying. On the other hand, a lecturer who offers a variety of resources options to the students,

e.g. lecture notes, textbooks, online material, etc. gives more space to the students to decide how they should structure their learning resources in order to prepare for the examination.

Several researchers have also used Bernstein's work in instructional contexts to explain various educational issues through the concepts of classification and framing. For example, Morais, Neves, and Pires (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.

3.2 Positional Identities

In this section I will talk about the use of the concept of identity in the research field of mathematics education. Then I will focus on Holland et al.'s (1998) concept of positional identity which I included in the construction of the theoretical framework. I will first explain the concept and then describe how I used it.

3.2.1 Identity

In a recent work Darragh (2016) examines the use of identity in the literature of mathematics education over the past 20 years. She argues that identity can be approached either as an action and be framed sociologically, or as an acquisition which fits into a psychological frame. For the approach that sees

identity as an action she draws on Mead's perspective: "A Meadian identity is an action, it is something one does, and it is multiple, contradictory and socially constituted" (Darragh, 2016, p. 27).

Several theorists, including Holland et al. (1998), consider identity as an action rather than an acquisition. Black et al. (2010) talk about the wide use of the concept of identity in mathematics education in order to discover students' engagement with mathematics. Moreover, Ulriksen et al. (2013) suggest the important role that identity plays in the selection of the course that students choose to study and once they decide this whether they commit to the course or drop out after a while. Similarly, the concept of identity contributes to understanding the reasons why some students might decide to continue (or discontinue) studying mathematics (Black et al., 2010).

Solomon (2007) argues that identity has a central role in the sociocultural accounts of learning. In the case of mathematics undergraduates, it is a useful concept for clarifying what students think about themselves as learners and as future mathematicians. To explore this, there is a need to understand students' identities in the interrelation between different practices.

In the analysis of the teaching-learning interactions in the university context, the concept of identity can be used to investigate what lies underneath these interactions. As Lerman (2001) puts it, identity can be used to zoom in to the degree that individuals interact during the teaching-learning interactions.

Another sociocultural perspective describes identity as the experiencing of ordinary ventures with shared values and rules of participation. As Wenger (1998) reports: "We know who we are by what is familiar, understandable, usable, negotiable; we know who we are not by what is foreign, opaque, unwieldy, unproductive" (Wenger, 1998, p. 153).

Darragh (2016) explores in what ways identity can be defined and reports the following classification: participative, discursive, performative, narrative or psychoanalytic. In each definition the social context is taken into consideration as a way of constructing identity. I am not going to describe in detail every definition. I will describe only the participative classification which is the one I use in this study. Participative identity is concerned with definitions which account for the ways in which "identity is constructed in participation and engagement in a social group" (Darragh, 2016, p. 24).

3.2.2 Positional identities

Holland et al.'s (1998) concept of positional identity is an example of participative identity. The authors develop their ideas regarding identity through discussions of the works of others and their own research projects. They draw on Vygotsky's and Bakhtin's work, in order to extend the anthropological encounters with identity and self to the cultural studies of the individual. They suggest that identities do not take a finalised form; they are always unfinished and in process. Identities happen in social practice while the individuals get engaged in various social activities.

People get an idea of who they are by telling to others who they are, but most importantly by telling themselves who they are and thus trying to act so. The formation of identity comes as a result of the production of objectifications of self-understandings which will lead to a particular conduct. Individuals find themselves between past stories which have been settled inside them and discourses and images of the present which attract them.

The authors direct their attention to "the development of identities and agency specific to practices and activities situated in historically contigent, socially enacted, culturally constructed "worlds": recognised fields or frames

of social life..." (Holland et al., 1998, p. 7).

While people act in socially and culturally constructed worlds they develop a sense of themselves. These identities, as long as they are conscious, allow people to have a degree of control over their behaviour. The identities that Holland et al. (1998) investigate are the ones that track people's participation and agency in the figured worlds. With this term the authors refer to activities that are socially produced and culturally constructed. I will list now some characteristics of the figured worlds which are central to the development of Holland et al.'s (1998) theory.

- Figured worlds are historical phenomena into which we enter or we are recruited and which develop via the work of their participants. They are processes which shape our lives as we intersect with them.
- The position that each participant takes in a figured world matters. Some figured worlds we may know very well, some others we may never be able to enter because of the social position that we hold, and some others we may not even encounter by coincidence.
- Figured worlds are socially structured and reproduced. They attribute roles to the participants and they are dependent on the interaction among the participants.
- The identities acquired within the figured worlds are historical developments, which grow with the extended participation in the positions attributed by the social structure of the worlds' activity.

Consequently, through the figured worlds we have "a means to conceptualise historical subjectivities, consciousness and agency, persons (and collective agents) forming in practice" (Holland et al., 1998, p. 41). In this

study the socially enacted and culturally constructed world, therefore the figured world, is the context of university, and more specifically the context of university for first year mathematics undergraduate students.

The authors make a distinction between the features of identities that are concerned with the figured worlds - narrativity, storylines, desire, and generic characters - and the features that are concerned with an individual's position in respect to socially identified others. Although in the analysis I use only the concept of positional identities which the participants form while acting in the figured world, I considered it helpful to explain also the figured worlds in order to make it more comprehensible. I am going to explain now the concept of positional identities, and to point out in what ways I use it in the construction of the theoretical framework.

Holland et al. (1998) argue that each individual has some characteristics (language, particular actions, emotions, etc.) which act as identification with social categories and position the individual in particular ways, with respect to whom they interact with. Moreover, by taking into account how a person feels in the interaction with others - comfortable or constrained - defines each individual's positioning with respect to others. This positioning is concerned with power relations (for example, the authority of lecturers might constrain or prevent students from asking questions). The authors define positional identities as: "the day-to-day and on-the-ground relations of power, deference and entitlement, social affiliation and distance - with the social-interactional, social-relational structures of the lived world" (Holland et al., 1998, p. 127).

Furthermore, positional identities refer to the ways that a person comprehends their social position in a lived world. This is dependent on the other people that are present, on the degree of access that this person has

to spaces, on the activities that are performed, the genres and any kind of voices. The development of the positional identity is a long term process which occurs though during day-to-day practices. It is built again and again, through various means of artifacts, or indicators of positioning, which the newcomers will slowly learn how to identify and then most likely to identify themselves with; either in a positive or in a negative way, which will lead to either acceptance or rejection. Therefore, the affording of the position derives from the practice. While the individuals engage in different activities, the communication and interaction will eventually contribute to the construction of the social positioning and the social relations among them. This is linked with Bernstein's concepts of classification and framing, described earlier; according to the power and control that will be carried through the level of interactions the individuals will acquire a particular position.

In this study I draw on the concept of "positional identity" which refers to the ways that a person identifies their position in relation to others, mediated through the ways that make them feel comfortable or constrained. I focus particularly on the concept of space of authoring. Here an individual can orchestrate the social discourses and practices which allow them to act in a particular way. In this sense a message transmitted by the lecturer which varies in classification and framing can influence how students participate differently in university practices (i.e. opens up or constrains their space of authoring), hence shaping their identities as mathematics learners in different ways while they participate in these practices (e.g. a brilliant mathematician, a dropout, etc.). As Lerman (2000) argues, the individual trajectories in the development of a person's identity when s/he engages in social practices are influenced by the ways that this person functions in this specific practice. Through the engagement in the practice an individual is attributed a different

positioning. In our context, this means that the identity that the students bring with them from school can be reshaped through their involvement with university practices. The messages presented in this study are carried through these practices and contribute to the reshaping of students' identities by positioning students with respect to the new practices of university.

3.3 Learning Zone Model

Senninger's 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. By using Senninger's model I can decompose students' movement from the field of school to the field of 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 I can depict how students are affected differently by the same message. This provides the opportunity to account for each student as an individual learner; this is important because if we attempt to alleviate the difficulties that students face during transition we need to pay attention to students' agency.

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. I 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. This is because the content of mathematics and the practices regarding the learning of mathematics are recognised and fixed in students' minds from their school experiences.

In this model's adaptation, I 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; the procedure makes them feel anxious, the anxiety and fear create a feeling of discourage-

ment and consequently they quit trying.

Between the comfort and discomfort zones lies the transitional zone, the one that Senninger (2000) refers to as the learning zone. 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. I hypothesise that the boundaries between the zones can be pushed by transmitting messages that prompt changes in students' actions and thinking. This will be explored in more detail in the Results section. I will investigate how the degree of power and control carried through the transmitted messages prompts the students to move between the zones.

3.4 Theoretical framework

In this section I will describe how by bringing together all the previous concepts I developed the theoretical framework.

My main motivation in this study is to examine how the messages transmitted by the lecturers influence students' transition to university. Initially, I needed an instrument for the analysis of each transmitted message. I considered as the most appropriate tool Bernstein's (2000) concepts of classification and framing. These two concepts go into depth in the teaching-learning interactions and helped me to identify the underlying structures of power and control conveyed through each message.

After analysing the messages I needed to see how the variation in power and control influenced students in the ways that they interpreted the mes-

sages. In doing so, I used Holland et al.'s (1998) concept of positional identity. In this way I could see how students in the interaction with the transmitted messages felt comfortable or constrained in the new context and how they positioned themselves, hence constructing their identities as university mathematics students. This happened by taking into account the elements of their identities as mathematics learners formed during the previous years through their schooling and the degree of power and control of every message they interacted with. Additionally, the use of positional identity gave me the chance to explore why different students responded differently to the same message. Here, it was important to consider the structural-agentic process of the transition to university, i.e. the relation between the individual's identity and the rules imposed to him/her by the institution and society at large.

Finally, in order to evaluate the whole transitional experience and explore whether students adjusted smoothly or not in the new context I used an adaptation of Senninger's (2000) learning zone model. I examined in what ways students were prompted to take action in furtherance of their learning from the transmitted messages and how this interaction moved them between the zones and eventually positioned them in the university setting - in relation to the comfort, transitional and discomfort zones. Students' movement between the zones can be prompted by messages that refer both to the content of mathematics and study guidance. This happens because the messages that the lecturers convey through the teaching-learning interactions refer to both the content of university mathematics and the learning practices that students need to acquire at this level. For instance, in Section 5.2.1.2 (p.152) Elsa describes how by receiving the message transmitted through the different types of assessment she put in more work during the semester and managed to catch up with all the content. This particular message referred

to a learning practice and by interacting with it Elsa moved into the transitional zone. On the other hand, Jason in Section 5.2.3.2 (p.172) describes how his lecturer's lively examples transmitted his (lecturer's) intrinsic enthusiasm for the content of mathematics and made it easier for Jason to understand abstract concepts. By interacting with this message, which was about mathematics, he managed to learn the concept and move into the transitional zone.

Bernstein (1996) argued that individual enhancement is the "experiencing of boundaries... not as prisons... but as tension points condensing the past and opening possible futures." Building on this idea and combining it with Holland et al.'s (1998) concept of positional identity and Senninger's (2000) learning zone model I demonstrate in the data analysis how the degree of power and control, carried through the transmitted messages, interacts with students' identities as mathematics learners and triggers their positioning by crossing (or not) boundaries among the zones. Consequently, by exploring what is transmitted, how it influences students and why they take a specific positioning in the new context I attempt to give the whole picture of students' transitional experience.

3.4.1 Summary of the key theoretical concepts

In the following table (Table 3.1) I illustrate a summary of the key theoretical concepts that I employed in the theoretical framework and their meaning.

Concept	**Meaning**
Classification	Shows the power relations between categories and sets the limits of the discourse. Strong classification entails strong boundaries (which I will represent with '+'), weak classification entails weak boundaries (which I will represent with '-').
Framing	Shows the control relations on communications and sets the form of realisation of the discourse (who can control the selection, sequencing, pacing and evaluation of the communicated knowledge). Strong framing (which I will represent with '+') means that the control is with the transmitter, weak framing (which I will represent with '-') means that the control is with the acquirer.
Positional Identity	Shows how individuals identify their position in relation to others according to the ways that make them feel comfortable or constrained.
Comfort Zone	This zone consists of the things that students know already from school regarding the learning of mathematics (both mathematical knowledge and pedagogical approaches).
Transitional Zone	In this zone students can grasp new meanings, adjust to the new context and expand their ways of learning mathematics.
Discomfort Zone	This zone includes the things that students find completely different in the university context, regarding the learning of mathematics, from those experienced at school.

Table 3.1: Key theoretical concepts

CHAPTER 4

Methodology

In this study I took an interpretivist paradigm and I used qualitative methods to analyse my data. With the use of this paradigm researchers reveal the interpretations of a phenomenon by the social actors; in order to understand the phenomenon under investigation the researcher has to see things from the view point of the people who are involved in it (Pring, 2004). In this sense, the truth does not lie "out there", expected to be discovered, it lies in how the researcher interprets the phenomenon by interacting with the actors involved in it. This interpretation is acquired in a clear, open and systematic way. Similarly, for this study I interacted with the students and their lecturers in order to understand in depth the effect of the transmitted messages on their transitional experience. By using this paradigm, I was able to investigate the phenomenon in great depth and collect honest and trustworthy accounts from the participants, something that enhanced the validity of the collected

data.

Although for me as a researcher elements of the truth can be revealed by both qualitative and quantitative research methods the time restrictions that a PhD programme imposes and some practicalities did not let me employ both. In the context of my study I would have liked to have a bigger cohort of participants and include also other variables that would help me to understand students' transitional experience. For instance, it would have been helpful to include a quantitative analysis of the data that I collected from the first questionnaire. The time limitations did not allow me though to take further actions. Because of the nature of the study I had to follow students during the first semester of the studies, hence all the data collection needed to finish during a very restricted time window. Therefore, I had to make a choice about what methods I would use in order to be both consistent with the time schedule of the programme and to give also a good account of the secondary-tertiary transition. This is why I chose to employ only qualitative methods. In this way I attempted to understand in depth what the lecturers and students have to say and explore how the teaching-learning interactions between them at this phase can influence students' transitional experience. The methods I chose to employ were appropriate for this work and good for the purpose of the study in general. Of course every methodology has its limitations but at the end of the day there is no such thing as "perfect" methodology.

4.1 Pilot study

During the spring semester of the academic year 2014-2015 I conducted the pilot study of my research project. My main motivations for the implemen-

tation of the pilot study were to design and evaluate a research protocol, to test whether or not the research instruments were appropriate, to identify barriers that arise during the implementation of a study, to develop a research plan, to reflect on my role as a researcher by analysing a small data set, to explore the potential of the theoretical/methodological framework and to familiarize myself with the various stages of a research process.

In this pilot study I investigated the different kinds of messages that a mathematics lecturer sent out to his students through the discourses and the practices he used in the lectures. I followed ten students who were in the second semester of their studies for a joint degree in Mathematics during the attendance of a Multivariate Calculus module. The research was conducted through observations of the lectures and focus groups with the students. The observations and the focus groups were preceded by an informal discussion with the lecturer at the beginning of the semester; the lecturer referred to his teaching plan and the ways he expected students to work for this module. A sequence of observations of the lectures followed. During the observations I focused on the messages that the lecturer transmitted to his students and kept a record of them. Subsequently the focus groups were formed. In the focus groups I brought up for discussion some of the messages that I observed during the lectures and the students discussed and commented on them.

For the categorisation of the transmitted messages that I identified during the lecture observations I used aspects of grounded theory (Strauss & Corbin, 2008). I classified the messages in the following distinct categories:

- Messages about learning habits in university mathematics
- Messages about the learning resources
- Messages about students' engagement in the lecture theatre

- Messages about what students should do when they feel stuck

After the identification and categorisation of the messages, I employed Bernstein's (2000) concepts of classification and framing to analyse each message separately. These two concepts contributed to the creation of boundaries between the different practices that took place in the lecture theatre and created a picture of the control that the messages had on students' interpretations. The findings of this study provided some indications about the extent to which the different kinds of messages sent out by the lecturer are important. They began to reveal the ways in which these messages can shape students' conception of university mathematics and thereby affect their transitional experience.

4.2 Main Study - Data Collection

For the conduct of my main study the participants completed a consent form through which they were assured that their identity would remain anonymous and that they were able to withdraw their participation if and whenever they wanted to. I also completed an ethical checklist which required consideration of the potential risks to the participants, data protection issues, details of participants recruitment and various ethics aspects. Finally, I checked whether the study complied with the British Education Research Association's (BERA) guidelines.

The research was conducted in a UK research intensive university among ten first year honours degree mathematics students (nine single honours and one joint honours with mathematics education). The time frame of the study was 13 weeks; during this time, I implemented individual interviews with the two lecturers, observations of lectures, questionnaires, focus groups and

individual interviews with the students. I will explain now why these methods were the most appropriate for my research and in the following subsections I will describe in more detail when each collection method was used, in what ways and for what purpose.

The lecture observations were theory-driven (Cohen, Manion, & Morrison, 2011); I sought 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. My observations were highly focused on the interactions between students and lecturers during the classes and the unit of observation was the transmitted messages. With the use of the first questionnaire, which was semi-structured (Cohen et al., 2011), I gathered information about aspects of students' identities as mathematics learners and about the very first messages received in the university context. The final questionnaire was more open and word-based (Cohen et al., 2011). Through this I had the opportunity to see whether students were consistent with the previously received messages or whether there have been other messages more influential to their learning. Finally, the focus groups and the interviews were semi-structured and informal (Cohen et al., 2011). During the focus groups themes of the transmitted messages emerged that were influential on each student's transition. I examined these messages further and in more depth in the interviews. The agenda for the interviews was enhanced from prior data gathered from the lecture observations and the questionnaire. With the collected data from the interviews I constructed narratives of students' identities as mathematics learners and thus I monitored their trajectory and their eventual positioning in the university setting, which happened as a result of their interaction with the transmitted messages.

4.2.1 Modules selection

My attention was focused upon two modules in particular, hereafter Module A and Module B, which were compulsory for all students during their first semester at university. Module A is an introductory module in Analysis and Module B an introductory module in the thinking and reasoning required at university level mathematics (e.g. introduction to proof by induction, proof by contradiction, introduction to sets, etc.). These two modules were selected because of their importance in the first year of studies of a mathematics degree. Moreover, the content of these modules is completely different from school mathematics modules and is crucial for students' further trajectory in the degree.

4.2.2 Collection methods

4.2.2.1 Interviews with lecturers

Firstly, two weeks before the beginning of the first semester 2015-2016, I interviewed the lecturers that would teach Module A and Module B (herein Lecturer A and Lecturer B). During the interviews I asked them to describe to me their detailed teaching plan, the reasons behind the choices for this specific teaching plan and the expectations that they had of their students. Through these interviews I wanted to explore the lecturers motives for these particular choices (e.g. selection of specific resources, use of particular assessment approaches, etc.) and to get a first idea of the messages that they intended to transmit to their students through their teaching, about mathematics and the learning of mathematics at this level.

4.2.2.2 Lecture observations

At the beginning of the semester I commenced the observations of the lectures. Module A was taught for three hours per week and Module B was taught for two hours per week. I observed 27 lectures of Module A and 17 lectures of Module B for a time period of 10 weeks (week 1 - week 10). During the observations a list of the most prominent transmitted messages was kept. My focus was on both implicitly (e.g. a message transmitted through a practice regularly used by the lecturer without explaining the benefits of using it, see for example message $M_{2.1}$ in Section 5.1.2.1) and explicitly (e.g. a suggestion made by the lecturer revealing specifically the benefits for students' mathematical knowledge, see for example message $M_{1.1}$ in Section 5.1.1.1) transmitted messages, and verbal and non-verbal messages (such as hand gestures, practices, etc.). In addition to the observations, I collected further information from the university's internal webpage where the lecturers were posting material for the students (such as general information about the course, further reading sections, details about the assessment practices, etc.). The lectures were audio recorded and then transcribed.

4.2.2.3 First Questionnaire

In week 2 during the attendance of Module B I distributed the first questionnaire (Appendix B.1) to 84 students. I explained the nature of my research project to the students and invited them to complete it. The questionnaire consisted of general questions about students' profile and background (e.g. gender, mathematics modules studied in the sixth form, factors that influenced their degree choice, etc.), about their expectations from the degree, and about the most important message that they had received concerning the study of mathematics at university level until that point. The ques-

tionnaire was used as a first source of information regarding the messages that students had received about university mathematics before starting the degree and the messages received during the very first two weeks of their studies. From this cohort of students, 56 consented to take part further in the research and to get interviewed.

Once the questionnaires were completed by the students they were scrutinized and based upon their answers 18 students were selected to be participants in the focus groups. The selection of participants was based on several factors:

- I tried to include the same number of female and male participants
- I took into consideration the variety of messages that students mentioned in the questionnaire and I included students that had received different messages
- I took into consideration the expectations students had before coming to university and I included students with diverse expectations
- I took into consideration reported changes in expectations arising in their first two weeks at university and I included both students whose expectations were reassured when they began their degree and those students whose expectations were not met.

4.2.2.4 Focus groups

Four focus groups were formed and took place between weeks 5 and 6. In the focus groups I discussed with the students the answers that they gave in the questionnaire and the messages that I had observed being transmitted from their lecturers. In this way I tried to gain a more collective view of the

interpretations that students made concerning the messages that they had received. Based on the focus groups' discussions, 10 students were selected for further individual interviews. My main interest during the selection process was to include students that had different interpretations of the same received messages, students that had received different messages from their lecturers, and students that had been influenced differently by the transmitted messages during their transition to university. This choice was made in order to give the broadest possible picture of the messages that are transmitted during the teaching-learning interactions and how these can influence students' transition.

4.2.2.5 Interviews

The individual interviews with the 10 students took place between weeks 9 and 11. The interview protocol was designed based on the messages that I have observed the lecturers transmitting through their teaching. The interviews were semi-structured and the protocol was informed from the participants' answers given in the previous phases (questionnaire and focus groups). For example, when a student referred to a message that had influenced them during the focus group, in the interview I asked them to elaborate more on this particular message.

The discussion with the students provided me with an in-depth understanding of their background, their relation with mathematics until that point, the main factors that influenced their degree choice, the expectations they had before coming to university, and the messages that they had received during the first semester of their studies. In these meetings we discussed in detail every message that they had received from their lecturers and they considered influential to their settling into university. Students commented

on the transmitted messages, on the ways that these messages influenced them and on the actions that the messages prompted them to take – or not – in order to adjust into the new context. Both focus groups and interviews were audio recorded and later transcribed.

4.2.2.6 2nd Questionnaire

At the end of the semester I sent the final questionnaire (Appendix B.2) via email to the 10 students. This questionnaire consisted of five items; students were asked to mention the most important messages that they had received during their attendance of the two modules, their final marks in these modules, and the most important message that they had received generally in university during the first semester of their studies. Through this questionnaire I wanted to find out how consistent the students were in their responses regarding the messages that they had received, whether there were any further changes from more influential messages than the ones that they had already mentioned, and their progress in the two modules. Six of the students returned the questionnaire completed.

4.3 Data Analysis

4.3.1 Messages categorisation

The data collection was completed at the end of the first semester. The messages collected from the observations of the lectures were identified and classified into categories simultaneously with the data collection. This categorisation contributed to the design of the interview protocol. The classification was informed by the pilot study that I implemented during the first year of my doctoral degree, where I employed aspects of grounded the-

ory (Strauss & Corbin, 2008) for the categorisation and the analysis of the messages. More specifically I used the methods of open and axial coding. The open coding was used for the identification and initial classification of the messages identified in the lecture observations and the interviews with the lecturers. In this process I paid close attention to the details of the transcripts from the audio-recordings. The axial coding was used for the re-examination of the identified messages and their final classification in categories and more specified subcategories. Some of the codes that were used were: study habits, notes, problem sheets, feeling stuck, mathematical conversations, mathematics support centre, tutorial, etc. The six categories that arose from the lecture observations refer to messages regarding:

- The things that students should do during lectures
- The things that students should do outside lectures
- The things that students should do when they feel stuck
- The assessment
- The general study habits (advice)
- The lecturer's intrinsic enthusiasm for mathematics

Each one of the six main categories was broke down in subcategories which referred more precisely to every transmitted message. I included messages that were mentioned from at least three students in any phase of the study (questionnaire, focus group, interview) in order to give a more representative picture of the range of the transmitted messages. I scrutinised the collected data and identified which students talked about each message.

In Appendix C I quote extracts of transcripts from one lecture observation and the interview with Lecturer A. In this way I want give an example to the reader and explain in detail how I identified the messages from interviews and observations of lecturers. Moreover, I show how I interpreted what the lecturers said as messages and therefore I demonstrate the rigour of the process that I followed.

In the following I am listing in tables, the main categories of the transmitted messages, the subcategories, which lecturer transmitted the message and the number of students that talked about it.

The first category of messages (The things that students should do during lectures, Table 4.1) was analysed in four subcategories; the gappy notes ($M_{1.1}$), the hand gestures ($M_{1.3}$), the discussion with the peers ($M_{1.4}$), which were all transmitted by Lecturer A and, the written notes ($M_{1.2}$) which was transmitted by Lecturer B.

Message	Transmitted by	Mentioned by
Gappy notes ($M_{1.1}$)	Lecturer A	8 students
Written notes ($M_{1.2}$)	Lecturer B	6 students
Hand gestures ($M_{1.3}$)	Lecturer A	3 students
Discussion with peers ($M_{1.4}$)	Lecturer A	9 students

Table 4.1: Things that students should do during lectures

The second category of messages (The things that students should do outside lectures, Table 4.2) was divided in two subcategories; the problem sheets ($M_{2.1}$) and, the textbooks ($M_{2.2}$) transmitted by both Lecturer A and Lecturer B.

Message	Transmitted by	Mentioned by
Problem sheets ($M_{2.1}$)	Lecturer A & Lecturer B	7 students
Textbooks ($M_{2.2}$)	Lecturer A & Lecturer B	4 students

Table 4.2: Things that students should do outside lectures

The third category of messages (Table 4.3) which refers to the things that students should do when they feel stuck was divided in two subcategories; asking the lecturer questions ($M_{3.1}$) and, consulting the tutor, the Mathematics Support Centre (MSC) or a friend ($M_{3.2}$). The former was transmitted by both lecturer A and Lecturer B and the latter transmitted by Lecturer A.

Message	Transmitted by	Mentioned by
Ask the lecturer ($M_{3.1}$)	Lecturer A & Lecturer B	4 students
Tutor/MSC/Friends ($M_{3.2}$)	Lecturer A	7 students

Table 4.3: Things that students should do when they feel stuck

The category referring to the assessment methods (Table 4.4) used by the two lecturers was broken down into the class test ($M_{4.1}$) employed by Lecturer A and, the coursework ($M_{4.2}$) employed by Lecturer B.

Message	Transmitted by	Mentioned by
Class test ($M_{4.1}$)	Lecturer A	7 students
Coursework ($M_{4.2}$)	Lecturer B	9 students

Table 4.4: Assessment

The messages which were concerned with the general study habits (Table 4.5) were classified in the following subcategories: time-management ($M_{5.1}$), definitions list ($M_{5.2}$), keep up/do not fall behind ($M_{5.3}$) and, it's ok if you don't understand everything ($M_{5.4}$). All the messages in this category were transmitted by Lecturer A.

Message	Transmitted by	Mentioned by
Time-management ($M_{5.1}$)	Lecturer A	7 students
Definitions list ($M_{5.2}$)	Lecturer A	3 students
Keep up/Do not fall behind ($M_{5.3}$)	Lecturer A	6 students
It's ok if you don't understand everything ($M_{5.4}$)	Lecturer A	6 students

Table 4.5: General study habits

The last category of messages (Lecturer's intrinsic enthusiasm for mathematics, Table 4.6) is the only one that was not analysed in further subcategories. This happened because the message transmitted by Lecturer B was rather precise and did not break down into more specialised information.

Message	Transmitted by	Mentioned by
Lecturer's intrinsic enthusiasm for mathematics (M_6)	Lecturer B	3 students

Table 4.6: Lecturer's intrinsic enthusiasm for mathematics

In the following figure (Figure 4.1) I represent the time frame of the study. I demonstrate the whole process of data collection; when exactly each method took place and for which purpose it was used. In summary, the lecture observations lasted 11 weeks. Before the beginning of the semester I conducted interviews with the lecturers. From the data collected from the lecture observations and the interviews with the lecturers I identified the transmitted messages and the motives behind their transmission. In week 2 I distributed the first questionnaire to the students. Based on students' responses in this questionnaire I formed the focus groups which met in week 5 and 6. Afterwards I selected 10 students as main participants of the study who I interviewed from week 9 until week 11. At the end of the semester the 10 students completed the final questionnaire. From the two questionnaires and the data that derived from the focus groups and the interviews I investigated how students interpreted the transmitted messages and what was the impact on their transition.

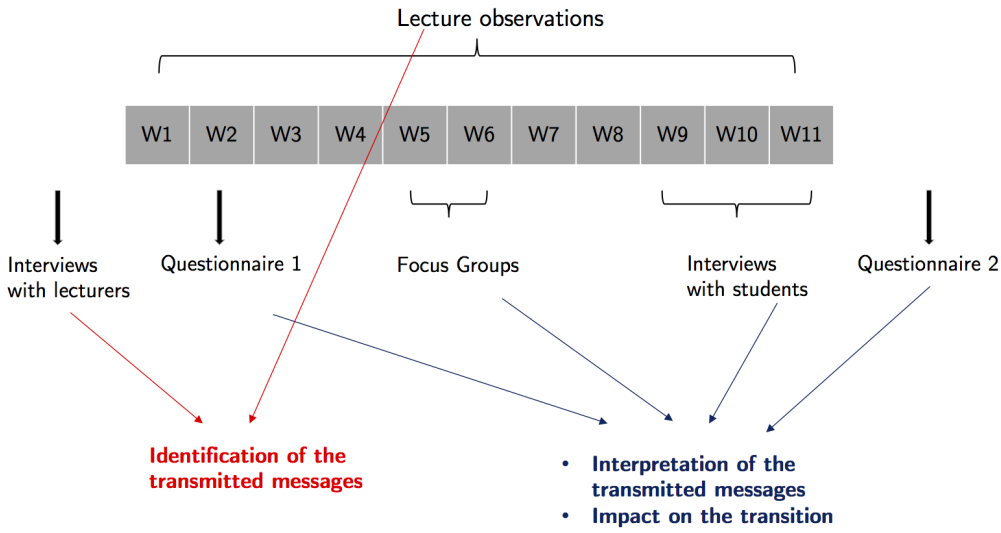

Figure 4.1: Data collection frame

4.3.2 Analytical methods

The data analysis was implemented in two phases. Firstly, I identified the messages transmitted by the lecturers during the lecture observations. These messages were classified as described above. Following the identification and categorisation, each transmitted message was analysed to determine the degree of power and control that it was carrying. In the interviews the students had the opportunity to comment on some of the received messages which were identified and considered important through the observations (either because the lecturer was particularly emphatic, or because they were influential on students' learning). I asked the students which were the messages they had comprehended through the teaching-learning interactions (not all the messages were comprehended by all students and, some of the messages might

have been considered important by me 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 my observation list; none of the participants though referred to non-observed messages.

Through students' interpretations I explored the link of the degree of power and control with the implications that the messages could possibly have on their transitional experiences. But, in order to examine the extent to which the messages influenced each individual student I needed to investigate the collected data further. Therefore, I carried out a second level of analysis, where I examined each student separately, in respect of the messages that they had received, their interpretations and the influences on their transition. Students talked about the most influential messages that they had received and how these messages affected them. For this reason I considered the concept of positional identity and the learning zone model. Finally, I constructed narratives in order to build each student's story separately and stress the impact of the messages upon this trajectory. I will explain below each step of the data analysis process.

4.3.2.1 Different levels of analysis

First phase: Analysis of the transmitted messages

Initially, I scrutinised the transcripts of the lecture observations, the list of the transmitted messages that I kept during the observations and each module's webpage in order to identify and classify (as described previously in detail) the transmitted messages. For each message I examined which lecturer transmitted it and in what ways (for instance, there were messages conveyed explicitly through words and, others conveyed implicitly through various practices that the lecturer used). Moreover, I examined thoroughly

the transcripts of the interviews with the lecturers in order to clarify their motives for using specific practices and giving particular information to the students. This contributed to the recognition and analysis of the messages.

With the use of Bernstein's (2000) concepts of classification and framing I examined the degree of power and control that each transmitted message carried. Taking into account different students' interpretations of the same transmitted message I attempted to see whether there was a link between the extent to which each message was classified and framed and the ways that students interpreted it. This way of analysing the data gave me a first idea about what happens in the teaching-learning interactions but not the whole picture of how students' transition can be affected by how and what the lecturers tell them during the lectures. Therefore, I took the analysis a step further and examined how each individual student was influenced by the transmitted messages during this phase. This led me to the second level of analysis which I describe below.

Second phase: Analysis of the impact of each transmitted message on students' transition

In order to understand the impact of the transmitted messages on students' transition, I considered each student that took part in the study as a unique case. I examined closely the questionnaires and the transcripts from the focus groups and the interviews for each student individually. Through this close examination I recognised the various messages that each student had received from the lecturers. I paid attention to the ways that every student interpreted the received messages, to the kind of actions/changes that the message prompted them to take in furtherance of their learning and, to the level of power and control that was conveyed through this message (for in-

stance, was a particular student more eager to focus on messages that carried high levels of power and control or the opposite?).

To explore these aspects I used Holland et al.'s (1998) concept of positional identities. With the use of this concept I explored whether the power and control transmitted through the messages was making the students feel either constrained or comfortable in the teaching-learning interactions at university. Moreover, in order to evaluate the whole transitional experience I employed an adaptation of Senninger's (2000) learning zone model. This model helped me to define how the students positioned themselves during the move between the two educational settings in respect of the received messages (e.g. some students might feel constrained receiving messages which carry a high degree of control and therefore position themselves in the discomfort zone).

4.3.2.2 Narrative analysis

Narratives were constructed from students' responses on the questionnaires, focus groups and interviews to explore how their identities mediated the interpretation of the received messages, and what was eventually their positioning in the new setting. For this purpose I used Bruner's (1996) theory on narratives. In Appendix D the reader can find a full transcript of the interview with one of the participants, Jason. In this section I explain how I constructed the narrative (the recognition and realisation rules that I used) and I present utterances from the student that suggest his mathematical identity.

According to Bruner (1996) individuals develop a version of themselves in the world through their own narratives, and it is through narratives that a culture supplies its members with models of identity and agency. Each

narrative consists of a sequence of events and through this sequence the meaning that the narrator wants to recount is carried. Narrative itself is a discourse and behind every discourse there is a reason for being uttered. Bruner (1996) cites nine features that narratives have in the forming of cultural "reality": time structure, generic particularity, reasons, hermeneutic composition, canonicity, ambiguity, troubles, negotiability and, historical extensibility. Three of these elements (time structure, reasons, and troubles) are of particular importance in this study and I will explain below why.

The narrative divides time into segments by unraveling critical events. In this study with the narration of their stories students unfold the moments that they received important messages from their lecturers (either implicitly or explicitly) regarding their settling into the new context. In this way it is possible to isolate the events and explore them separately in order to identify what lies beneath them that makes students consider them as important.

The things that individuals describe in their narratives are never accidental; they are triggered by their beliefs, their values, their desires, etc. Therefore, narratives explore reasons and not causes. In the narration of their stories, the participants of this study recount the reasons that particular instances in the teaching-learning interactions challenged their thinking about the learning of mathematics. This challenge contributed to the reshaping of their identities as mathematics learners which resulted in a specific positioning in the context of university.

Stories that people choose to narrate are usually created through troubles. Similarly, when students choose to talk about incidents that happened during their adjustment to university, often they refer to times that they struggled to get familiar with the new practices and the new ways of approaching mathematics. This brings to the fore such kinds of events and facilitates the

recognition of students' difficulties and the exploration of possible ways to alleviate them.

With the use of narratives I try to give an insight into students' trajectories from school to university and to the impact of the received messages on this process. This methodology, provides an understanding of how past experiences with mathematics can be influential during the current teaching-learning interactions in the university context and, whether there are any possible changes in the near future that may contribute to a smoother integration. With the analysis of students' narratives I focus on the kinds of messages that they receive from their lecturers, the interpretation they make out of them and the impact that these have on the transitional experience. In this way I can see clearly how their identities as mathematics learners are (re)shaped through the teaching-learning interactions and how this attributes them certain positions in the university context.

I constructed the narratives based on the model past-present-future that the methodology provides. Initially the first questionnaire was designed in order to gather information regarding students' background. Namely their previous relations with mathematics, their study habits at school, their principal motives for choosing to study for a degree in mathematics and the expectations that they envisaged from the degree. This information was strengthened from the focus groups and interview data where I asked the students to provide me with more details about their background stories. In this way, I gathered all the required material to build each student's background profile. It was also an opportunity to identify elements of students' identities as mathematics learners.

For the next phase - the present - I focused my attention mostly on the focus groups and interview data and less on the first questionnaire. In

this case I identified the messages that each individual student talked about during our discussions, and the interpretations they made out of them. By decomposing each message to determine the degree of its power and control I explored in what ways students' identities were impacted in this interaction and to what extent. Then I explored what changes they were willing to implement (or not) in their learning - the future - in order to integrate better into the new context, and according to these how they positioned themselves. Finally, the ways they pictured their future selves as mathematics learners were enriched from the data collected from the second questionnaire (this applies only to the six students who returned it). In this questionnaire the students had the chance to mention what they would change in their learning habits during the second semester of their studies as a result of a message transmitted by their lecturers.

4.4 Summary

In this chapter I presented how I collected the data for my study and the collection methods that I used, namely interviews, questionnaires and focus groups. Moreover, I described the reasons behind each choice and what kind of information each collection method provided me with.

After portraying the data collection methods I described how I analysed the data. At first, I described how I implemented the categorisation of the transmitted messages and I continued with the description of how these categories were broken down into more specified subcategories. Each message was linked to the lecturer that conveyed it and to the number of students that talked about it.

The analytical methods that I used were separated in two phases. Ini-

tially I illustrated how I analysed the transmitted messages with the use of Bernstein's concepts of classification and framing. Afterwards, I explained how I examined the impact of each transmitted message on individual students with the use of the concept of positional identity and the adaptation of the learning zone model. Finally, to bring all these together, I described how I used narrative analysis in order to construct the students' narratives.

In the next chapter, Results, I will present the detailed analysis of the collected data.

CHAPTER 5

Results

In this section I present the results of my research study. As mentioned in the previous sections the messages transmitted by the lecturers to the students were analysed with the use of Bernstein's concepts of classification and framing Bernstein (2000). Each message was decomposed to identify through the underlying structures of power and control in what ways it was influential on students' transition. This analysis is presented in Section 5.1. After carrying out this analysis I realised that there are other aspects that interfere with the ways that students respond to each message. The most significant aspect was the role of the identity that students bring with them when they come to university to study for a mathematics degree. For this reason I used the concept of positional identity as this was developed by Holland et al. (1998). The positional identity refers to the ways that a person identifies their position in relation to others, mediated through the ways that make them feel

comfortable or constrained. By doing so I explored to what extent each student's identity contributed to the interpretation of the transmitted messages and consequently to their transition. Additionally, I discovered how the aforementioned affected students' positioning in the university mathematics context. For this purpose I used an adaptation of Senninger's (2000) learning zone model. The role of the identity and the positioning of the students in the new setting are presented in Section 5.2. In this section I created narratives from the data that arose from the questionnaires, the focus groups and the interviews and I built up students' profiles as mathematics learners. I present students' trajectory from school to university mathematics by focusing on the messages that they consider as most important and on the interpretations they make out of them mediated through their identities.

5.1 Transmitted messages

In this section the messages, as these were transmitted by the lecturers during the lecture observations, are introduced. This part consists of six subsections which include the distinct categories of messages that were identified in the data. The rational for the selection of the messages that are presented here is given in the previous chapter (Methodology), in Section 4.1.3. The means through which the messages were transmitted are described. Each message is analysed to determine the degree of power and control that it carried. In addition, I illustrate the interpretations that students made out of them.

For the analysis of the messages I used the concepts of classification and framing (Bernstein, 2000). With the decomposition of each transmitted message to the level of power and control that it carried I intend to explore the power-control relations in the teaching-learning interactions and hence an-

swer the first research question - How do students interpret the different messages they receive within the university community? This is what I present in this first part of the results.

5.1.1 Things that students should do during lectures

This category is concerned with the messages which the lecturers transmitted during the lecture observations and which referred to the things that students should do when they attend the lectures. Three of the messages relate to practices that Lecturer A used (gappy notes, hand gestures, discussion among peers) and one of them to one of the practices that Lecturer B used (written notes).

5.1.1.1 Gappy notes $M_{1.1}$

The two lecturers used different teaching practices for their lectures. Lecturer A employed "gappy notes". These are printed notes which 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. During the interview the lecturer said that she 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.

In the first lecture the notes were collected by students as they entered. Lecturer A explained that students should treat them as something that they own and to add more notes themselves.

> Lecturer A: 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.

By employing this practice she addressed an explicit message to her students: 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 made clear what topics are to be covered and she set distinct boundaries regarding the things that students are expected to do. The framing in this case is mixed. On one hand the lecturer exerts strong control by employing this practice. The selection of the content included in the gappy notes, the ordering that it follows, the required pace for covering each part and the evaluative criteria of the activities included in the gappy notes are all defined by her. The students have to follow and engage with them to participate in the lectures. The gappy notes operate as the lecturer's controlling device; through them she made clear when she wanted 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 own learning. This is apparent for instance, when she invites them to treat the notes as their own and add whatever they think can be useful for their learning.

Eight out of the ten participants commented on Lecturer A's lectures and the use of gappy notes. Some said that by employing these notes the lectures became more active, the students had enough time to think and take in, they were more attentive, became more responsible for their own understanding and had a good resource for revising. In the following extracts it is apparent that the students recognised the benefits of using the gappy notes. Specifically Kenny, mentioned that this way of delivering the notes made 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 preferred this way of having the notes as opposed to the ways that other lecturers provided them (e.g. expecting students to copy from the whiteboard). Owen argued that by employing gappy notes Lecturer A gave the 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 in the message transmitted with the use of gappy notes is evident. Although the lecturer used a different teaching practice, compared to that experienced at school, the students seemed to feel more

comfortable during the lectures because, as they argued, they had time to think and this was very important for them considering that the material taught was new and therefore needed more time to be understood. Kenny indicated that the gappy notes made 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 influenced students in the ways they positioned themselves not only during lecture time but also afterwards.

5.1.1.2 Written notes $M_{1.2}$

Lecturer B did not provide printed notes to the students. He chose to write on the whiteboard during the lectures and students copied the notes. He considered this practice important because, as he claimed, it makes students more eager to attend the lectures.

> Lecturer B: I never distributed notes and then I had better attendance, students were attending lectures were making notes, 'cause I will be using the whiteboard, writing all the way [...] just the usual whiteboard lecture.

Nevertheless, the lecturer had to upload a version of handwritten notes, in addition to other material (exam past papers, solutions, etc.), on the module's webpage. This happened in order to comply with the university's policy regarding the resources provided to the students. Lecturer B explained in more detail why he prefers the students to have the notes in this way and he developed his thinking regarding other ways of providing the notes, such as the gappy notes.

> Lecturer B: I think students need to see how things emerge, how

> things appear and gappy notes is something... artificial. I think the lecture is more natural, because you can see how things appear, what is the logic, how it goes. Also maybe it keeps the pace a bit lower... Maybe it's just that I am not modern, that's how I was taught and I like it. [...] they [students] have a feeling, that if they have notes they don't need to attend the lecture. But in fact in the lecture I say twice more than what is written in the notes, sometimes even body language, the stress is important you know, you say more when you explain, you don't write everything. I will be talking a lot in the lecture but I will be writing not much. So I will be writing what is necessary for them to have lecture notes but I will be explaining more.

In the first lecture the lecturer talked to the students about all the necessary information they needed to know for this module. He stressed that he would be using the whiteboard and that they were allowed to interrupt and correct him if he made mistakes.

> Lecturer B: I will be using the white board. Sometimes I may be saying plus and writing minus, sometimes it happens and it is beyond my control. Please then shout, stop me, tell me that it should be plus not minus.

The message that the lecturer wanted to transmit by employing this practice is that students need to be attentive during the lectures and see how the knowledge emerges in order to acquire it. It is a powerful message; by writing on the whiteboard and not providing any printed notes the lecturer made explicit to the students that he expected them to copy the notes in order to

learn and participate in the lecture. There is also high degree of control carried through this message. The selected topics that are covered during the lectures have been chosen by the lecturer; the order that will be followed to cover these topics and the required pace of delivering them are also defined by the lecturer. Therefore all the control in this case is with the lecturer. Students' thinking regarding the way they can have access to the knowledge is directed entirely by their lecturer. They are expected to copy exactly what he writes on the board; the lecturer gives them little opportunity as to write down further ideas or what they think as useful for their learning. We can see here that Lecturer B is exerting even more control than Lecturer A who invites the students to add "extra" notes of what they consider helpful in the gappy notes.

Six of the students talked about the practice of copying the notes from the whiteboard. Jeremy said that this practice kept him more attentive during lecture time compared to the modules in which it is not used.

> Jeremy: It just keeps us sort of more attentive... in some of the modules that we don't write that much I am sort of falling half asleep trying to keep up, whereas in the other ones I sort of have to stay awake and pay attention.

Other students found challenging the fact that they had to copy the notes and at the same time focus on understanding the material taught. One of them, Emily, admitted that even though she was not in favour of this practice it can be useful eventually because the lecturer gave a lot of examples.

> Emily: ...despite the fact I have to try and understand and write at the same time he does a lot of examples... which I find to be

> quite useful because... the things you learn from the examples are really applicable to the coursework...

Likewise, Owen explained why he did not like this practice. He considered the pace rather fast for learning and understanding (despite the fact that his lecturer has already said he thinks this technique is slower), especially for this kind of material which differed in many ways from school mathematics. However, he admitted that this practice encouraged him to spend more time after the lectures to comprehend the concepts.

> Owen: ...it's a little bit different to what we have been doing previously in A level... he uses the writing down technique and going through it really quickly but I don't think it works as well as it does in [other modules] [...] I'd say it made me focus more on my time outside the lectures... I am definitely putting more time to thinking outside the lectures so I understand what is happening.

The strongly classified and framed message transmitted though the writing of the notes influenced students in various ways. They all employed the practice despite the fact that it was not their favourite one (compared to the practices that were used in other modules, and the practices that they were used to at school). The students paid close attention during lecture time, which was one of Lecturer B's main motivations for employing this technique. Furthermore, even the students that struggled to catch-up with the writing of the notes in real time stated that they got benefits from it. Like Emily who focused on the examples to understand better the material taught, or Owen who was motivated to put in more effort outside lectures to comprehend the content of the module. Therefore, we can see here that there

is a need for exploring the students' identities to explain why the message affects them in different ways. At the end the message had a positive effect in most of them even if initially they did not see it in that way.

5.1.1.3 Hand gestures $M_{1.3}$

One of the things that Lecturer A strongly encouraged her students to do during the lectures was to communicate mathematics with the use of hand gestures. The lecturer used this practice a lot herself on many occasions. For instance, when she introduced the concept of a convergent sequence she gestured in the air to show the behaviour of a particular convergent sequence. Moreover, she talked explicitly to the students about the benefits of using gestures in the learning of mathematics.

> Lecturer A: I have been doing some reading lately about how much gesture helps people learn things, apparently it works, apparently getting people to just trace things on worked examples make them learn and remember things better. So when I ask you to do sensible gesturing for things that's not 'cause I am crazy, it will help you remember things perhaps...

She encouraged them to do the same whenever there was time for discussion among students about different mathematical concepts.

> Lecturer A: ...tell the person next to you what that sequence looks like, you may gesture in the air if you wish.

She would frequently praise the students every time she noticed that they were gesturing with their hands.

> Lecturer A: I am seeing gestures in the air that is good...

The message that Lecturer A wanted to address by implementing this practice was that the learning of mathematics is facilitated with the use of gesturing and the same holds for the understanding of the concepts. She made clear her expectations to the students regarding this practice, and we notice the high level of control carried through it. On the occasions that she used it herself she selected the concepts that she considered important to use it for and this directed students' thinking regarding when to use it themselves. When she invited the students to employ the same practice the sequencing (the ordering of the concepts in which the hand gestures would be used) and the pacing (how much time should student devote to exploring mathematical concepts with gesturing) was defined by her. Consequently, the message transmitted through the use of hand gestures carried also high degree of control.

Three of the students received the message and talked about it in our discussions. They recognised the motives behind the lecturer's choice of using such a practice. The use of hand gestures is considered a helpful tool that facilitates the learning in different ways, as Carin observed.

> Carin: [Lecturer A] likes hand gestures [because it] makes us remember more, so... she is always making a constant effort to try to use more hand gestures.

Similarly Jason mentioned how important he thought this practice was and he linked it with analogous practices used by his school teachers.

> Jason: Lecturer A puts a lot of emphasis on visualisation and physically using your body to represent things. Visualising in some form is a very useful tool. My best teachers at school always tried to make me visualise what was being said.

The extensive use of hand gestures and the message that the lecturer wanted to address through this practice was perceived by a number of students. Some of them were already familiar with this technique of representing mathematics, like Jason, but for some others was completely new. Irrespective of the familiarity of these three students with this practice, the high level of power and control that it carried facilitated their learning. As Carin stated the hand gestures contributed to enforcing the learning of the concepts. In addition, Jason's previous experiences from school helped him to recognise and value more easily the importance of visualisation.

5.1.1.4 Discussion with peers $M_{1.4}$

One of the practices that Lecturer A used extensively during her lectures concerned the discussion among students on various mathematical concepts. The lecturer talked during the interview about the importance of this practice and she expressed her motives behind choosing to implement it.

> Lecturer A: ...being able to talk about the ideas, and being able to explain why you think what you think, even if... you are wrong, I think that's important...

In every lecture, she invited the students to engage in discussions mostly by giving them different mathematical tasks, included in the set of notes that she provided, or by asking them to work on things that would come up spontaneously, such as finding a counter example for a statement discussed at that time. In the first lecture, she invited the students eight times to engage in a conversation, asking them "tell the person next to you..." whether a specific statement is true or what the explanation for a particular argument could be. She explained to them in more detail why she considered it important to do so.

> Lecturer A: At university the aim is not just for you to "do" mathematics, but to learn to communicate clearly...

The message she intended to transmit through this practice was explicit, carried a lot of power and set clear boundaries about the importance of being able to communicate mathematics. The power carried through the message made the students recognise that at university they need to develop the skill and habit of communicating mathematics clearly. It also had a high level of control. The selection of the topics for discussion was controlled by her; students were able to learn how to communicate clearly mathematics by engaging in discussions with specific tasks. The ordering of the tasks that were to be discussed and the time spent for conversations on each one was also defined by the lecturer.

In the interviews almost all of the students talked about the sorts of discussions that took place during Lecturer A's lectures. The majority of the students considered the encouragement to engage in mathematical conversations very helpful. They approached it as a good way of getting different perspectives from other students which eventually facilitated their understanding and at the same time enhanced their learning. Like Lesley argues in the following.

> Lesley: I do find that really helpful... When you explain something to someone else it helps you as well and it is nice to hear somebody else's point of view... Just to hear another explanation, it can just sort of make you remember more or in an easy way.

On the other hand, two of the students disliked this practice and they admitted that they never engaged in conversations with other students during the

lectures. These particular students found no purpose in discussing because they felt they could deal efficiently with the various tasks themselves. For example, Jeremy talked extensively about it.

> Jeremy: I don't really like to speak to people, when she says speak to people I just sort of sit alone, I just read through it... and when she gets there I can't be bothered to go through it 'cause I've just gone through it...

The strongly classified and framed message regarding the discussion during lecture time was easily understood by the students but it did not influence all of them in the same way. A number of students found it helpful and important to have mathematical conversations in the lectures whilst a few others considered it inessential. The first ones employed the practice of talking and discussing mathematics and they reported influences on their learning, like Lesley who said that through the discussion it is easier to understand the mathematical concepts. The other students who thought of it as an insignificant thing to do during lectures carried on working on the different tasks on their own with no obvious effect from the message on their learning. Once again, the variety in the responses stresses the importance of taking into account students' identities. For that reason I will report later in the chapter an analysis using identity as a concept that will explain the differences in students' responses that arise here.

5.1.2 Things that students should do outside lectures

In this category I illustrate the messages that students perceived regarding the things that they should be doing outside lecture time. Both lecturers expected them to work on exercises based on the content that was covered

during the lectures. The way that the exercises were distributed differed. Additionally, the lecturers recommended various textbooks for further reading for the two modules but with no high expectations that the students would engage with such reading matter.

5.1.2.1 Problem sheets $M_{2.1}$

Lecturer A included the problems at the end of the weekly gappy notes. She did not ask explicitly the students to work with the exercises but by including them in the notes she showed them implicitly that while doing the reading for the module outside lectures they need also to cope with the problems. In the interview she talked about the selection of resources she provided the students with and referred briefly to the problems.

> Lecturer A: Problems, you need to be doing problems that's about [it] really.

In one of the first lectures Lecturer A made clear to her students that they are expected to spend study time on solving problems.

> Lecturer A: As I told you on the notes earlier on and as it says there, you will be expected to spend about an hour between Monday and Wednesday learning new material by reading or by working on short problems.

The message that the lecturer wanted to transmit is that spending individual time working on problems is important for understanding the material taught. The power of the message was strong as the lecturer made clear her expectations by giving them these particular problems. The framing though varied. The control over the selection of the problems was strong - the lecturer was the one to decide which problems would be included in the notes

- but the same did not happen with the sequencing and the pacing. The students were the only ones responsible for the order in which they would choose to solve the problems and also for the time that they would spend on each one. Consequently, the control over sequencing and pacing was weak and rested with the students.

Lecturer B chose a different way to provide his students with the problems. He uploaded some exercises to the module's webpage at the end of a set of typed notes for each topic covered in the module. He went through these selectively during the weekly tutorial sessions that students attended in addition to the lectures, and he expected that the students would 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 observation of 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 to understand the concepts was the message that the two lecturers transmitted. Although the way that the message was transmitted differed, the means were the same for both of them; the problem sheets. The power exerted through this message was strong and the boundaries were clear; by getting a specific number of exercises to practice students would acquire a better understanding. But the framing was rather weak. Apart from the selection of the problems included in the problem sheets which was defined by Lecturer B, the students had complete control over this practice. They could work at their own pace, they could organize the work in whatever way they preferred, they could select which exercises they would solve and which not, and there was no evaluation purpose defined by the lecturer behind this practice.

The students commented on things that their lecturers asked them to do outside lectures. Seven of them referred to the exercises or problem sheets. Three students said that they were not told explicitly to work on the problems but by being given to them they realized they had to. Two students mentioned just that they work with the problem sheets. And finally, two others talked about the differences that they identified between school and university and the ways they had to work when they were not in the class; at school most of the work was done in the classroom, students were told to work on the problems and then submit them for marking, the teachers checked the problems, there was no assessed coursework and they did not struggle for time. Jeremy expressed his thinking about it.

> Jeremy: 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 were 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 prioritise what counts for the degree, like the coursework.

The weak framing in the messages from both lecturers regarding the work on the problems in combination with the differences that arise between the two educational levels seem to influence students. The lecturers adopted weak framing in the transmission of this particular message. Lecturer A included the problems in the notes without referring extensively to them or telling explicitly that they need to be done. In this way she left the decision entirely to the students. Similarly, when Lecturer B 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 this message, it is more probable that students would ignore it and they would procrastinate until something that counts towards their degree, like an examination or assignment coursework, would arise. We note here how the weakly framed message did not prompt the students to take action and practice the exercises.

5.1.2.2 Textbooks $M_{2.2}$

Both lecturers suggested a list of textbooks to the students for additional reading in case they wanted to enrich their learning resources beyond their lecture notes. None of the lecturers talked about this recommended list during the lectures or generally regarding the use of textbooks. The suggested list of textbooks for both modules was included in the general information about the modules in the webpage.

Lecturer A included the following note in addition to her recommended reading list on the webpage:

> You do not need to buy a book for this module; everything you need will be in the notes. However, you might like to examine some books, because sometimes a different person's explanation makes different connections with your existing knowledge and therefore helps you to understand more fully.

A similar note was added on the webpage by Lecturer B:

> Some students do like to have an alternative source to consult however. The following books are suitable recommended reading. Always bear in mind though that reading a mathematics book is not like reading a novel. It involves active participation. If you do follow a textbook be prepared to invest a lot of time in it. Always remember that mathematics is not a spectator sport, so, even when reading, take copious notes and do it for yourself!

Lecturer A talked during the interview about the use of textbooks outside the lecture time. She said that she did not believe that students would really use them.

> Lecturer A: I do not really expect many people to do this, I mean that's sort of yeah if you want to read more.

The message that the lecturers transmitted was that through additional reading from various textbooks students can enhance their learning and delve more deeply into mathematical concepts. The message was powerful; both lecturers made clear their expectations regarding the use of these books. The way they chose to transmit the message was rather implicit. Unless students visited the modules' webpages they would not be aware about the reading list. The framing in this case was weak. Although the control over the selection of the books was with the lecturers (specific number of books selected for each module) the ordering (which book they would read first, which second, etc.) and the pacing (how much time would be spent on the reading of each book) that students would employ when reading them was entirely defined by themselves. The students had almost the entire control over this practice.

However, it was interesting to observe that despite the weak framing several students used the textbooks during their study time. An important factor in this behaviour was that students used to read from textbooks when they were at school. Four of the students talked about the use of textbooks. Lesley described that the textbooks at school included examples which students could use when they felt they did not understand something. On the other hand, the lecturers suggested textbooks for extra reading but not in a compulsory way.

> Lesley: At school they did a lot more examples, and you can go to them... if you are struggling, and there was a lot more examples because you had textbooks and things, you had a lot of content

> whereas here you only get what they give you... I think they've recommended sort of some [books] if we wanted them but they've not said "You must go".

On the contrary, Elsa said that she used various textbooks from the library when she worked outside lectures, particularly for Lecturer A's lectures. She referred to the list with the recommended textbooks by the lecturers to which she added books that she found herself.

> Elsa: I think it was my own initiative... maybe it's a combination actually 'cause we did have suggested reading at the start... I don't think I took many books from the suggested reading list but it might have given me ideas to go and look for books.

The two lecturers transmitted the message of improving learning through the use of textbooks in a very similar way. The high degree of power which was carried through this message was influential only to the extent that the students understood what were the benefits of having such a list for their learning. The weak framing played a more important role, and more specifically the low level of control over the sequencing and pacing. The freedom that both lecturers gave to the students to decide how and if they would use the extra reading functioned in two ways. Students would either ignore it, as Lesley did, because it was not "a must do" imposed from the lecturers. Or, as in the case of Elsa, looking for books that could be helpful in her study could motivate and enhance her learning.

5.1.3 Things that students should do when they feel stuck

The two lecturers had different approaches regarding the ways they encouraged the students to seek help when they felt stuck. Lecturer A welcomed questions during the lecture time, or small clarifications right after the end of the lectures but stressed also the importance of using the support provided by the university, like the personal tutor, or the mathematics support centre. On the other hand Lecturer B presented mostly himself as a source of help. In the following subsections we will see in more detail how the two lecturers transmitted this information to the students.

5.1.3.1 Ask the lecturer $M_{3.1}$

During the interview Lecturer A described how she supports and encourages her students; when they do not understand something, she would encourage them to ask her questions in the lecture time or right after. She also expressed her enthusiasm about having people who are eager to ask, something that did not happen often throughout the previous years when she was teaching this module.

> Lecturer A: ...people are putting their hands up in lectures and asking questions. I have never had that happen before, I think it was just the second lecture when one kid did it and I just answered and then three or four more people just in rapid succession and I just answered and then I was like: This is great! So not everybody is confident to do that by any means but I am getting people who are putting their hands up to ask a question immediately... So sometimes they are actually getting some help during the class,

> lots of people come and ask me small questions after the lecture which I welcome...

Lecturer A was also observed to encourage questions from students during the lectures. The following extract is from a lecture where the lecturer has just answered a question and welcomed more of them after lecture time for the students that did not feel confident to ask during lectures.

> Lecturer A: If you have questions like this and you are shy and you don't want to put your hand up in the lectures, you can always come and ask me at the end.

Along similar lines Lecturer B was willing to offer help to his students whenever they felt they did not understand. He stated that clearly during the interview when he described in what ways he advises students to act when they do not understand something.

> Lecturer B: I always tell them that I am very happy to help; if they have a question they can ask me after the lecture, or during the lecture, or in the tutorial or come to me here in person and speak to me. I always encourage them. But again not many of them do this, take advantage of this.

During the lecture observations he made himself quite clear from the beginning of the course that he was happy to answer questions when students did not comprehend something. He stated this explicitly in the first lecture as we can see in the following extract.

> Lecturer B: And also please ask, you are very welcome to ask, stop me in the lecture and ask questions. Sometimes if you miss

> something in my lecture it's enough, in almost 99% of the cases, it's enough to repeat what I said, just to repeat and you will understand me again. So if you miss something, please stop me and ask your question, because your question will be also the question of many other students. Right? So, feel free to ask me.

Both lecturers transmitted a clear message to their students; they were supportive and willing to answer questions and clarify misunderstandings that the students might have. The power of this message was strong. The lecturers made explicit from the beginning of the course that they expected the students to raise questions whenever they did not understand. The framing on the other hand was rather weak. The lecturers had control over the selection of options that they would offer to the students regarding where to seek help when they feel stuck. In this particular message they both suggest themselves as a source of help. But the students had control over the sequencing and pacing; what kind of questions they would ask, when and how.

In the interviews four students talked about this suggestion. All of them recognised that their lecturers were willing to assist them when they felt stuck. Nevertheless, most of them mentioned how different was the experience of approaching a lecturer at university compared to a teacher at school. Elsa explained that the lecturers, by encouraging them to ask questions, showed them that they were approachable and eager to help them despite the limitations that existed in building a personal relationship with each individual student. In her case, even though she was intimidated, she had asked questions.

> Elsa: I think it just shows that all the lecturers are very friendly and that they want to help us and they will understand that they

> can't.. they will never get to know 200 people and be able to help them individually so they kind of stress that it's important for us to go and ask questions to them which is kind of their way of helping us, which is really nice... If I am really struggling at something I'll go and ask. Sometimes I am a bit nervous to go and ask 'cause it's just... if I feel like my question is stupid...

Some others preferred to communicate their questions to the lecturers by writing emails, as Owen describes in the following extract.

> Owen: ...so after the first [email], when I emailed and they responded quickly, when I had another problem I emailed that person they responded quickly so you do get quick responses... they obviously do give you their email I find that is a helpful way to contact them...

The high degree of power transmitted through this message made the expectations of the lecturers clear to the students. This was obvious during the discussions as the students who talked about it stated explicitly what their lecturers expected from them. The weakly framed message gave a lot of control to the students to raise questions. Despite the space that was provided by the lecturers, the majority of the students did not attempt to ask questions. The barrier of feeling exposed in front of many people made even those students that were willing to ask feel anxious, like Elsa. She and others chose a "safer" option and wrote their questions in emails.

It is important to consider here how different aspects, like the identity or the choice of a particular practice, play a significant role when we want to understand how messages affect students. For instance, the identity (e.g. shyness) has to do with the different ways students responded to this message.

But also the practices (lecturing to big numbers of students) influence how they react to the message. If there were smaller groups, maybe students would react differently even if they were shy. These matters will be explored in more detail in the following section of the analysis.

5.1.3.2 Tutor/MSC/Friend $M_{3.2}$

An additional option for having their questions answered when they felt stuck was suggested to the students by Lecturer A. She explained that apart from asking her questions they could take advantage of the university's support structures to answer their queries outside lecture time, like the mathematics support centre and their personal tutor or they could turn to someone more familiar, like a friend. The lecturer described her thinking behind this suggestion during the interview.

> Lecturer A: ...there is plenty of support in this university right? I mean first years have got their tutors that they see once a week, that is supposed to help them with [the module], so that's the first place they should go and get into the habit of going. The mathematics support centre has four hours of help a day so most people should be going there first; that's the point of having the mathematics support centre.

During the lectures she talked explicitly about the different options that were available to students when they felt the need to turn to someone for help and ask about things they did not understand. She presented a variety of different options, some of them provided by the university. What is important to notice here is that she presented herself as the last option.

> Lecturer A: You can talk to your tutor, you can talk to mathematics support centre staff, talk to each other. If you are not sure, after you have done all that come and ask me.

The message she wanted to transmit here was slightly different from the previous one (where she was suggesting only herself as a source of help for students' queries). With this message she wanted to show to the students that there is a lot of help provided for them by the university and that it is their responsibility to take action and access it. This is a strongly classified message which carries a lot of power. Lecturer A is rather specific about the expectations that she has from her students regarding where they should seek help and she erects clear boundaries. The framing in this case is mostly weak; the selection of the different kinds of help is defined by the lecturer, therefore is strong. But the control over the sequencing and pacing rests with the students; students are responsible for the organization and pacing of the ways they will choose to ask questions and get them answered.

Many of the students referred to the support provided by the university. Seven of them talked about the mathematics support centre and the tutors. Others among them referred to the suggestion of Lecturer A to turn to friends for help. When Emily talked about the ways students were expected to work outside lecture time she pointed out that on particular occasions it was important to try first themselves and then seek help.

> Emily: ...[for] the problem sheets... is good to have a go by yourself and then after that go to your friends and then go to your mathematics support centre or this kind of thing.

Similarly Carin stated that by taking action in furtherance of her learning through these suggestions she became more independent.

> Carin: So I think it has made me more independent and made me not necessarily work out for myself but made me find out ways to work out for myself, whether that be I have to go to the library and get a book and try to work out, whether that be I have to ask someone else or going to the mathematics support centre. So I think it definitely made me more independent in my studying in general I suppose not just maths.

On other occasions, students received the message regarding the different sources of help suggested by their lecturer but they preferred to follow the ones that were more convenient for them. Like in Kenny's case who said that he emails his tutor when he has questions but he never tried to visit the mathematics support centre.

> Kenny: I had this tutorial session where there was just me and another guy and the tutor and then we talked properly so that made it better. Before when I was in like a group of eight sitting there... I just didn't feel comfortable to like talking in front of everyone else I guess... Now it's fine, now I know properly, it's much more comfortable asking questions... rather than just sweeping them under the rug and leaving it. [...] I still don't go to the mathematics support centre or anything... I don't feel there is a clear place that tells me where I should go, I don't think anyone really told me about these times, it's not been given to me clearly anyway. I don't know I never looked for it. Neither has it been emailed to me.

The strongly classified message was perceived by the majority of the students, and even those that did not consider every sort of help suggested by

Lecturer A, still recognised and referred to the various options. Despite the weak framing that this message carried some of the students exploited the space provided by the lecturer; they took action and looked for answers to their questions. We noticed Carin admitting that by seeking help in different places she became more independent in her learning. On other occasions, accessibility played an important role in the choice of support. Like Kenny, who preferred to ask his tutor directly instead of visiting the support centre because the opening times were not made explicit to him.

5.1.4 Assessment

The two modules were assessed in different ways. 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% to the overall module mark. In addition to the obvious evaluation purpose, the methods of assessment implemented by the two lecturers transmitted messages that we will now explore.

5.1.4.1 Class test $M_{4.1}$

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 get prepared. 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 of the semester.

Lecturer A: ...the tests are important because Analysis wipes the

> floor with people who don't keep up... I like to have a large number of small tests rather than one big test, 'cause if people leave it till week 7 and then they realise that they have not caught up, it's really hard... it helps them know what they do not know, it helps them get some feedback on their thinking...

During the lectures she emphasized these points and made students understand why having this particular kind of assessment is important.

> Lecturer A: So, 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 when they are put up [on the webpage] 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 about this practice. 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 also strong and with the lecturer. The evaluation purpose of the tests was apparent and defined by the lecturer. The same held for the selection (which would be the questions included in the test) and the ordering (what order these questions would follow) of the content of the tests, and for the pacing (how much time had students available for the test) required to be followed by the students. Moreover, the control of the message was reinforced by Lecturer A's words, where she

informed the students how they had to work for the tests in order to succeed; students had to review, keep up, think about things, consider the feedback and learn from this.

Seven out of ten participants referred to the message that Lecturer A intended to transmit with the use of the tests. Carin argued that it is important having the tests during the semester. Given the fact that at university there is no-one to advise you to study regularly it is easier to fall behind. Therefore, the test is considered a good opportunity to keep 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 recognised 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 [in] the rest [of the modules] 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.

The strongly classified and framed message that was transmitted by Lecturer A through the use of regular class tests influenced the majority of the

students in various ways, irrespective of their identities. The effectiveness of the message can be explained from the exchange value that the tests offer. From the above extracts it is obvious that the use of this practice created room for challenge in students' thinking, opportunities for keeping up with the material covered and chances for feedback. All of these were in accordance with Lecturer A's intentions and her decision to use the class tests for Module A.

5.1.4.2 Coursework $M_{4.2}$

On the other hand, Lecturer B chose to give his students two courseworks. He said that by doing so, students had to invest individual time on the given exercises. This is apparent in the following extract from the interview with the lecturer.

> Lecturer B: ...they also have two courseworks, they definitely have to spend time on their own.

At the beginning of the semester Lecturer B referred to the courseworks, he described the concept and gave some information to the students. Later in the semester he referred to them again when they were distributed. The excerpt below is from the first lecture.

> Lecturer B: Assessment of the module; there will be an exam at the end in January, which will be worth 50% of the total mark. And then 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, no more than three. It can be done individually if you prefer but it's

advisable to work in groups. Each coursework will be worth 25% of the total module.

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' thinking 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 was defined by the lecturer, therefore the framing was strong and he was the one holding the control over these two components. But the ordering, the way that students would work on the coursework and how they would organize their study, and the pacing, how their time would be shared among the different tasks, were not defined by the lecturer. Therefore, in this case the framing was weak and the students had complete control over the ways they would work for the coursework.

Despite the mixed framing by Lecturer B the students received the message, and talked about it in the focus groups and interviews. Some recognised 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 at school.

Alex commented on how having assessment during the semester, in addition to the final examination, was beneficial for examination preparation in

respect of both modules.

> Alex: I think it 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 it was when they were asked to work in groups. By working with peers during the coursework he had the chance to adopt the same way of working for 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. Although she knows that the coursework counts in the overall evaluation of the module she complains. The change in the practice of assessment at university is beyond her expectations and it bothers her.

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

Regardless of the differences in control that the two lecturers exerted through the messages regarding assessment, it seems that students still got influenced in their learning. The message regarding assessment delivered its aims to almost everybody despite their identities. The evaluation purpose

and the high degree of control that this had in the two different practices is what made it effective and influential. 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 in furtherance of their learning is not a strongly framed message that the lecturers transmit but the exchange value of the assessment. For them it was taken for granted that they would put in effort and work on whatever counts towards their degree. The strong assessment-driven background made them pay more attention to the learning opportunities that would be exchanged for a mark at university.

5.1.5 General study habits

All the messages described in this category were transmitted by Lecturer A. During the lectures, she gave plenty of advice to her students regarding how they should approach their studies. By taking into consideration that students until that point were told by someone else what they need to do, through this advice Lecturer A attempted to show them in what ways they could be effective in the university context. She talked to them about how they should manage their time, and about 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.

The messages described in this category were transmitted by the lecturer either verbally or with the provision of various resources, like reading sections included in the gappy notes. The reading sections referred to information regarding how first year undergraduate students can improve their study time by employing certain practices, like organising a time-schedule for the week, or making lists of questions for the content they do not understand

in each module, etc. Every participant in the study referred at least once, during the focus groups or the interviews, to the advice that Lecturer A had communicated. I classified six subcategories which referred to six different types of advice for students' learning habits.

5.1.5.1 Time-management $M_{5.1}$

The lecturer stressed to the students the importance of managing their time effectively in order to be efficient in their studies. She talked about it during the lecture time and she also included a reading section in one of the weekly sets of gappy notes. This reading part consisted of information about how students can manage the different activities they undertake while studying. This referred to both university activities such as, get the coursework ready on time, revise the notes, etc. and aspects of their social lives, e.g. time devoted to friends, time for sports, etc. In this way the lecturer tried to show an example of how daily life and responsibilities can be structured.

The lecturer raised a discussion about the fact that students need to be responsible for their time-management at university as opposed to how that responsibility at school lay largely with their teachers.

> Lecturer A: ...[school] teachers tend to keep track right? So, I mean I can't say: "Hi Sam, how did you get on with your work yesterday?" I can't do that, there is 200 of you right? So you need to take responsibility for that, no one is coming to you to check, you need to take responsibility for it. I am not going to be checking on you... You do it, you do it, you don't, you don't. But you don't get to complain later if you haven't done the work. That's sort of the rule of life really. You put your effort in and you get what you get.

The message that the lecturer wanted to transmit to the students is that they have to become accountable for their learning but also for their lives in general. The power carried through the message was strong; the lecturer made clear what she expected her students to be doing regarding the management of their time. The framing in this message was mixed. The control over the selection of communication is strong; Lecturer A chose to talk about it during the lectures and also to give additional reading to the students for deepening their skills of time-management. But the required ordering (what students will choose to prioritise) and the expected pacing (how much time will students dedicate for each activity) would be entirely defined by the students. Therefore, the control over the sequencing and pacing of the time-management is weak and rests with the students.

Seven students talked about this advice during the focus groups and the interviews. The majority of them perceived the message and they were motivated by it to take some action and organise their study time more effectively. Like Kenny who stated that it was the first time he was getting informed thoroughly regarding what it means to manage your time and this helped him to be more consistent with his study.

> Kenny: ... [it] is do more work regularly and often, I guess that's what that reading kind of told me, because before everyone just says manage your time better. And what am I supposed to do then? I have never heard of time-management... Well I changed... now instead of just on the deadline, doing whole day's work I'll do like two hours work on each bit of coursework every week so then when I get to the deadline I don't have so much to do. And then it was the problem sheets that they give you every week, I spend half hour on each one now so I am not as far behind. And

> the coursework is easier, everything is easier.

Another student, Alex, tried to do the same after receiving the message from Lecturer A, but he admitted that he was not that successful. There have been weeks when he was productive and other ones when he was not. He changed his way of working and tried to manage his time by making a list of the modules that he had to study. Despite the effort, he did not succeed to study efficiently for every module of his list.

> Alex: When I think: "Ok, I will do some work now" I have like a list of the six modules in which order I should do them and the bottom two never really get worked on 'cause I am too busy focusing on Module A. So I end up sort of ignoring, just spending time in lectures trying to make sure I've caught up. Well not caught up but just not fall behind.

In addition to the students that understood the message and tried to improve their study by managing their time more effectively there was also one student who, although he had received the message, admitted that he did not take any kind of action from it.

> Eric: We have been given a time-management reading by Lecturer A, I haven't read it... I haven't been given any advice on time-management from anything else apart from that.

The strongly classified message transmitted by Lecturer A was easily recognisable by the students. The majority of the students who talked about the advice regarding the time-management were encouraged to make changes in their learning to facilitate it, even if it did not always work, like in Alex's case that was described above. The mixed framing transmitted through this

message resulted in a number of students ignoring it and preferring to stick to their old habits while working outside lectures. Nevertheless, the weak control over the sequencing and the pacing gave space to the students who took action from it to organise their study time the way they considered better and eventually act independently and become responsible for the things that needed to be done. That was in accordance with the message that the lecturer transmitted by raising the issue of time-management.

5.1.5.2 Definitions list $M_{5.2}$

Another piece of advice that Lecturer A gave to her students regarding how to organise their study was about the creation of definitions lists. The lecturer emphasised the significant role that definitions play in university mathematics. She suggested the practice of making lists of definitions as a convenient way to facilitate the structure of their study. She explained this to her students during one of the lectures.

> Lecturer A: Definitions are absolutely central to this class, if I were you I would start making a definitions list on a separate piece of paper today, so that you have everything in your hands and you can refer to it regularly.

A few lectures later she returned to the point that she had raised regarding the use of this practice.

> Lecturer A: Please take my advice... If you've got the definitions list on hand you will not have to search back through your notes to find things to work with, right? That will just make you more efficient, it will make you go through things, it will enable you to test yourself regularly.

With this advice the lecturer wanted her students to develop some good habits while studying outside the lectures. The message is about the importance of definitions in this module and about how an effective organisation of them will help the students develop a good structure for their study. The power that Lecturer A exerted through this message was strong. She set clear boundaries about what she considers as a good practice while working individually on mathematics. The framing on this occasion was mixed; although the control over the selection of communication of the message was strong and entirely directed by the lecturer, the level of the exerted control over sequencing and pacing differed. The students were the ones responsible for controlling how (and if) they would work with the definitions lists and how much time they would spend on this practice. Therefore the control over sequencing and pacing was rather weak.

Three students talked about this advice from Lecturer A. All of them took actions in furtherance of the organisation of their study plan because of this message. For instance, Alex admitted that the moment she talked about it he realised that he had to change the way that he was setting up his study material until that point. He changed his whole way of studying, which until then was mostly influenced by what he used to do at school, and eventually he became more organised as he admitted.

> Alex: It changed my work pattern, I used to just do past papers and I printed off at the start of the year, I printed off in advance all the past papers, this is in A Levels... And when I got here I had intentions of printing off every problem sheet... but it doesn't work like that... so I can't look in the future and do advanced work... And so I changed my work around that, I am a lot more organised than I have ever been before with keeping my work in

a certain place.

Carin also mentioned that she used the practice of making lists of definitions following Lecturer A's suggestion. She referred to it as an action that she has taken from a transmitted message. The influence of the message made her employ the lists of definitions in the rest of the modules as well.

> Carin: ...initially I just had one for module A 'cause Lecturer A told us to do it and then now I began to realise that it is actually beneficial to have them across modules as opposed to just like having a different technique for each module.

The strongly classified message transmitted through the creation of definitions lists was not perceived by many students. Although it was given very clearly and explicitly by the lecturer, not many of them considered it as important. An explanation for this can be the absence of a connection to the tests. As we will see in the next piece of advice given by Lecturer A (Keep up/Do not fall behind), which is again weakly framed, the link that she made with the tests made it immediately understandable by more students. However, the students who perceived the message about definitions lists got influenced to a great extent from it. They all adopted the idea of making lists of definitions and they improved the organisation of their study material. The mixed framing exerted through this message gave enough control to some of the students to organise their study the way they thought it best suited them. The practice was also adopted to facilitate the study of other modules. On the other hand, the weak framing over the ordering and pacing might explain why a number of students avoided following this practice.

5.1.5.3 Keep up/Do not fall behind $M_{5.3}$

During the semester Lecturer A talked many times to the students about the significance of being consistent with the work and not cram it all in at the very last moment, before the final examination. She emphasised the responsibilities that students have to take over their studies and the fact that there will be no one else to show them how to do things, like it used to be throughout the previous years of their education. Moreover, she provided them with feedback along the way, to keep them aware of whether they were doing well or not. One way of providing them with feedback (apart from the three class tests where it was given collectively after the marking through the webpage of the module) was through sets of exercises that students had to do during lectures. These were in the form of statements and the students had to judge whether they were true or false. The lecturer gave them some time to work on them individually, and then they had to vote whether each statement was true or false. A detailed explanation was required whenever a statement was false. The following extract is from the lecture observations where the lecturer explains to the students why it is important to keep on track.

> Lecturer A: But I can't get to know you all, I can't give you individual feedback, in a class like this, well... This module wipes the floor with people who don't keep up, so if you don't keep up with the main concepts each week you will find yourselves really struggling about week 5. So one of the reasons that I do this is to give you a little bit of feedback on a regular basis. So you get a sense of what you know, what you don't know, it doesn't cover everything but it gives you a sense of what you might want to review.

Although the lecturer transmitted a similar message with the use of class tests, on this occasion she stated explicitly that students had to put work in and keep up. The message was clear; students need to work independently, and invest time outside lectures regularly to succeed. The power exerted through this message was strong. The lecturer stated in a clear way what she required her students to be doing. The framing in this case as well was mixed. The control over the selection of communication was strong and with the lecturer. On the other hand, the control over the sequencing and pacing was weak and with the students. It was entirely up to them how they would structure their study in order to keep up and what was the required time spent on the study of the module to not fall behind and take action in furtherance of their learning.

Six students talked about this message during our discussions. Some of them mentioned that they had to keep up with the module and not fall behind because of the explicit message that Lecturer A transmitted. A characteristic example is Alex, who received the message early on in the semester and described how his lecturer's words were imprinted on his mind and motivated him to work for this module.

> Alex: It was sort of brought to us on day one of lectures, she said Module A will wipe the floor with people that don't keep up well and so from that moment on whenever I had work [for module A] to do I instantaneously did it the next day because I am actually petrified of falling behind in it simply because of how much she tells us not to... I am actually, I wouldn't say ahead but I have not fallen behind... and I am really glad I haven't because it's enhanced my learning... so she was right. And I've tried to keep that with the other ones but I haven't done it as rigidly.

Some others received the message implicitly through the continuous effort that they had to put in for the tests. The tests control the sequencing and pacing that they have to follow; there is a deadline and they need to keep up or fail.

> Owen: I think this semester sort of made me realise that the class tests... they definitely do help 'cause it means like you are forced to keep up... it is a percentage of your module at the end so you are going to want to do your best on them so you are going to have to keep up...

There were occasions though where the students understood the transmitted message but did not really change something in their study habits. This happened with Jeremy, who admitted that even though he received the message he did not put work in to keep on track with the module.

> Jeremy: ...if I don't get something I am trying... putting in a bit more effort but usually I don't put in that much effort to most of the work... I don't really do as much as I should... Sort of just because I am quite lazy... it doesn't bother me...

As in the previous cases where the lecturer transmitted messages through the different kinds of advice, the high degree of power made the message easily recognisable to the students. Although the degree over selection of the communicated knowledge was high, once again the weak framing over the sequencing and pacing gave all the control to the students. This resulted in the following; students would either understand the message, act independently and be consistent with the work for the module or they would understand the message transmitted through the advice without putting it into practice.

On other occasions the message for keeping up was received by students in combination with the work that needed to be done for the tests.

5.1.5.4 It's ok if you don't understand everything $M_{5.4}$

The lecturer explained to the students that during her lectures there would be occasions when they would not take everything in. She made clear that this was normal, and not something that should worry them as long as they would try to study afterwards and think about the things that have been discussed. By doing that she meant to show them that they were more or less all in the same boat and that not understanding something when it was firstly introduced was not something that someone should be ashamed of. This level of mathematics requires deep thinking about the concepts and continuous work.

> Lecturer A: Remember that 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. She set clear boundaries regarding what she perceived as a legitimate level of understanding when she delivered the lectures. The message carried a high level of power. The lecturer stated her expectations in a straightforward way. Although the selected concepts that needed to be understood by the students were chosen by her, the lecturer gave space to the students to acquire understanding of these concepts in their own way and at their own pace. Therefore, the control of this message was rather weak and lay mainly with the students.

Six of the students received the message and commented on it. Emily said that through this message she recognised 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 and said 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 who perceived this message seemed to be influenced to an extent. From the above extracts it is obvious that strongly framed messages received in the school context are still influential. The fact that they did not understand everything, like they used to at school, made them feel displaced. Lecturer A's message though, with the space that it gave to the students made an impact on their thinking. It provided them with emotional encouragement and made them feel more comfortable. This message made the "not understanding everything" situation legitimate in the new context. It stressed the fact that with adequate effort there are possibilities for grasping new meanings and understanding the concepts eventually.

5.1.6 Lecturer's intrinsic enthusiasm for mathematics M_6

Lecturer B used a variety of examples during his lectures to explain different mathematical concepts. With the use of these examples he conveyed his enthusiasm about the content of mathematics that he was teaching and this caught students' attention. He facilitated students' understanding by using them and created a generally positive attitude regarding the learning of mathematics. On certain occasions he presented mathematical arguments in the form of stories; these could be either narrations of anecdotes, drawings on the white board or stories in which he included body movements to give a clear picture of what he was describing.

In the following I will cite two extracts from the lecture observations where the lecturer employed these characteristic kind of examples to help his students to understand. In the first extract the lecturer introduced inductive proofs and presented various examples to his students, one of which I quote here.

> Example: Every number greater than or equal to eight can be written as a sum of threes and fives.

Before writing the proof the lecturer drew on the white board a picture of a weighing scale which on the one side had an 11 pounds piglet and on the other side two weights of 3 pounds and one weight of 5 pounds.

> So let me illustrate this by a picture. I am drawing this, a scale. This is an 11 pound piglet and it can be weighted using weights of 3 and 5 pounds only. So every weight bigger than 8 pounds can be weighted using weights of 3 and 5 pounds only. It's not an

> obvious statement, it's not immediately obvious but by induction is absolutely obvious.

Another similar instance occurred when the lecturer talked about the density of the set of rational numbers in the set of the real numbers. Once again before he started writing the proof he used an example. In this particular example he used body movements to put more emphasis.

> The proof that $\mathbb{Q}$ is dense in $\mathbb{R}$ is based on the following, so imagine the following situation: Friday night, is very dark, I am walking home from a pub, and I don't watch my steps, and there is a ditch across the road and I don't see it, the ditch is $50cm$ long, and I walk fast for instance and my step is 1 m or $80cm$ the ditch is $50cm$ my step is $80cm$ and I walk fast [he walks in a straight line in the room] so is there a chance that I will miss it? There is a chance that I miss it. Now suppose that I am not in a hurry, I am walking very relaxed and my step is $40cm$ [he is walking again in the room] very relaxed, and the ditch is $50cm$ can I miss it? No way, yeah? So I will use this principal now to prove that the set of rational numbers is dense.

With the use of these examples the lecturer managed to transmit his enthusiasm to the students. The abstract concepts were integrated into lively stories of every day life situations. This contributed to students' understanding and helped to keep the students attentive and focused during lecture time. Both classification and framing of this message were at a high level. The examples used for every concept were explicitly distinguished and each one referred to a specific mathematical idea. The selection of the examples,

the ordering that they would follow and the pacing devoted for each one of them, were always defined by the lecturer.

The realistic examples and the positive attitude that was spread through them in the lecture time had influences on students' learning. Three students talked about the examples during the interviews and the focus groups. Emily referred to the example with the pig and the weighing scale. She said that it made her feel that mathematics can be fun at university as well. She compared this incident, where with the use of a funny example she came to an understanding of what was being discussed, to the moments that she did not understand and felt lost in the lectures.

> Emily: I think from that amongst other things has told me that maths as a degree is just a roller-coaster 'cause... there are moments like: Oh my god he is throwing a pig on a weighing scale in lectures and it actually does make sense what you are doing. But then you have other moments where you literally just like after you have done six hours of revision and you are just like so tired and you don't feel any smarter, you don't feel like you understood anything more and you are just like I don't want to do this anymore...

For Elsa an enthusiastic lecturer can make the students feel more engaged and focused with the actual content of the lectures. She admitted that she liked this way of delivering the lectures and referred to Lecturer B's lectures. Even though she thought of him as a traditional lecturer, with the writing on the white board etc., she considered the funny examples that he brought into the lectures helpful for students' understanding.

> Elsa: ...he is very traditional but he still makes it quite engaging,

> 'cause he is quite funny as well... When he is giving examples he will just come up with funny stories... [Once] he was trying to explain some theory to us and he did it by like gesturing with the size of his steps across the room and just like that kind of thing. He obviously knows that explaining things like that makes it more understandable than just reading the theory 'cause it was quite difficult... it was kind of counter-intuitive theory so he thought of a method, a more simple method just to give us an idea of how that worked.

Similarly, Jason described how he felt inspired by Lecturer B's lectures. He considered that with the use of such examples students can engage more with the concepts that are discussed.

> Jason: Sometimes anyway it's a show, it's a performance, and that's what you want in my opinion from a lecturer, you want to be engaged, you want to get lost in what they are saying.

From the above extracts it is apparent that Lecturer B's mathematical enthusiasm conveyed with the use of the realistic examples affected the students. The high degree of power and control carried through the practice of using the examples played an important role in their learning. The students felt more engaged during the lectures, their confidence was boosted and they acquired a deeper understanding of the abstract concepts that were discussed. Despite the differences in the identities of the three students that talked about Lecturer B's enthusiasm we observe how he made them feel comfortable and created a positive feeling during his teaching.

5.1.7 Representation of the messages

In the following table I summarise all the transmitted messages and in the diagram (Figure 5.1) I represent the messages in respect to the level of classification and framing. The messages are placed on the first and fourth quadrant because they all carried a high level of power, therefore the classification was strong. We observe though differences in the degree of control in the transmitted messages.

In the right top corner of the diagram we can see the messages of the first identified category which referred to the things that students should do during lecture time ($M_{1.1}, M_{1.2}, M_{1.3}, M_{1.4}$) and are all strongly classified and framed. In the same quadrant is placed Lecturer A's message conveyed through the use of class tests ($M_{4.1}$) and Lecturer B's message regarding his intrinsic enthusiasm for the content of mathematics (M_6). Closer to the x-axis of this quadrant we observe the message about coursework ($M_{4.2}$), which had strong framing over the selection and evaluation of the communicated knowledge but weak framing over the sequencing and the pacing.

The fourth quadrant contains the messages that were weakly framed. These are the messages concerning the things that students should do outside lecture time ($M_{2.1}, M_{2.2}$), the messages about the things that students should do when they feel stuck ($M_{3.1}, M_{3.2}$) and all the messages that Lecturer A gave about the general study habits that need to be adopted at university ($M_{5.1}, M_{5.2}, M_{5.3}, M_{5.4}$). These messages were all framed strongly over the selection of the communicated knowledge and they were weakly framed over the sequencing and the pacing. In this case there was not an explicit evaluation purpose.

Transmitted messages	
$M_{1.1}$	Gappy notes
$M_{1.2}$	Written notes
$M_{1.3}$	Hand gestures
$M_{1.4}$	Discussion with peers
$M_{2.1}$	Problem sheets
$M_{2.2}$	Textbooks
$M_{3.1}$	Ask the lecturer
$M_{3.2}$	Tutor/MSC/Friend
$M_{4.1}$	Class tests
$M_{4.2}$	Coursework
$M_{5.1}$	Time management
$M_{5.2}$	Definitions list
$M_{5.3}$	Keep up Do not fall behind
$M_{5.4}$	It's ok if you don't understand everything
M_6	Lecturer's intrinsic enthusiasm for Mathematics

Table 5.1: Summary of the transmitted messages

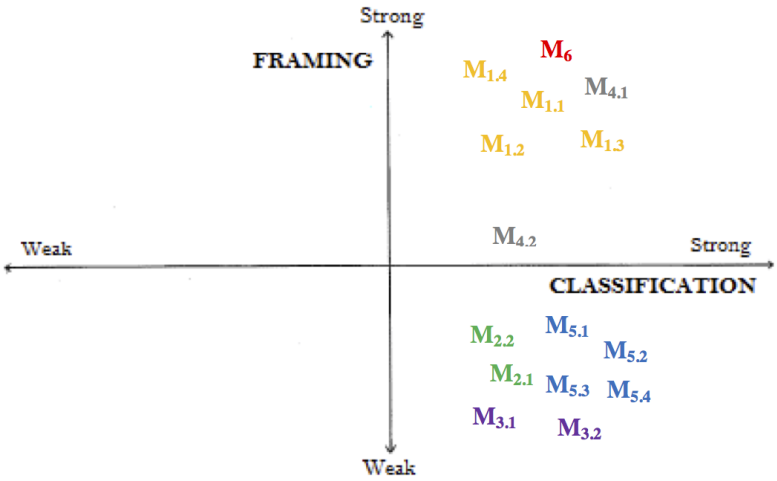

Figure 5.1: Messages representation

5.2 Students' narratives

In this section I present how students narrated their experience of the transition to university mathematics. Based on Bruner's (1996) work (see Methodology chapter, Section 4.2) I am building students' narratives of identity (Williams et al., 2009) from the interviews we had during the first semester of their studies. With these narratives I want to show the role that the messages transmitted by the lecturers played in each of the students' trajectories from school to university.

Each transmitted message that I included in my analysis was analysed with the use of Bernstein's (2000) concepts of classification and framing (Section 3.1). The data showed that different messages, according to the level of the power and control that they were carrying, had different influences on students' learning (the level of control is accounted over the selection, sequencing, pacing and evaluation of the communicated knowledge, whenever it is strong I use: '+' and whenever it is weak I use: '-', see for instance Table 5.2). For this reason I considered it important to look at how students' identities (as expressed in their narratives) influenced and were influenced by the messages. Therefore, in the following I will explore in what ways the messages carried through the discourses at university level (which I explored in detail in Section 5.1) (re)shaped students' identities, built throughout their schooling and their experiences of university so far. For that purpose I use the notion of positional identity (Holland et al., 1998). As I explained in the Theory chapter (Section 3.2) positional identity is concerned with the ways a person identifies her/his position in relation to other people, mediated through the ways that make her/him feel comfortable or constrained. In our case, this could mean the way that a student positions him or herself in relation to other people, particularly the lecturers and fellow students,

will have an effect on how he or she responds (or not) to a specific message transmitted by the lecturer. For instance, on some occasions a strongly classified and framed message can make a student feel comfortable and willing to take initiatives and be proactive in her/his learning. Or it could be the exact opposite, that a certain student feels constrained when the lecturer has all the power and control in the teaching-learning interaction and feels more comfortable acting independently. Such differences will be explored in this part of the results.

Moreover, I will demonstrate how the impact of the messages triggered the students to take certain positions in the new setting. An adaptation of Senninger's (2000) learning zone model (explained in detail in Section 3.2) will contribute towards our understanding of this positioning. With the hypothesis that there exist three possible zones that students can move into during this phase (comfort zone - transitional zone - discomfort zone) I investigate how the interaction of the transmitted messages with students' identities place the students in certain zones and the effect that this positioning can have on their transitional experience.

I will explain now how I constructed the narratives and how this construction helped me to answer my research questions. In each story I take as a starting point the biographical information that the students shared about themselves with respect to their relationship with mathematics and their decision to study for a mathematics degree (e.g. interest in mathematics, school study habits, influences in the degree choice, expectations, etc.). Then I move on to explore how they experienced the first semester at university. Through this trajectory I depict the role of the transmitted messages and the influences that these had on students' adjustment to the new context using the theories that I mentioned above.

My first research question (How do students interpret the different messages they receive within the university community?) was answered in the first part of the Results chapter (Section 5.1). The received messages are interpreted by the students in some way and this interpretation leads them to take some action from the transmitted messages or ignore them. This interpretation is interacting with their identities and helps me to answer my second research question - How are these interpretations shaped by their individual backgrounds and previous experiences? Finally, by evaluating the whole picture, based on students' responses I gain an understanding of how the received messages prompt the students to move (or not) between the three zones (see Section 3.3). In this way I explore the impact on their transition which will answer my third research question - How do they [the interpretations] facilitate or hinder students' transition?

Below I present the narratives of five students which I consider to be characteristic of the different categories according to the ways that they reacted to the received messages and of the different ways of adjusting to the new context. The analysis of the other five participants can be found in the Appendix A.

The four different categories of the ways that the students reacted to the transmitted messages consist of:

- Students who took action from all the messages, irrespective of the degree of classification and framing (Representative student: Elsa)
- Students who took action mostly from strongly classified and strongly framed messages and ignored the weakly framed ones (Representative student: Lesley)
- Students who took action mostly from strongly classified but weakly

framed messages and ignored the strongly framed ones (Representative student: Jason)

- Students who ignored the messages, irrespective of the degree of classification and framing (Representative student: Jeremy)

Moreover, the three different categories of the ways that students' transition has been influenced by the received messages refers to:

- Students whose transition was facilitated in the interaction with the transmitted messages (Representative student: Elsa)
- Students whose transition was hindered in the interaction with the transmitted messages (Representative student: Eric)
- Students whose transition was facilitated in some aspects and in some others was hindered in the interaction with the transmitted messages (Representative student: Lesley)

5.2.1 Elsa's narrative

Elsa was not entirely sure which university degree to follow. She chose Mathematics because of the career opportunities that the degree offers: "I felt the need to do a degree that led to a wide variety of career possibilities..." She expected university mathematics to be about solving real world problems, proving lots of theorems, more abstract ideas, and "a combination of various aspects of mathematics, and a combination of various concepts" as she stated in the first questionnaire. When she eventually came to university it was not exactly as she expected it to be: "Some of the lecturers aren't as similar to school teachers as I expected. Much harder than I expected, even though I did expect it to be difficult." In her story she refers many times to the differences that she recognises between school and university practices.

In the next part I will introduce Elsa's background story and the information that she shared with me which appear to be crucial for the (re)shaping of her identity as a mathematics learner. I will also present the most important messages that she received from her lecturers and how the interaction with these messages influenced her transitional experience.

5.2.1.1 Background information

Elsa chose to study for a degree in Mathematics mainly for the career prospects that the degree provides: "I really wasn't sure what I wanted to do and started with applying to something completely different... an animal course but then I decided that maths has more like career opportunities and I could still do something like hands on... As working with animals, like on a weekend or something, I wouldn't have to have a degree or anything like that to do it, could be more like a hobby." Her decision was influenced to some extent by her school teacher: "My maths teacher kind of influenced me slightly to do

maths but is mostly myself I think... It took me long time like to decide, but there wasn't like one person who really influenced me." She considered very helpful the initiative that her school undertook of inviting first year students from different university courses and come to talk about their experience as freshmen. In this way, for the first time, she began to learn about what it means to live away from home. She also acquired information about various university practices: "They talked a lot about how... how difficult or easy is living by yourself the first time... and also how they got on with their courses... but it was useful to kind of have an idea that you are in a massive lecture theatre you are given presentations but then you have to go off and do work by yourself and that kind of thing."

While Elsa was at college she did not take A Level Further Mathematics because it was not offered. Whenever she faced difficulties while doing mathematics she would mostly consult her school teacher for help. She also mentioned that she did not work with her friends at school. Elsa expected studying mathematics at university to require independent study and be much harder than at school. She also thought that it would "Be easier during the first week or two..." than what she eventually found it to be.

An issue that emerged often during our discussions concerned the differences in the practices between the two educational settings and how these differences affected her way of approaching mathematics at university. For instance, she mentioned the different cohort size of the lectures: "At college, obviously it was a much smaller classroom, so a teacher would come around to everyone individually, and if you... needed to ask something all you had to do is to put your hand up and she would come and help you... but here they kind of expect you to do more by yourself and there is not really time where you can go and see them individually because it's not like practical."

Another aspect that surprised her was the work load that is set at university. The work load in addition to the lecture hours which were longer than the hours spent in the school classroom was a big difference for Elsa. This made her realise that she had to set priorities in order to be consistent with her learning and her responsibilities: "You go through topics much more quickly, the workload is much bigger, so I think you are kind of just prioritising the most important things. Like we say that I am never going to get everything done but I need to get certain things like courseworks and problem sheets, revision for tests those need to be done." Moreover she noticed that at university she had to change her ways of working and invest more time outside lecture time in order to comprehend what the lecturers teach. Things that got her frustrated at college were not an issue anymore at university: "...it's more difficult to understand on the spot in the lecture. So there is a lot of lectures that I go and I really don't understand what is going on... At college if I couldn't do the problems I'd get more frustrated rather than just relax and look back at what we know and try to apply it, I got like really stressed about it. But here I just kind of go through what I know and try to apply it and then I use the internet a lot more to research..."

The message that she considered as most important during the first two weeks at university concerned the amount of time that is required for studying outside lectures: "They have made it clear to understand it that we should be aiming for three to four hours per module per week... but I struggle to fit that much into my week." Through this message Elsa realised that students must become more independent: "I think this thing is like a very important message 'cause the lecturers are there to help us but you are not going to understand everything just from the lectures, it's very important to do independent study and that's like a big change from college..."

5.2.1.2 Experiencing university mathematics

Elsa talked about all six categories of messages as these were classified from the data (a summary of the received messages is presented in Table 5.2). She received messages from the things that students should do during and outside the lectures, from the assessment practices used at university, the things that students should do when they feel stuck, the general study habits and the lecturer's intrinsic enthusiasm for the content of mathematics.

Things that students should do during lectures

Elsa referred to the different teaching practices that the lecturers use at university. She admitted that she is in favour of different activities taking place during the lectures, such as in Lecturer A's module: "I definitely feel better with the ones that give us different activities because they kind of keep me thinking throughout the lecture... when a lecturer moves around for instance and does gestures and that kind of thing I find that... it helps me to understand the work a bit better [when] they are not just still talking and writing the whole time... I think I am just one of those people who learn better by doing things and watching things than just listening to a lecturer talk." Moreover, she said that even lecturers that use more traditional ways of teaching (e.g. writing on the board and expecting students to copy) can still make the lectures engaging with their attitude, like Lecturer B: "...one of them he is very traditional but he still makes it quite engaging, 'cause he is quite funny as well, but he is very traditional he writes things on the board and we copy it down." Elsa seems to be more influenced by the lecturers who show an interest in getting the students involved during lecture time.

Either this happens by giving them different mathematical activities to work on or with their attitude towards mathematics while teaching. She enjoyed these kinds of lectures more because, as she claimed, they contributed to her understanding.

In this category Elsa referred to two completely different practices which carried the same level of classification (strong) but sometimes varied in the level of framing. The degree of control transmitted with the use of gappy notes was mainly strong, but in particular instances - when Lecturer A provided space for the students to treat the notes the way they thought best - could also become weak. On the other hand there was always strong control transmitted with the use of written notes in Lecturer B's module. Despite the difference in the two practices Elsa felt comfortable employing both of them. The most important aspect that she recognised in these practices was that she felt engaged and she could think during the actual lectures which eventually led to enhancement of her understanding. The strong power and control transmitted through these practices facilitated her learning and confirmed her identity as a mathematics learner; she referred to herself as the person who learns better by "doing and watching things". Drawing from these messages Elsa positioned herself in the transitional zone. This was stressed even more when she expressed a sense of discomfort for the lecturers who did not encourage the students to get involved in different activities and spent the whole lecture just talking.

Things that students should do outside lectures

The work that needs to be done outside lectures is the next category of messages that Elsa talked about. She referred to the importance of working with the problem sheets and reading from different mathematics textbooks

while studying.

Problem sheets

Early on in the semester Elsa admitted that she struggled to find enough time to fit in all the required work for the modules. Despite this fact she recognised how important it is to work with the problem sheets: "So I have to make sure I do those [the courseworks] but in order to do those I find it handy... that I do some of the problem sheets as well, because the questions can be quite similar and they help me to understand it [...] if you don't do any problem sheets you are not going to get in trouble or anything but it helps you... is just realising that you are going to do them for your own help rather than because they are going to be marked." Elsa understood the value of attempting the problem sheets. This contrasts with the majority view of the rest of the participants in this study. She acknowledged that working with the problem sheets is important regardless of the fact that they are not getting marked. This work improved her understanding and helped her to get prepared for the things that are assessed (e.g. courseworks or tests).

Elsa is one of the few participants who not just comprehended the lecturers' intention behind the use of the problem sheets, and the benefits that this has on students' learning, but she was also willing to take action and work with them. With the low level of control that both lecturers exerted though this practice they gave space to the students to take responsibility for their learning and work independently outside the lectures. Elsa recognised this and took advantage from the provided space. She reshaped her identity as a mathematics learner by setting priorities not only for achieving a good mark but also for acquiring a better understanding of the concepts. She acknowledged the benefits of working first with the problems and then putting in work for the things that get assessed. By grasping this message Elsa moved

into the transitional zone, and distanced herself from the discomfort that the workload caused her at the beginning of the semester.

Textbooks

For her study outside lectures Elsa used various textbooks from the library, particularly for Module A. She did not rely only on the textbook lists that the lecturers had suggested, she sought more books herself: "...I don't think I took many books from the suggested reading list but it might have given me ideas to go and look for books." She argued that in the different textbooks she found further explanations to the ones that the lecturers offered, and this contributed to her understanding. She said it was particularly helpful using them for Module A, because in the class tests of this module proof construction was required: "I find that the proofs can be very difficult to understand. So if I read different versions of the same proof it definitely helps me... It definitely helps me with the tests, because it gives me a better idea how to construct proofs myself..."

Elsa recognised the strongly classified message transmitted by the two lecturers regarding the use of textbooks. In this case, as previously with the problem sheets, she was willing to take the space that the lecturers provided by exerting weak framing and to have control over her learning outside lecture time. She did not just rely on the recommendations of the lecturers but she went a step further; she looked for more books in the library which could likely facilitate her learning. Additionally, she seemed to be well aware in what exact part of her study the textbooks were beneficial (proof construction) and tried to take the most out of them. The message conveyed with the recommendation of the books strengthened and reshaped Elsa's identity as a mathematics learner by motivating her to become more proactive in her learning habits and include more helpful resources. The message prompted

her to move into the transitional zone, where she felt comfortable with the practice of using textbooks and eventually made regular use of them in her study time.

Assessment

The various assessment practices used at university is another topic touched upon by Elsa who claimed had significance in her understanding: "I actually find it quite good because since it is a quite difficult course to do I think it's all the tests and the courseworks that... help me to understand... 'cause I'd might found it difficult to sit down and really make myself understand if there wasn't a test coming up... I have to make sure that every week I am keeping on top of at least parts of the work..." Regardless of the heavy work load and her struggle to find enough time to fit in everything, she considered the different ways of assessment helpful for the learning of mathematics at this level.

The tests and courseworks encouraged her to invest more time for working and for comprehending the concepts taught. In contrast to the majority of the participants in this study who talked only about the exchange value, Elsa focused on grasping a deeper understanding through the assessment approaches employed by the lecturers. She acknowledged that if the assessment was not scheduled in this way throughout the semester it would have been hard for her to cope with it, and catch up with all the material covered only for a single final examination at the end of the semester. This recognition came as a result of the strong power transmitted through the messages regarding assessment. The strong control that Lecturer A exerted with the use of the class tests, and the weak control that Lecturer B exerted by employing the coursework, both enabled her to take action and study. Despite

the difference in the level of control in these two messages Elsa was eager to reform her identity and work regularly every week instead of cramming in everything at the end of the semester. The assessment practices helped her to move into the transitional zone and adjust to the new requirements.

Things that students should do when they feel stuck

In the story of her experiences during the first semester at university Elsa narrated how she acted when she had questions to ask: "If I am really struggling at something I'll go and ask. Sometimes I am a bit nervous to go and ask 'cause it's just... if I feel like my question is stupid.. some of them do say that... there is not such a thing as a stupid question... if it's a proper problem that I need to go through or like a proof that I don't understand, something to go through... to sit down for while to explain it, that's the kind of thing I would go to the mathematics support centre about." Elsa acknowledged that the lecturers were willing to help the students whenever they felt they did not understand and they encouraged them often to not hesitate and ask them questions. In other cases she reported that the lecturers encouraged the students to visit the university mathematics support centre.

We can see here that the high level of power made the suggested sources of help easily recognisable and Elsa was rather eager to use them. The low level control transmitted through this message influenced her identity and gave her the chance to respond differently in different situations as to how she should get her questions answered. For instance, her anxiety created a feeling of discomfort to ask the lecturers directly, but given the encouragement from lecturers to ask for help when needed, she overcame this anxiety and communicated her queries. On other occasions, when she considered that more time needed to be invested in an explanation, she chose to use the

mathematics support centre. Therefore, the space provided by the lecturers with the transmission of these messages was used rather efficiently by Elsa who positioned herself in the transitional zone.

General study habits

It's ok if you don't understand everything

The unexpected upturn of the workload was emerging frequently in our discussions. Elsa admitted that she started feeling better about it when she realised that she was just in the same situation as the rest of her peers. This was particularly stressed from Lecturer A's message about not worrying when students could not get everything straight away: "I think it's just realising that everyone finds it difficult and the lecturers encouraging us that we are not going to get everything as long as we try to understand the main things... in the first few weeks I remember just feeling so bad that I was not understanding the work... something just changed when I realised that everyone was in the same boat..."

The advice given by Lecturer A made an impact on Elsa's thinking. Initially she was frustrated by not understanding everything. The high level of power transmitted though Lecturer A's words by admitting that it is fine if students do not understand everything, and that everyone is in the same position, made Elsa feel more comfortable and confident. In fact, her identity as a mathematics learner was reshaped by realising that not understanding everything is a legitimate situation during the transitional phase. By grasping this message Elsa moved from the discomfort zone to the transitional zone and focused on understanding as much as possible in order to enhance her learning instead of feeling frustrated by not getting every single detail.

Lecturer's intrinsic enthusiasm for the content of mathematics

Elsa considered that an important characteristic of Lecturer B's lectures was the enthusiasm that he demonstrated whilst explaining concepts: "...he is very traditional but he still makes it quite engaging... When he is giving examples he will just come up with funny stories... [Once] he was trying to explain some theory to us and he did it by like gesturing with the size of his steps across the room... He obviously knows that explaining things like that makes it more understandable than just reading the theory 'cause it was quite difficult... it was kind of counter-intuitive theory so he thought of... a more simple method just to give us an idea of how that worked." Elsa thought that Lecturer B's enthusiasm made the students feel more engaged and focused on the actual content of the lectures. Even though she thought of him as a traditional lecturer, the funny examples that he used helped students' understanding of rather difficult concepts on many occasions.

The strongly classified and framed message transmitted by Lecturer B was easily recognisable and comprehensible by Elsa. The enthusiasm that he transmitted through his examples and stories made her understand counter intuitive concepts which would have been hard to understand in the first place without the use of such examples. This way of teaching kept her engaged and contributed to her understanding. It is apparent that the message affected her thinking and made her feel comfortable not only during the lectures, but also afterwards when she did not have to put in additional work to comprehend what has been discussed. In the interaction with Lecturer B's approach Elsa's identity as a mathematics learner was reshaped; the examples made her feel more comfortable with her understanding and she positioned herself in the transitional zone where she could even grasp concepts which initially seemed hard to understand.

5.2.1.3 Overall impact

Elsa got influenced by messages that were carrying both high degree and low degree of control. For instance, she was willing to take action from the weakly framed message transmitted by her lecturers regarding the use of the problem sheets but at the same time she was happy with strongly framed messages like the writing of the notes. In both cases in the interaction with the transmitted messages she was prompted to take action towards her learning and as a result she moved into the transitional zone where she managed to adjust smoothly in the new context.

In the following table (Table 5.2) I represent the messages that Elsa received, the degree of classification and framing that they were carrying, and finally the effect that the interaction with these messages had on her transitional experience.

Strong classification entails strong boundaries (which I will represent with '+'), weak classification entails weak boundaries (which I will represent with '-'). Framing shows who can control the selection, sequencing, pacing and evaluation of the communicated knowledge. Strong framing (which I will represent with '+') means that the control is with the transmitter, weak framing (which I will represent with '-') means that the control is with the acquirer. I will use the same representation for the rest of the participants as well (e.g. in Table 5.3, Table 5.4, Table 5.5, Table 5.6, Table A.1, Table A.2, Table A.3, Table A.4, Table A.5).

Whenever she faced difficulties adjusting to the new setting during the first semester at university, Elsa took action from the messages transmitted by her lecturers. These actions were not influenced by the transmitted degree of control. She was willing to take action from any message that would contribute to her understanding, whether this was strongly or weakly framed.

Message	Classification	Framing	Positioning
Taking notes ($M_{1.1}, M_{1.2}$)	$+$	$++++$	Transitional zone
Problem sheets ($M_{2.1}$)	$+$	$++--$	Transitional zone
Text books ($M_{2.2}$)	$+$	$++--$	Transitional zone
Class test ($M_{4.1}$)	$+$	$++++$	Transitional zone
Coursework ($M_{4.2}$)	$+$	$++--$	Transitional zone
Ask the Lecturer ($M_{3.1}$)	$+$	$+---$	Transitional zone
Visit the MSC ($M_{3.2}$)	$+$	$+---$	Transitional zone
It's ok if you don't understand ($M_{5.4}$)	$+$	$+---$	Transitional zone
Lecturer's intrinsic enthusiasm (M_6)	$+$	$+++$	Transitional zone

Table 5.2: Messages received by Elsa

For instance, she talked about using the books that the lecturers suggested, with additions that she made, but we also saw that she appreciated the use of gappy notes and the engagement in the activities included in them. Her identity as a mathematics learner was reshaped and enhanced while interacting with the conveyed messages.

Elsa seemed to be a very proactive and dedicated student. On the occasions that she spotted differences between the school and university contexts she positioned herself in the discomfort zone. An example of this would be when she talked about the unexpected amount of work. Despite this fact she seemed to be immediately eager to grasp any opportunity given by the lecturers, transmitted either through weakly or strongly framed messages, and move to the transitional zone. From what she described we did not notice Elsa remaining at any time in her comfort zone.

She did exceptionally well at the end of the semester in both modules. She achieved 93% in Module B and 94% in Module A.

5.2.2 Lesley's narrative

Lesley chose to study mathematics because she had a personal interest in the subject and enjoyed doing it while she was at school: "I just love maths so it was an obvious choice." She expected the content of university mathematics to resemble the A Level Further Mathematics. This expectation was based on information that she received from her school teachers: "...my further maths teachers, they were saying: 'You will be fine, it's basically just second year further maths.' But it's not." The main difference that she recognised between school and university mathematics is the proof construction: "There is a lot more proofs and I find them quite difficult to understand, I think that's the main difference."

In the following I will introduce some information from her trajectory from school to university which she shared during our talks and I consider important for the formation of her mathematics learner identity. Moreover, I will talk about the messages that she received from her lecturers during the teaching-learning interactions and which had an impact on her transitional experience.

5.2.2.1 Background information

For Lesley, the choice of studying for a mathematics degree was an obvious one because, as she said, she loved doing mathematics throughout her previous years at school: "I came to study maths just because I really enjoy the actual I'd say sort of methods type maths, like sort of complex but not so much proofs and I thought that's what university mathematics is..." The main influence in her decision to choose this degree was her school mathematics teachers who encouraged her to pursue the degree: "Teachers gave me advice, like my further maths teachers [...] Just basically that: 'You can

do it'. Like: 'Don't think you can't, don't regret it.' kind of thing. But not from family or anything, they didn't really mind what I do as long as I was happy with that."

While she was at school she had taken A level Further Mathematics and there were instances when she faced difficulties in doing so. On these occasions she asked for help from family members (nevertheless she did not refer to a family member with a degree in a science subject). She did not use to do mathematics with her classmates. In the first questionnaire Lesley wrote that she expected university mathematics to be about abstract ideas, but when she came to university she realised that it was not like that: "It's a lot harder but that's my fault for believing rumours that uni isn't that hard." In a later stage in the semester, during the focus group, she said: "... everyone said that the jump from school to sixth form is harder than the sixth form to uni, but they lied! ...I got told that first year was just Further Maths A Level, but that wasn't true either.

At the beginning of the semester she felt troubled by the differences between the two educational contexts. The most significant difference that Lesley recognised between the two institutions was the use of proof construction at university: "There is a lot more proofs and I find them quite difficult to understand, I think that's the main difference... maybe that's why I am struggling more, and missing something from the lectures..." Other differences were concerned with the teaching practices, or the fact that students live for the first time alone, away from home. All these differences made the gap between school and university wider for Lesley: "I think there is a very big jump from sixth form to uni, mainly because so much has changed, like the way that things are taught, you are not living at home any more..."

5.2.2.2 Experiencing university mathematics

Early in the semester Lesley reported that the most important message she had received until that point was transmitted by Lecturer A and it was included in the gappy notes as a quote: "If you are doing a decent degree you will struggle... I think that sums it up." She agreed with that and reported that sometimes she felt really stressed about it. Lesley referred to three out of the six categories of the transmitted messages. She talked about the things that students should be doing during and outside lecture time, and the assessment.

Things that students should do during lectures

Lesley talked about the things that students should do during lecture time and she referred to the discussion amongst her peers, the gappy and written notes. I will explain below in what ways she interpreted the messages transmitted through each practice, and how in the interaction with each message her identity played an important role on the ways that she settled in at university.

Discussion with peers

The mathematical conversation among peers was a familiar practice for Lesley, who reported that it was also used at school: "School was a lot more discussions and stuff like work with your partner and things like that..." She considered it helpful and recognised the benefits that the discussion can have on students' understanding: "I do find that really helpful... When you explain something to someone else it helps you as well... Just to hear another explanation, it can just sort of make you remember more or in an easy way."

The high level of classification and the familiarity of the practice made this message easily recognisable. This practice was already a part of her identity as a mathematics learner and therefore encountering it at university made her feel comfortable. As we will see in the following, whenever practices with which she was familiar emerged in the lectures, she always considered them helpful for her understanding. The high level of framing of this message played an important role on how Lesley interpreted it. The strong control carried through this practice regulated Lesley's thinking about how she should be performing during lecture time. She thought that on the one hand by engaging in conversations she could get different perspectives which may advance her understanding, and on the other hand by recalling such conversations in a later stage it would be probably beneficial for an

assignment or during the examination. The use of this practice made her feel rather comfortable and contributed to her positioning in the transitional zone.

Gappy and written notes

Lesley talked about the practice of writing the notes during lecture time: "Personally I feel like when I write down it makes me remember it more and if I am not writing it I'll then have to flip back and read some bits to remember it and it's hard to understand things later on. Whereas if I get from the beginning writing down I get it more." She considered the two different approaches employed by Lecturer A and Lecturer B as the same because they both required the students to write down. By writing down the notes (either filling the gappy notes or copying from the board) the students were given the opportunity to think and acquire a better understanding according to Lesley.

She was happy to engage in the practice of writing down notes in lectures. She did not distinguish between the two quite different approaches - gappy notes, and copying from the board. What she considered as the most important aspect of writing notes during lecture time was that by writing down it was easier for the concepts that were taught to be remembered later. The high level of power that these two practices carried made them readily comprehensible by Lesley. Moreover, the high level of control that the lecturers transmitted reassured her identity; she appeared to be more comfortable with these kinds of practices where the lecturers had the control over how students should be acting during lecture time. The transmitted message moved her into the transitional zone where we can see her eager to get involved with the notes and enhance her understanding.

Things that students should do outside lectures

In her story Lesley reported often how hard it was for her to work outside lecture time due to the late time-schedule of the lectures. This is another feature of university that she found completely different from school and which troubled her: "...at sixth form... I'd finish at 3:30 to work till about 6... I just can't get into a routine of working late at night, it doesn't really suit me."

She recognised that the lecturers expect the students to have a go with the problem sheets and in particular instances use mathematics textbooks that they suggest in order to facilitate their study.

Problem sheets

Initially she talked about the problem sheets and referred to Lecturer B who stressed explicitly the importance of working with them: "...he encourages [us] that if we do the problem sheets [it] will help us." She perceived that the main reason for working with the problem sheets was to get prepared for the examination at the end of the semester. However, she found it rather hard to cope with them because of the heavy workload expected of the students: "[They say] do the problem sheets... I find it hard to get all the problem sheets done, especially now, we have got coursework I put that first... but then by the time I finish that I won't have time to do the problem sheets so I can't do everything and then I am not really good at studying at night and all lectures finish like 6 most of the days..." Lesley elaborated further on the issue and admitted that one of her lecturers (who did not participate in this study) emphasised the significance of working with the problem sheets and the link to the examination: "I heard that if you do every problem sheet then there is nothing on the exam that will really shock you, so I think that is why they try to get you to do them... I at least try, because of what they

said. Which I don't think I'd do if they didn't tell us to do... if I can fit in time I do give it a go." Towards the end of the semester she reported that her engagement with the problem sheets had only become worse at that point because of the workload coming from the coursework: "Not much has changed, if anything I think I've got worse on doing problem sheets and I am not up to date or... but that's because we got so much coursework and if I have spare time I'll spend it doing that."

This strongly classified message was easily comprehensible by Lesley who referred to it in our discussion. Despite the fact that she recognised it, the low level of control that it carried in addition to the workload of the course, made her ignore it to a certain extent. Due to its weak framing the message provided her with enough space to choose how to organise her study outside lectures. This choice resulted in investing her time on the things that count towards the degree, such as the coursework, rather than the problems sheets, although she was aware of their contribution to her understanding. This is what she considered most important for enhancing her learning. She felt unable to put yet more effort into working on the problem sheets, thereby discontinuing what little progress she had already made with them. This particular message did not have a big effect on her learning. It mainly caused her distress about having even more things to do which positioned her in the discomfort zone.

Textbooks

The use of textbooks was another topic that Lesley brought up in our discussions. She reported that while she was at school the use of textbooks was really helpful for her understanding. The fact that they are not used at university puzzled her: "At school they did a lot more examples, and you can go through them if you are struggling, and there was a lot more examples

because you had textbooks and things, you had a lot of content whereas here you only get what they give you." Despite acknowledging the lecturers' suggestions of using the textbooks the fact that they do not present this practice as obligatory led her to not use them: "...they've recommended sort of some [books] if we wanted them but they've not said: 'You must go!' "

The changes between the two contexts affect Lesley's thinking about how she should be working. The weakly framed message transmitted by the lecturers through the recommended textbooks did not have any impact on her work. She admitted how helpful it was for her to study from textbooks while she was at school, and thus one would expect her to do the same at university. But, because the lecturers did not stress it enough she decided to disregard the practice. We observe a conflict here in her identity as a mathematics learner; on the one hand she felt constrained by the fact that there was not a set textbook for each module, but on the other hand when the lecturers suggested various mathematics textbooks she ignored their advice. In this case the lack of control led to her discounting a practice that used to be significant at school. Disregarding this message positioned Lesley in the discomfort zone where by ignoring a previously helpful practice her settling in became harder.

Assessment

Lesley talked about the differences in the assessment methods used at university. She referred mostly to the coursework: "I didn't expect it to be this much coursework... and I am not used to it, 'cause at sixth form we had exams at the end of the year and that was it for maths. So it is hard having something constantly in the back of your mind like: 'Have I handed it [the coursework] in yet?' It's quite stressful but then maths at university it was always going to be stressful." The fact that she had to put in effort

continuously in order to prepare the courseworks made her feel constrained, it kept her slightly behind and she could not perform as efficiently as she used to do at school: "...usually, before, I'd get things done and then I'd be on top of everything, it's so hard to be on top everything here and it's hard not to stress about it."

Lesley, in common with the majority of the students in this study, focused mostly on the exchange value of the coursework. In this case it was not the level of power and control conveyed through the assessment methods that affected her. It was the exchange value and the differently scheduled assessment practices. Lesley struggled with the constant work that she had to put in for the courseworks, she felt distressed and positioned herself in the discomfort zone. The stress caused from this situation affected her identity as a mathematics learner. While trying to become more effective in her study she ended up becoming more strategical: "I learn differently... Like this morning we had a question that used words that were really similar to a question in my coursework, so I was like... extra focus on this..."

5.2.2.3 Overall impact

In the following table (Table 5.3) I present the messages that affected Lesley during this phase. She was influenced the most by messages that carried a high level of control and she tended to ignore the ones that were weakly framed. The influences from the school context were always evident in her story and these sometimes impeded her adjustment to the university setting. On particular occasions the differences which arose between school and university led her to adopt a strategical way of approaching her learning.

Several times during the semester Lesley found herself in the discom-

Message	Classification	Framing	Positioning
Discussion with peers ($M_{1.4}$)	$+$	$++++$	Transitional zone
Taking notes ($M_{1.1}, M_{1.2}$)	$+$	$++++$	Transitional zone
Problem sheets ($M_{2.1}$)	$+$	$++--$	Discomfort zone
Textbooks ($M_{2.2}$)	$+$	$+---$	Discomfort zone
Coursework ($M_{4.2}$)	$+$	$++--$	Discomfort zone

Table 5.3: Messages received by Lesley

fort zone. The differences between school and university contexts were the main reasons for positioning her there. She found numerous issues troublesome, such as the absence of textbooks, the continuous assessment during the semester, the workload, etc.

However, there were instances when the messages transmitted by the lecturers contributed to moving her from the discomfort zone to the transitional zone. These were messages which carried a high degree of control. For example, Lesley considered the strongly framed message transmitted by Lecturer A regarding the communication of mathematics among peers during the lectures to be helpful. Previous experiences from school contributed to the way she interpreted this message; Lesley admitted that this practice resembled the discussion that used to take place in the mathematics classroom. Similarly, Lecturer B's practice of getting the students to copy notes from the board during the lecture prompted Lesley to be more attentive during lectures and enhanced her understanding.

Lesley reported that all these changes between the two educational settings made her feel less confident about her learning and her performance: "As a person I think I am not as confident with my maths... if I think back to sixth form the month before the exams I was in a lot better place, I knew

the content more, whereas I am panicking a bit now." Despite the fact that she faced various difficulties during her integration into the new context, she managed to be successful in her examinations at the end of the semester. In the final examination Lesley obtained 60% in Module A and 71% in Module B.

5.2.3 Jason's narrative

Jason came to university to study for a mathematics degree highly influenced by his parents' professional background. He referred to further influences, particularly two of his school mathematics teachers who instilled in him inspiration for the subject. The same kind of inspiration he found in Lecturer B's classes at university who, as he said, reminded him of his former teachers. He expected that mathematics at university would be a challenge and this is how he approached it. He did not have a lot of social interactions during the first semester of his studies. Instead he preferred to be focused on his work for the course.

In the following I will demonstrate the messages that Jason talked about and which had an influence on his settling into the new context. Through his story I will show also aspects of his identity as a mathematics learner which played an important role in the interpretation of the received messages.

5.2.3.1 Background information

In the narration of his story Jason referred to many influences from his family environment which enhanced his interest in mathematics: "...my granddad was a physicist ...he taught me a lot of physics, he has always done maths with me, as a kid growing up... I don't know, a real memory of mine is when my uncle taught me how to calculate every square number by the previous

square number which is really simple when you think about it. When I was 10 I was really smart at it, it's always stuck out, I've always known my times tables, I've always been the kid in the class that knew the 15 squared, this in primary school... I think it's always been there and I've never really taken so much attention to it... I didn't realised that I had maybe a better mathematical understanding than most kids 'cause I didn't do any work and the work that I was doing was fine, doing the homework but I still got the same grades as everyone else that was working hard." He also described how his parents' career choices affected his interest in mathematics in a significant way: "My mom is an artist and my dad is a computer programmer so he is obviously very mathematical... the combination of the two was very good... 'cause when I had to draw and all these things... it helped me with my diagrams mathematically, if you can draw out what you are trying to picture then it makes a big difference." Additionally, Jason talked about his school teachers who inspired him to a great extent and whose attitudes and practices made him love mathematics: "I had two Further Maths teachers that I will always remember and they will always be an inspiration for me. They were very strict and very old fashioned and it is what I needed, someone straight, and they were very enthusiastic... I think just having two great teachers was enough for me to be inspired to want to do this for the rest of my life... I wanted to do my best for them..."

During school he had taken A Level Further Mathematics and he never faced difficulties in doing so. He expected mathematics at university to be about solving real world problems, proving lots of theorems and more abstract ideas. When he arrived at university he found it was as he expected it to be. Furthermore, he thought that studying mathematics at university would require independent study, it would be more personal than at school,

it would progress in a faster pace and it would be harder than at school. The differences in the content of mathematics taught at university did not trouble him; he approached these differences as opportunities to challenge his mathematical knowledge: "I didn't mind, I wanted the challenge, I didn't come here for a repeat of last year... I wanted new material, I wanted to find how stuff works with integration, differentiation..."

5.2.3.2 Experiencing university mathematics

I will present now the messages that Jason referred to during our discussions. These messages concerned general study habits, lecturer's intrinsic enthusiasm for the content of mathematics, things that students should do during lectures and assessment.

General study habits

Time-management

Jason talked about the time-management challenges that arise at university: "I go home every single weekend and see my girlfriend... generally speaking all the work I have to do is Monday to Friday, and because I know this, it makes a big difference having five days not seven, I have to manage my time well. I do struggle to fit things in but I prioritise so I don't feel bad. I manage well I think..." His main concern did not focus on finding a balance between working on problem sheets and preparing the tests/courseworks, as was the case for most of the students. For Jason the work always came first. His real struggle was to find a good balance between personal life and work.

He described in detail the management of his study time. He mentioned though that this was not influenced by the message that Lecturer A transmitted. Although he had received this strongly classified and weakly framed

message it did not have any impact on him. The reason was that he came well prepared from school to university, in terms of organizational skills, and thus he was not influenced by Lecturer A's message, conveyed through the reading sections, about time-management. All the influences regarding how to manage his time efficiently derived from his school teachers: "I read it but I didn't take much from it... that's what I was doing already, I was taught at school you know... I think my teachers prepared me really well 'cause they knew... what I would be doing, 'cause I always knew I was going to do a maths degree." We notice here that although Jason recognised the message he disregarded it. This happened not because he did not consider the message important but because he had already received enough information about how to organise his study time at school. Thus, good organisational skills and time-management were already an aspect of his identity as a mathematics learner before coming to university. He felt comfortable with the management of his time due to his effective planning. Therefore, he remained in his comfort zone by exploiting a skill acquired and developed during school years.

Lecturer's intrinsic enthusiasm for mathematics

Jason referred to the enthusiasm that Lecturer B was bringing to the lectures through his teaching. He emphasised that this attitude reminded him of his school teachers: "[He is] funny but strict, very enthusiastic, very knowledgeable... he is similar to the teachers that I had and who inspired me." He described Lecturer B's classes as "shows" and he said that this was an important feature because he made students feel involved: "Sometimes anyway it's a show, it's a performance, and that's what you want in my opinion from a lecturer, you want to be engaged, you want to get lost in what they

are saying." This intrinsic enthusiasm for the content of mathematics was transmitted to the students through the use of particular examples. According to Jason, in this way Lecturer B demonstrated his love for the subject and that was actually making a difference between him and the rest of the lecturers. In order to emphasize his argument he contrasted this to Lecturer A's lectures: "I think as good as Lecturer A is, [she] can be very blank and very [much the] same, whereas you want [a bit] more theatricality, you want a story actually." He claimed that through the narration of a story-example the students were more willing to learn: "Picturing in your head more, you can understand it... I'm talking more of a story... If you are doing a problem you can picture him doing, you picture Lecturer B with the foot steps, you can picture you know every time I look at it, I think it was $\mathbb{Q}$ is dense in $\mathbb{R}$, so I can picture Lecturer B doing the steps and makes sense."

This strongly classified and framed message had a great effect on Jason's thinking. The strong control exerted through the use of the examples and the enthusiasm that Lecturer B brought through them made him follow and enjoy the lectures and also understand complex arguments and abstract concepts. By framing the concepts in this way, through lively stories and sometimes whole-body gestures, the lecturer transmitted his love for mathematics. According to Jason this was a rather powerful practice as it motivated the students and kept them engaged during lecture time. He felt comfortable with it, and to some extent this happened because it was already a part of his identity as a mathematics learner. The influence from his school teachers was noticeable once again and came to the fore when he recognised similarities in Lecturer B's teaching practices. The interaction with this message, which resembled school practices, positioned him in the transitional zone.

Things that students should do during lectures

In this category of messages Jason talked about the gappy and the written notes in Lecturer A's and Lecturer B's modules respectively, the discussion among students that take place in Lecturer A's module and finally the hand gestures used by Lecturer A during the lectures. I will explore them in more detail in the following.

Gappy notes and written notes

Jason commented on the gappy notes and the written notes that his two lecturers used. He did not make any particular comments about the use of the practice during the actual lecture time. He considered the gappy notes very good and useful for revising: "They are really neat I know where everything is, that is really good, that is what you want from notes, it will be great to do revision from..." Although Lecturer B used a more traditional way of providing the notes Jason did not seem to be bothered: "[With] Lecturer B isn't the same... but I don't mind at all."

As mentioned in Section 5.1, both messages transmitted with the use of gappy notes and the written notes were strongly classified and framed (with the gappy notes leaving also some space for the students to act independently). Here we observe Jason feeling comfortable with both of them. He did not comment extensively about them but he appeared to consider the gappy notes as a good source for revision and he did not seem to be troubled by the written notes. He was satisfied with both kinds of notes and by employing them he moved into the transitional zone where he enhanced his learning.

Discussion with peers

The mathematical conversation among peers was another message that Jason commented on. Although he recognised the message and he seemed to

understand the logic behind it, it did not prompt him to take any action at all: "I don't speak to anyone from the course, I go there and sit on my own and make notes. It's quite an arrogant thing to do but I find it most useful for me... I think is fairly obvious what the answer is and so I tend not to engage... in the conversation about the answer... I hate conversations around me, they are extremely silly, or stupid, or annoying, and I tend not to speak to people for that reason."

Jason recognised easily the strongly classified message. The high level of control conveyed through the message of involving students in mathematical conversations had no effect on Jason at all. He appeared to be very confident about himself and his knowledge and he did not consider important the exchange of ideas with his peers which resulted in the disregard of this message. For Jason mathematics is an individual task which he can complete successfully on his own. For this reason he felt constrained when he was asked to engage in mathematical discussions and he positioned himself in the discomfort zone.

Hand gestures

The last one of the messages in this category that Jason talked about was concerned with the use of hand gestures during the lectures. He claimed that this was the most important message that he had received from Lecturer A: "Lecturer A put a lot of emphasis on visualisation and physically using your body to represent things. Visualising in some form is a very useful tool. My best teachers at school always tried to make me visualise what was being said."

The high level of power facilitated the recognition of this message which Jason considered to be very useful. Additionally, the high level of control exerted through this strongly framed message reassured his identity as a

mathematics learner. This happened because once again Jason identified similar aspects between school and university practices. He felt comfortable with this practice which was familiar from school and positioned himself in the transitional zone where the use of hand gestures facilitated his understanding.

Assessment

Coursework

A striking contrast between Jason and the rest of the students who participated in the study was identified in the ways that they approached the coursework. Jason saw a challenge behind the questions included in the coursework and he was rather happy to work with it: "I like having a challenge to be set... and to go away and try it over. Even if I get it wrong and I get bad mark... I still enjoy... like the best example was Lecturer B's question 4d that was really good." Another thing that he commented on had to do with the group work that Lecturer B required for the second piece of coursework. In this case, like previously with the discussion amongst his peers, Jason preferred to work alone and not get involved with other people: "Even the group coursework I do it on my own... I know that if I find two other people to work with me I will end up doing most of the work and they will be doing nothing, and I'd rather do all on my own. It sounds really bad but for me, I'd rather work on my own than with other people." Moreover, he explained that he tried to find a person to be as passionate about mathematics as he was to work with but unsuccessfully: "I am looking for someone who is serious about it, about maths and enthusiastic... I've tried to find someone that was passionate..."

The way that Jason responded to this message highlighted to a great

extent his identity as a mathematics learner. On the one hand the weak control provided by Lecturer B with the use of coursework made him feel comfortable; he approached the coursework as a challenge that he had to deal with. By seeking answers to the questions on the coursework he widened his mathematical horizons and became more knowledgeable. Even when he could not find the correct answers he still enjoyed the control that he had over his learning, working on his own terms and exploring the new knowledge. On the other hand, the strong control exerted by the lecturer for working in groups made him feel constrained. He was not keen on being told how to work, he preferred to be consistent with his own ways of working, which he found most effective. Overall, his engagement with the coursework positioned him in the transitional zone.

5.2.3.3 Overall impact

The messages that carried low level of control and the messages that stemmed through practices which resembled the ones used at school were the ones that influenced Jason mostly during the first semester of his studies. In the first case (with the weakly framed messages) Jason had enough space to act independently and the interaction with these messages positioned him in the transitional zone. In the second case (where the messages were familiar to him from the school context) the messages already existed in his comfort zone and by receiving them in the university context he was eager to move into the transitional zone. Only on one occasion he remained in the comfort zone because the strongly framed practice (time-management) employed by Lecturer A existed already in his study habits. His identity as a mathematics learner built during the previous years through schooling played an important role in the interpretation of the messages. On certain occasions when

the lecturers framed strongly the transmitted messages (e.g. the message transmitted by Lecturer A through mathematical conversations) Jason felt constrained and positioned himself in the discomfort zone. In the following table (Table 5.4) I present an overview of the received messages and their influences.

Message	Classification	Framing	Positioning
Time-management ($M_{5.1}$)	$+$	$++--$	Comfort zone
Intrinsic enthusiasm for mathematics (M_6)	$+$	$+++$	Comfort/Transitional zone
Taking notes ($M_{1.1}, M_{1.2}$)	$+$	$++++$	Transitional zone
Discussion with peers ($M_{1.4}$)	$+$	$++++$	Discomfort zone
Hand gestures ($M_{1.3}$)	$+$	$++++$	Comfort/Transitional zone
Coursework ($M_{4.2}$)	$+$	$++--$	Transitional zone

Table 5.4: Messages received by Jason

Generally, Jason did not seem to face difficulties in the adjustment to the new context. The power of previous practices used at school, was fairly evident in his arguments and in the approaches that he followed at university. For instance, whenever certain practices made him feel comfortable at university (such as Lecturer A when she used hand gestures to visualise mathematical concepts, or Lecturer B with his enthusiasm about mathematics) he instantaneously compared them with the ones employed at school. Therefore, the impact from the received messages at university built upon the features of his identity as a mathematics learner, which was formed from the teaching-learning interactions experienced during the previous years through schooling.

The strong influences from his school mathematics teachers, and also

from his family, contributed to build Jason's mathematical identity. He preferred having the control over his learning and acting independently. This also explains the fact that most of his actions resulted from weakly framed messages. In the interaction with these messages his strong mathematical identity positioned him in the transitional zone. He did not seem to feel any kind of discomfort in the new setting except for when he was asked to work with other people which contrasted his belief about mathematics being an individual task. His final score in Module A was 69 % and in Module B 66%.

5.2.4 Jeremy's narrative

Jeremy chose to study for a mathematics degree because he enjoyed the subject: "I like mathematics and I am good at it." One of the main influences for his choice comes from his family environment and more specifically from his uncle who is a mathematics teacher. Before coming to university Jeremy expected that studying mathematics at this level would require independent work. This view was confirmed when he started the degree: "I think sort of like it's going to fall more on to you, whereas I went to sixth form and it was quite supportive, so the teachers got you to do things and things like that. Whereas when I came here was a bit sort of, everything is... on you. And there wasn't... like they were not forcing you to do stuff..."

In the next section I will present some features from his background experiences of the learning of mathematics which I consider significant in the formation of his identity as a mathematics learner. Moreover, I will describe the interaction of these aspects of his identity with the transmitted messages at university and the extent to which these influenced his adjustment to the new setting.

5.2.4.1 Background information

Jeremy's decision to study mathematics at university was based on his ability to do mathematics as he stated in the first questionnaire. Another influence came from his family: "My uncle is a maths teacher, and that's why I am doing the four years master's instead of just a bachelor... I am quite competitive, he had the best degree in the family so I wanted to try and beat that."

During his time in the sixth form he took A Level Further Mathematics but he never considered that it was particularly difficult. He expected mathematics at university to be about solving real world problems, proving lots of theorems and more abstract ideas, which eventually it was like that as he said. Moreover, Jeremy considered the learning environment in the sixth form more supportive. Early enough in the semester he realised that in the new context the responsibility for learning rests with the students. He reported that he was prepared for this change, as his school teachers had already informed him about the level of difficulty and the level of independence that university mathematics would require: "...my teachers were like: 'It's going to be harder... here at A level we sort of help you but at university it is sort of more independent you have to do your own stuff...' " This was reaffirmed from Lecturer A during the first week at university, who told the students that from that point onward the responsibility for their learning would fall more on them than the lecturers.

The most important message that Jeremy received during the first two weeks of the semester referred to the level of difficulty of the degree: "It's hard, so don't give up." Later in the semester, during our discussion he expressed his thinking about that: "...most people think maths is a hard subject and it's not really that hard as long as you process things and you just

have to keep going that's it and because the jump from A level to university is a bit bigger it's going to be harder to understand the stuff quite as well as you did at A level so you just kind of have to keep going at it until you get it."

5.2.4.2 Experiencing university mathematics

During our discussions Jeremy talked about the things that students should do during and outside lecture time, the assessment practices and the general study habits that need to be adopted at university level. I explore these four categories in more detail below.

Things that students should do during lectures

In this category of messages Jeremy referred to the the gappy and the written notes that Lecturer A and Lecturer B used respectively, and the discussion among peers that Lecturer A encouraged during her lectures.

Gappy and written notes

Jeremy talked about the practices that the lecturers used during the lectures, and more specifically the writing of the notes: "It just keeps us sort of more attentive... in some of the modules that we don't write that much I am sort of falling half asleep trying to keep up..." Although the two approaches differed between them significantly, Jeremy (like many other students that commented on the notes) identified them as the same. This happened because in each case, no matter how the material was delivered, he had to write down, either by filling out the gappy notes or by copying the notes from the board. The practice of writing the notes kept him attentive during lecture time in contrast to the modules in which this technique was not used.

Despite the fact that the motivation behind the use of these two practices

was completely different, Jeremy recognised them as the same. As I presented in Section 5.1 Lecturer A employed the gappy notes because she wanted the students to be part of creating the notes, make their own version and interact. On the other hand, Lecturer B used the written notes because he wanted his students to see how things emerge. Both practices were strongly classified and this made them easily recognisable and understandable. They carried both a high level of control, with the only difference being that with the gappy notes there was also some space provided to the students to treat them the way they considered to be more helpful for their learning. In the interaction with this strongly framed message Jeremy's identity played an important role; he considered it helpful to write down the notes during the actual lecture because in this way he was more attentive. Both practices made him feel comfortable and contributed to his positioning in the transitional zone.

Discussion with peers

The mathematical conversations among students is the next thing that Jeremy talked about. He expressed his dislike for this practice used during Lecturer A's lectures: "I don't really like to speak to people when she says speak to people I just sort of sit alone I just read through it... and when she gets there I can't be bothered to go through it 'cause I've just gone through it..." Every time Lecturer A invited the students to engage in discussions on different mathematical tasks Jeremy chose not to get involved. Instead he tried to go through each given task and think about it himself. Despite the fact that he did not like the practice, he reported that he understood why the lecturer employed it; it helped students to exchange ideas and explain things to each other that might seem difficult in the first place. Jeremy admitted that he was not the "talking type" of person and this is why he did not like discussing with his peers.

The practice was comprehended by Jeremy due to the high level of power that it carried. Moreover, it is evident that the high level of control transmitted with the use of this practice eventually did not have an impact on Jeremy's ways of working during lecture time. Although he understood why such a practice was proposed by the lecturer, and its benefits on students' learning, he considered it not appropriate for him. The high degree of control conveyed through this message conflicted with his identity and constrained him. Jeremy did not feel comfortable to engage in conversations with other students. He felt rather confident of himself and his mathematical knowledge and he considered that going through the tasks alone, without the help of other peers, could still build his understanding. Being asked to work with others moved him into the discomfort zone which he avoided by ignoring the message.

Things that students should do outside lectures

Problem sheets

Jeremy recognised that working with the problem sheets is the main thing that students should be doing outside lectures. He found unusual though the fact that the lecturers did not provide the solutions at the same time as they provided the problems: "[It is] sort of weird I guess 'cause it is not what I am used to and it is a bit harder to know whether I am right or not but I suppose in a way it is sort of good 'cause it gets me to check back over what I've written and make sure what I have written is correct..." He admitted that he did not work with the problem sheets for two reasons. Firstly because when he was at school he was not used to doing any work outside the lessons: "I never really did work when I was at sixth form... [I] did the work in the lesson." And then because the problem sheets were not getting marked:

"...now that they don't check really that you do the problem sheets and stuff I'm just like: I am not doing them." The only work that he did do outside lectures was spending some time re-reading the lecture notes. He felt quite confident about himself and his understanding because he understood the concepts that were taught during lecture time: "It's because when they were going through the lessons I sort of understood... what they were doing, so I didn't really feel the need to do much of the homework."

The influences from the school habits which contributed to the formation of his identity were obvious in Jeremy's response to this message. The way he thought he should be working at university was affected by the fact that at school all the work was done during the lessons. Another influence came from the lack of control transmitted through the practise of using the problem sheets. Both lecturers gave space to the students to decide whether and how they would work with the problems. Jeremy took control over his learning and decided to ignore the problem sheets, at first because they were not marked and then because he thought that he had grasped the meanings during lecture time. Therefore, he believed that he did not need to practice further afterwards despite the fact that he recognised some of the benefits of working with the problem sheets, such as becoming more independent as a learner. Jeremy seemed very decisive and confident of himself and the choices that he made regarding his learning. The transmitted message did not prompt any kind of movement between the zones. Jeremy remained in the comfort zone where he was happy with his choices regarding the ways of working.

Assessment

Coursework

As we saw above Jeremy did not work outside the lectures with the problem sheets. He did work though for the things that were assessed, such as the coursework: "...with the coursework because I know it will be assessed and it will be marked so it is better for me to do it early so that I have enough time to make sure it is right instead of not doing it and just leaving it the last minute..." Whenever he faced difficulties with the coursework he used to access the facebook group chat where his peers were discussing different mathematical tasks or to ask his neighbour who was also studying mathematics: "Well most of the times if I am unsure there is a facebook chat for freshers... some people ask usually quite common questions and the stuff I get stuck with usually is within there so I usually go through that or I'll go ask the guy downstairs. In case I am really stuck and confused."

The message conveyed with the use of coursework was strongly classified but weakly framed, and this provided the students with a lot of control to manage it the way they considered most appropriate. It is apparent that Jeremy took over this control and tried from early on to work with the coursework. A strong motive behind his effort was the power of the exchange value that the coursework carried. If it was not marked he might have ignored it and would not have put in work as he did with the problems sheets. Furthermore, although previously he was not keen on talking to other peers he changed his mind when he needed help for the coursework. In that case he attempted to approach other students and ask for help. In the interaction with the received message his identity was reassured; by working for the coursework he enhanced his knowledge of the subject and positioned himself in the transitional zone.

General study habits

Keep up / Do not fall behind

One of the messages that Jeremy considered as very important was concerned with the advice regarding study habits: "...the jump from A level to university is a bit bigger it's going to be harder to understand the stuff quite as well as you did at A level so you just kind of have to keep going [with] it until you get it." Jeremy received the message about the continuous effort that students should put in to keep up. His interpretation was that students should not give up when they would realise how big is the jump from school to university mathematics. Instead they should keep trying until they acquire an understanding. Despite the fact that he acknowledged the importance of the conveyed message he did not take any kind of action from it: "...usually I don't put in that much effort to most of the work... I don't really do as much as I should... Sort of just because I am quite lazy... I can't be bothered to do it."

The strongly classified message transmitted by Lecturer A was received by Jeremy. The degree of control that this message carried was rather weak. Jeremy's interaction with the transmitted message resulted in him ignoring it. He chose to disregard the information that the lecturer gave and preferred to follow his own way of approaching his learning. There was no action prompted by this message and Jeremy positioned himself in his comfort zone where he remained idle.

5.2.4.3 Overall impact

In Jeremy's story there were no big influences from messages transmitted by the lecturers. In most of the cases when he talked about the messages that he received (regardless of the degree of power and control that they

carried) he described how he ended up ignoring them. All the work he put in for the degree was motivated by the exchange value of the coursework or the examination at the end of the semester. In certain cases there was an apparent impact from the school practices in his thinking regarding the study habits, such as when he referred to the work that was expected of the students outside lecture time (at school all the work was done during the lesson, at university there is work that needs to be done outside lecture time).

The messages that Jeremy discussed in our meetings and the extent to which these messages influenced him are presented in the following table (Table 5.5).

Message	Classification	Framing	Positioning
Taking notes ($M_{1.1}, M_{1.2}$)	$+$	$++++$	Transitional zone
Discussion with peers ($M_{1.4}$)	$+$	$++++$	Discomfort zone
Problem sheets ($M_{2.1}$)	$+$	$++--$	Comfort zone
Coursework ($M_{4.2}$)	$+$	$++--$	Transitional zone
Keep up ($M_{5.3}$)	$+$	$++--$	Comfort zone

Table 5.5: Messages received by Jeremy

In the narration of his story Jeremy exhibited many features of his identity as a mathematics learner. He always seemed very confident about his mathematical knowledge and abilities and he made clear from the beginning that his laziness was keeping him from putting in work for his studies. This realisation made him proactive to study in advance for the things that were assessed, like the coursework and the examination at the end of the semester. This was also emphasised towards the last phase of the study. He argued that the most important thing for him, which he realised himself and it was

not some kind of information communicated from his lecturers, was to put in work for the examination: "Do work really, which I haven't been doing... do your work... I guess 'cause I know the exams are coming and I have just been looking at the questions on the past exams papers and I don't really know as much as I should do for these questions. Just sort of just do work."

Jeremy received a variety of messages from his lecturers, both weakly and strongly framed, which did not influence him in any significant way in settling in at university. Although he recognised the messages he reported that they had no impact on his learning. This is why he ended up disregarding many of them. In Jeremy's case, the confidence that stemmed from his mathematical abilities and his self awareness in general, led him to follow his own path in the new setting. His main motivation to move along the zones and integrate in the new context was one, to achieve good marks at the end of the semester, which he eventually did. Jeremy scored the second highest mark among the participants of the study in Module A, 73% and a bit lower in Module B, 69%.

5.2.5 Eric's narrative

Eric described how much he loved mathematics since childhood: "I've always wanted to do maths from a young age". He was uncertain about which career path to follow and thus his decision was influenced by the career prospects that a mathematics degree offers: "[The most influential factor for my choice was] the career options and not being refined to [sic] early." He expected mathematics at university to be like A Level Further Mathematics but he realised early enough in the semester the differences in the content between the two contexts: "... [it] was probably stupid from me but yeah, I think for the theory side is just throwing [us] to the deep end but yeah starts to come

through but yeah it was definitely a setback when I did realise it was not just Further Maths."

In the next subsection I present the most significant aspects of his identity as a mathematics learner which influenced the interpretation of the received messages during this phase. Moreover, I explore the messages that he referred to during the interviews, in what ways the interaction with these messages was influenced by and influenced his identity and finally what was the impact on his transitional experience.

5.2.5.1 Background information

During our discussion Eric explained that he had an interest in the subject of mathematics since he was at school. When he was called to decide which degree to follow he considered seriously the job opportunities that a mathematics degree provides: "I don't actually know what I want to do career wise, and I know I've always loved maths... but I think since I've been here I've kind of leaned towards finance because I am not certain what I want to do. So some courses like banking and finance that's the career path I think I haven't fully decided yet. So I think that was the career options like, also the breadth of what I can choose and it's not just limiting me like some degrees do and that was a core reason for me choosing maths as well."

During his time at sixth form Eric had taken A Level Further Mathematics and there were times that he found the content particularly difficult. On such occasions he sought help in textbooks and on the internet. He used to work often with his friends while doing mathematics. Before starting the degree he expected studying mathematics at university to be about solving real world problems, proving lots of theorems and more abstract ideas. Eventually it was not as he expected it to be. He was especially troubled

with Module A: “Module A is horrible, only module which [it] wasn’t what I expected.”

His expectations were highly influenced by his school teachers. Eric argued that at school students were misled to believe that the mathematics degree would be similar to the content of A Level Further Mathematics and that school mathematics would contribute to students’ understanding during the first year at university: “...everyone thinks when you do Further Maths [that] you are going to find the first year so much easier... but it’s a common misconception I think, like teachers everyone just told me that.” At the beginning of the semester he felt rather uncomfortable in the university context; the proofs, the theorems and the definitions were hard to understand and distressed him: “...at first... it was kind of scary all these new notations... it is a whole different language.”

Despite the aforementioned misconception, regarding the content of mathematics, Eric reported that the school teachers informed the students accurately about the independent study required at university level: “I think it has been always told to me... through sixth form... like: ‘You need to start studying independently now because when you go to university you only get a few contact hours...’ I think I was prepared to definitely work by myself...”

The most significant difference that Eric recognised in the content of university mathematics was that the modules were more theory driven compared to school: “...they teach you the theory of it from the start. Whereas like with maths at school you kind of did a problem, they showed you how to solve it and then maybe talk briefly about it... so applying theories is quite different from the start.”

Eric mentioned that the amount of money that he paid for the degree was one of the reasons that motivated him to be consistent with his studies: “I

try to go to as many [lectures] as I can... paying nine grand of your money as well kind of influences how much you go [to the lectures]..."

5.2.5.2 Experiencing university mathematics

In the interviews Eric commented on four of the categories of the transmitted messages. He talked about the assessment practices, the things that students should do during and outside lectures and, the advice regarding the study habits. Bellow I will explore in more detail his interaction with these messages and the influences upon his transition.

Assessment

Class test

In one of our first meetings Eric talked a lot about how hard it was for him to comprehend the content of Module A and to do the required job. In the following meetings he explained in depth the reasons that were causing his distress and made him consider that Module A was "horrible": "I had a test the next week [of when the focus group met], was quite tough for me... I was quite worried... everything was so tough for me..." Although initially he struggled eventually he put in work for the tests. This happened because he listened to Lecturer A's message: "I think Lecturer A said it, she does tests but she makes them [the tests] weighted, so we actually put work in..." This was the main reason that made him cope with the work: "Makes me take it a little more seriously, means I put in the work that I might not have done otherwise..."

Eric perceived easily the strongly classified message transmitted by Lecturer A. The high degree of control that the message carried with the use of class tests affected his thinking about how he should be working. The

exchange value of the mark that the test offered was what eventually formed his priorities. Despite the fact that at the beginning he felt constrained by the time limits and the workload that came fast at once, by receiving this message from his lecturer he acknowledged that he had to try harder in order to succeed in the module. Although initially the differences between the two contexts positioned him in the discomfort zone the interaction with the class tests prompted him to become more proactive towards his learning and to move into the transitional zone.

Coursework

Eric described how important it was for him to prioritise the coursework. Through the engagement with this practice he realised that he had to become more independent over his learning. He recognised as the "biggest difference" between the two educational settings the fact that at school all the work was done during the lessons: "But I think the coursework is... the biggest difference. [At A level]... was kind of cram it all in... whereas here I have a better understanding of what I need to do... I find myself doing a lot of work... I wasn't doing work home back at school... I was just doing everything at school."

The high degree of power conveyed through the use of coursework made the message fairly comprehensible. In the interaction with this message Eric considered it important to prioritise the coursework because of its exchange value. The weak framing exerted by Lecturer B, over the sequencing and pacing of the coursework, made Eric realise that he had to become more independent and to take control over his work. By doing so he was able to recognise one of the biggest differences between the practices used at school and university mathematics. The received message prompted him to take action over his learning and moved him into the transitional zone.

Things that students should do outside lectures

The independent work that students were required to do outside lecture time was another topic that Eric referred to during the interviews. Initially he expressed his concern about not being able to handle all the things that the lecturers expected the students to do, in addition to the responsibilities that the new way of living alone imposed: "...last week I had three tests or something and now I've got two courseworks, I've got the test next week. That [is] the only problem I'd say, 'cause everything is going on and I'm struggling to prioritise. [...] I think I struggle for time... 'cause I'm self-catering, so I'm cooking, I have training 4-5 times a week I just don't find places to fit it in and then I'm waking up late... That's a big issue, I'm not waking up until 10:30. Yeah, I am struggling for time..." Later in the semester when we talked again about this issue, he mentioned that by that time he was more used to the university routine: "My body clock got a bit better... I find myself less tired and being more efficient with my time I think."

Problem sheets

Eric chose not to work with the problem sheets because they were not assessed: "Yeah [I] kind of forgot about the problem sheets... I have to go back to them but I think that is something I am planning to but when I am going to is another question. But I have the break to go through the problem sheets... I am not getting marked for it so I am not going to... I've got better things to be doing or more important things." Although he was determined about his engagement with the problem sheets at the end of the semester he changed his mind. He said that the message transmitted with the use of problem sheets inspired him to change his ways of working: "[I would] try

and keep up with the problem sheets".

The high level of power transmitted through this message made it easily recognisable, Eric talked often about the problem sheets in our meetings. Regardless of the fact that he did not work with the problem sheets, he understood that it was beneficial for his learning to do so. The weak control exerted though this message, by both lecturers, gave him space to choose and act independently. His choice was to disregard the problem sheets and prioritise the things that were getting assessed. At the end of the semester he eventually realised that working with the problems it was an indispensable part of the degree. The interaction with this message positioned Eric in the discomfort zone; despite the fact that he ignored the message in the long term he acknowledged that his performance would have been better if he had worked with the problem sheets.

Things that students should do during lectures

Discussion with peers

Another message that Eric received from Lecturer A was about the mathematical discussion among peers during lecture time: "...I found talking through stuff working actually... it goes really well for me, it's not something I necessarily did back at school... I've changed massively I think... doing much stuff like working in groups... taking all in and trying to see what works best." Eric considered this practice beneficial and he thought that it changed the ways he used to work for mathematics. He added that by engaging in discussions during the lectures he overcame his initial struggle with Module A, and changed his mindset regarding what mathematics really is about: "...thinking about maths it's not just black and white... but I think I've come around to a better understanding [of] proofs... [by] engaging in

the lectures..."

Eric felt really uncomfortable when he started attending Module A; at the beginning of the semester he talked about "a different language" which is used in this module. The high level of power conveyed through this message made it easily recognisable. Additionally the strong control that Lecturer A exerted by inviting regularly the students to engage in mathematical conversations helped Eric to alleviate the initial difficulties that he had with this module. Not only did it contribute to his understanding, but it influenced his whole thinking about what mathematics is. By employing this practice and having mathematical discussions with his peers, Eric became more engaged, he moved from the discomfort zone to the transitional zone and managed to reshape his identity as a mathematics learner.

General study habits

In this category of messages Eric referred to two of them; the time-management and the fact that it is ok when students do not comprehend everything straight away.

Time-management

Eric talked about the message that Lecturer A conveyed regarding management skills of the study time. He recognised and perceived the message but he admitted that he did not use the time-management reading section that Lecturer A gave to the students: "...I haven't read it... I haven't been given any advice on time-management from anything else apart from that." Despite the fact that he struggled to organise his time when he first arrived at university he disregarded the message. Later in the semester, during the interview he reported that he figured out himself how to be more efficient.

The high level of power transmitted through this message contributed

to make it easily comprehensible. At the same time though, the low level of control that the message carried led, as a result, to it being ignored by Eric. As I described earlier, his initial struggle with the workload and all the new requirements distressed him and positioned him in the discomfort zone. Eric was not willing to alleviate these difficulties by taking action from the message transmitted by Lecturer A.

It's ok if you don't understand everything

At the beginning of the semester Eric expressed many times his struggle with Module A and how different it was from what he expected mathematics at university to be. As the semester progressed he justified his view and he explained that what made him mostly struggle was the amount of proofs which was expected to be mastered by the students. At that point he recognised that Lecturer A advised the students to not feel bad when they did not understand everything straight away. This advice conflicted with his previous experiences of school mathematics and prevented him from taking any kind of action from this message: "I think it's been the amount of proofs we get set on us... Lecturer A does say I am not expecting you to understand it but I think that was difficult for me to comprehend as like with school they expect you to understand it and that's it..."

Despite the strong power that this message carried it was not enough to make it prevail against the information received during the school years. It is apparent here that the impact from the school practices was still influential on Eric's thinking regarding the learning of mathematics. He considered it natural to understand everything instantaneously and this perception did not leave any space for Lecturer A's advice to affect him. The weak control conveyed through this message contributed also to its disregard by Eric. He felt constrained engaging with Module A and positioned himself in the discomfort

zone. Interestingly, the conflict between the two messages (the pre-existing one acquired in the school context and the one received at university) did not help him to move from the discomfort zone to the transitional zone.

5.2.5.3 Overall impact

The messages that had an impact on Eric's transitional experience were the ones carrying a high level of power and control. Additionally, he paid great attention to the messages conveyed through the assessment practices. In the narration of his trajectory from school to university mathematics it was evident that his thinking regarding what mathematics is was highly influenced by the practices employed during the school years. In the following table (Table 5.6) I demonstrate the messages that Eric received from his lecturers and the impact that they had on his adjustment to the new setting.

Message	Classification	Framing	Positioning
Class test ($M_{4.1}$)	$+$	$++++$	Discomfort/Transitional zone
Coursework ($M_{4.2}$)	$+$	$++--$	Transitional zone
Problem sheets ($M_{2.1}$)	$+$	$++--$	Discomfort zone
Discussion with peers ($M_{1.4}$)	$+$	$++++$	Transitional zone
Time-management ($M_{5.1}$)	$+$	$++--$	Discomfort zone
It's ok if you don't understand ($M_{5.4}$)	$+$	$++--$	Discomfort zone

Table 5.6: Messages received by Eric

As illustrated in the table above in different occasions Eric moved from the discomfort zone to the transitional zone. This movement between the zones was a result of certain actions that he took from strongly classified and

framed messages. As it has happened with the message transmitted by Lecturer A regarding the mathematical conversations among peers, where he was prompted to engage in conversations and enhance his learning. Only on one occasion did he take action from a weakly framed message; the one that Lecturer B transmitted with the use of coursework. In this particular case the influence from this message can also be explained by the exchange value that the coursework offered.

Eric felt often constrained with the content of university mathematics and with the new learning practices. This resulted in his positioning in the discomfort zone. The most representative of these occasions was when he talked about the attendance of Module A which he characterised as "horrible". Despite the advice offered by his lecturer about how to deal with the new learning habits and practices, his school experiences were rather strong and prevailed which eventually prevented his movement into the transitional zone.

Overall Eric faced various difficulties during his transition. He was rarely prompted to take actions from messages. In the final examination of the semester he achieved 45% in Module A and 75% in Module B.

In the next chapter I will discuss the results of the study which I presented here.

CHAPTER 6

Discussion

The aim of this thesis is to explore in what ways and to what extent the messages conveyed through the teaching-learning interactions can influence first year undergraduate students' transition. I focused my attention on the information that the lecturers transmitted to the students regarding university mathematics and its learning.

In order to investigate this I posed the following research questions:

- How do students interpret the different messages they receive within the university community?
- How are these interpretations shaped by their individual backgrounds and previous experiences?
- How do they facilitate or hinder students' transition?

With the identification of the underlying structures of power and control of each transmitted message I explored their link with the ways that students interpreted the messages. The interpretation of the transmitted messages was mediated through students' identities as mathematics learners which allowed them to position themselves in the new context in particular ways. This positioning was related to the degree of power and control conveyed through the teaching-learning interactions. Students felt either comfortable or constrained in the interaction with the new practices and this had the following outcomes:

- They either took no action from a transmitted message and stayed in their comfort zone or,
- They took action from a transmitted message and moved from their comfort zone into the transitional zone or,
- The changes in the new context distressed them and moved them into the panic zone. In this case they either moved into the transitional zone or they stayed in the discomfort zone and tried to find ways to overcome the difficulties

In the following I will discuss each transmitted message separately based on the categories shown in Figure 5.1 (page 136). I will start with the first quadrant which includes the messages that are strongly classified and framed, beginning from message M_6 (Lecturer's intrinsic enthusiasm for mathematics) which carried the highest degree of power and control among the transmitted messages. I will then continue clockwise with the fourth quadrant which includes again strongly classified but weakly framed messages.

The discussion section consists of six parts - corresponding to the number of message categories. In each one of these parts I will present the transmitted

message and the underlying structures of power and control that it carried. Then I will discuss students' interactions with each message, mediated by their identities, and the consequent actions that each student took in relation to their transition. Finally, I will link these findings with the current literature and I will answer the research questions.

6.1 Lecturer's intrinsic enthusiasm for mathematics M_6

As described in Section 5.1.6 this message was transmitted by Lecturer B. It carried a high degree of power and control and was discussed by three of the participants during the interviews. Lecturer B with his positive attitude and the use of lively examples managed to transmit to the students his enthusiasm about the content of university mathematics and also to make abstract concepts more easily comprehensible. The strongly classified message was easily recognisable by the students and the high level of control that it carried regulated their thinking regarding their engagement with mathematics at this level. Previous literature confirms the effect of this positive attitude on students' learning. As Pritchard (2010, p. 618) reports teachers who express a "strong ethos of enthusiasm, organization and self-discipline" may affect how seriously students will take their work.

Emily reported that the lecturer, through the use of these examples, made his enthusiasm for mathematics explicit. At the same time, he put into context concepts that were initially hard to understand. In this way he facilitated students' understanding. The interaction with this message made Emily feel comfortable as it brought to the fore her beliefs regarding mathematics being a joyful activity. Therefore, by engaging in the lectures where these exam-

ples were used her learning was enhanced and she positioned herself in the transitional zone.

Similarly, Elsa and Jason mentioned how the lecturer's enthusiasm kept students attentive and focused during the lectures. Elsa said that although she considered him a traditional lecturer, by employing these "funny stories" in his examples he could make counter-intuitive concepts immediately comprehensible. Moreover, Jason stressed the importance of having mathematics teachers like him, whose lectures are like a performance, because in this way students can remain engaged with the learning of mathematics.

Elsa as a student was open and willing to take action from any kind of message that the lecturers transmitted (regardless of the degree of power and control that it carried) as long as she considered that this was enhancing her learning. For instance, with the transmission of this message she admitted that by seeing how enthusiastic Lecturer B was she was motivated to be more engaged during his lectures and therefore she moved into the transitional zone.

In Jason's case, his identity played an important role in the interpretation of this message. He compared Lecturer B's enthusiasm with his school mathematics teachers who inspired his love for the subject. In this way his identity as a mathematics learner was reassured and he moved into the transitional zone.

The importance of motivation and enjoyment in the learning of mathematics is an issue often discussed in the literature. Solomon (2009) talks about a decline in enjoyment reported sometimes by students who chose to study mathematics at university level. A reason for this is considered to be students' belief that the content of university mathematics will be similar to the content of school mathematics. Students who believe this lose their moti-

vation when the work at university becomes harder and they face difficulties in the adjustment to the new context. The results of my study complement Solomon's (2009) findings and show the other side of the coin. None of the participants who talked about Lecturer B's enthusiasm expected university mathematics to be similar to the school ones. More specifically, Jason expected university mathematics to be a challenge and both Elsa and Emily expected it to be harder than school. All these three students in the interaction with this strongly classified and framed message managed to engage in the lectures, understand difficult concepts and to identify the joy in doing mathematics which eventually positioned them in the transitional zone. Moreover, these results confirm previous work in the field by Hernandez-Martinez et al. (2011b), where the authors argue that many students in their study expected the transition to be a challenge and when supported appropriately by the institution, they relished it. Similarly, in this case we can see how the lecturer's use of vivid examples and his enthusiasm scaffolded the challenge of university mathematics. This is apparent through these three students' narrations each of whom identified the message and moved into the transitional zone.

6.2 Things that students should do during lectures

The next category of messages to which I will refer is also positioned in the first quadrant in Figure 5.1, which means all of these messages are strongly classified and framed. For each transmitted messages I will give students' most characteristic responses, and I will discuss the influences upon their transitional experience.

6.2.1 Gappy notes $M_{1.1}$

With the use of gappy notes Lecturer A wanted her students to develop certain types of thinking, to be active and engage in the notes construction by interacting with her and amongst themselves. The high level of power and control transmitted through this practice made the transmitted message clear and directed students' thinking regarding how they should be performing during lecture time. Nevertheless, on particular occasions the lecturer tried to be less controlling, and gave some space to the students, by inviting them to treat the notes the way they thought most appropriate.

Although the lecturer designed the notes in this particular way for the aforementioned reasons, many of the participants that commented on them focussed mostly on the fact that they had to write down. More specifically they considered this practice similar to Lecturer B's practice, where he expected the students to copy the notes from the board. Two of the students, Owen and Kenny, referred extensively to the gappy notes. They mentioned that by employing this practice Lecturer A showed them that she cares about how they learn; they had enough time to think and to acquire understanding during the actual lectures. In this way it was easier for them to grasp the concepts and they felt more motivated to put in work.

More specifically, for Owen the content of Module A was rather difficult to comprehend because initially he thought that university mathematics would be a continuation of school mathematics. The fact that Lecturer A used the gappy notes and on particular occasions gave the students the choice to focus on thinking and to catch up with the writing later, made him feel that he had the chance to understand the concepts during lecture time. In the interaction with this practice Owen enjoyed the space provided by the lecturer; he overcame the initial discomfort with the difficulty in the content

of the module and by taking advantage of this space he devoted his time to grasp the concepts and eventually to move into the transitional zone.

On the other hand, Kenny seemed to enjoy entirely the high degree of control exerted through the use of gappy notes. He mentioned that with the tasks included in the notes he was able to know whether he was performing well or whether he was at risk of failing, and he emphasised the fact that he did not have the chance to do the same in the rest of the modules. This control made him feel safe; by being explicitly told what he needed to be doing (e.g. what to read, which problems to work on, etc.) he got the feeling that he was able to keep up with the module. The interaction with this message moved him into the transitional zone, because by engaging with the construction of the gappy notes he "picked-up quicker".

Pritchard (2010) stresses the importance of "modern presentation methods" (such as provision of suitable handouts) in the delivery of lectures which can affect students' interest during classes. Something similar happened also with the use of the gappy notes. In this case, the lecturer not only attracted students' attention by using the gappy notes but most importantly, with a slight variation in the degree of control that she exerted she influenced differently students' thinking regarding how they should approach mathematics during lecture time. The different actions that the students took from the engagement with this practice emphasised how their identities played an important role in the interpretation of the message and consequently in their positioning. Owen is the kind of student that needs to process the concepts while they are taught and prefers to devote time to the writing of the notes later. Thus, when Lecturer A offered the students this choice he felt benefited. Kenny on the other hand, is the type of student that enjoys being controlled in his learning. With the use of gappy notes he has designated by

the lecturer what exactly he needs to write down, what is exactly the reading that he must do, etc. This makes him feel safe and comfortable because he does not have to take any initiative himself. Hence, through these two examples we see that it is not only the design and the use of new practices that we should take into account when considering how to get students well involved in the lectures. We should also account for students' agency and the space that each one of them needs in order to get involved.

6.2.2 Written notes $M_{1.2}$

During his course, Lecturer B expected the students to copy the notes from the board because he wanted to demonstrate to them how the mathematical knowledge emerges and what is the logic behind the taught concepts. Moreover, he considered that the students would be more attentive and pay attention to him by listening and copying from the board. The high level of power that the message carried made clear to the students from early on in the semester what they were supposed to be doing during the lectures. With the use of this practice the control rested with the lecturer and this affected students in different ways.

On some occasions students were just happy copying the notes and admitted that in this way it was easier for them to pay attention to the lecture. A characteristic example of such cases was Carin who said that copying what the lecturer was writing on the board while he explained it at the same time, was her favourite way of getting the lecture notes. She explained that this practice was familiar, as it was used in the school mathematics classroom, and this fact made her feel comfortable. The familiarity of the practice made her engage more easily with the copying of the notes and thus she moved into the transitional zone.

However, there were also students who struggled with the use of this practice because they could not find easily a balance between writing and understanding at the same time. For instance, Emily described the difficulties that she initially faced while attending this module. She said that she was not able to copy the notes and to concentrate simultaneously upon what the lecturer was teaching. This struggle was enhanced by the fact that she is dyslexic. To overcome the encountered difficulty she focused on the examples that the lecturer used while writing, which as she claimed, were rather useful for the coursework. Thus, by becoming more strategical and paying more attention to the written examples she overcame her struggle and moved from the discomfort zone to the transitional zone. The benefits from the use of examples in the learning of mathematics is supported in the literature. There is recent evidence which suggests that the understanding that students gain from the worked examples can be transferable to different kinds of problems (Pritchard, 2010).

Owen also expressed his struggle with this particular practice. The content of the module was completely different from the content of school mathematics and the lecturer's writing pace was rather fast for him. In order to deal with this he devoted more time outside the lectures going again over the material taught to comprehend the concepts. The high level of control exerted through this practice constrained Owen who needed more space during the lectures in order to enhance his understanding. As a result, this positioned him in the discomfort zone where he tried to find ways to alleviate the encountered difficulties.

All of the students that attended Module B followed this practice. The lecturer's view about students being attentive during lectures by writing down the notes is confirmed by previous studies in the field (for instance

Pritchard (2010)). The high level of power conveyed through the use of this practice put clear boundaries regarding how students should act during lecture time and regarding how they would get the notes for the module. Carin's response in this particular message contrasts De Guzman et al.'s (1998) study where the authors argue that a common difficulty for new comers at university is that they do not know how to take notes. Moreover, through her example this study stresses the importance of how previously used practices are crucial in the shaping of students' identities as mathematics learners. Carin explained that copying from the white board was a practice used widely at school and it was a "natural" thing for her to do the same at university. Her story emphasises also the extent to which previously used practices can have great influences on students' further trajectories (e.g. Carin did not struggle with the use of this practice compared to other students for whom it was entirely unfamiliar).

On the other hand, both Emily's and Owen's case confirm Gueudet and Pepin's (2016) work which emphasises the link of the new didactic contract with the use of and interaction with the different resources employed at university. Hence, how students make use of the different resources is shaped by the new didactic contract and further it shapes the mathematics they learn. For instance, in the interaction with this message Emily became more strategical and tried to find ways to benefit from the practice. Owen though remained constrained from the strong degree of control and attempted to engage with the notes in his own terms outside lecture time. Therefore, we see here how the high degree of control motivated Emily to find ways to deal with her initial difficulties with the writing of the notes, and at the same time restrained Owen who sought alternative ways to comprehend the material taught outside the lectures. This emphasizes the extent to which the

degree of control exerted through a lecturer's practice leads the students to take different actions influenced by their identities as mathematics learners.

6.2.3 Hand gestures $M_{1.3}$

By transmitting this strongly classified and framed message regarding the representation of mathematical concepts with the use of hand gestures, Lecturer A made explicit how the use of hand gestures contributes to students' learning. Moreover, by regularly inviting the students to gesture more she attempted to regulate their thinking about the benefits of this practice. The students who talked about it commented on the advantages that they recognised in their learning with the use of hand gestures.

Jason mentioned that he found the visual and physical representations as a useful tool for his learning. He expressed his familiarity with this practice which was used by his "best" teachers back at school who encouraged him always to visualise what was being taught. In this way by recognising the benefits of a familiar practice, which comprised already an aspect of his identity as a mathematics learner, he managed to move from his comfort zone to the transitional zone. Similarly, Owen identified the gesturing as an aspect of his identity and he described himself as a 'visual learner'. The strongly framed and classified message transmitted through the use of hand gestures helped him to deal with his initial struggle with the content of Module A and moved him from the discomfort zone to the transitional zone.

The benefits of the use of hand gestures on students' learning has been confirmed by numerous researchers. Biza, Giraldo, Hochmuth, Khakbaz, and Rasmussen (2016) report on various studies that consider the use of gestures during teaching as an important aspect in the communication of mathematical ideas. The same is apparent in this study with the strongly classified and

framed message conveyed by Lecturer A which regulated students' thinking and advantaged their learning. Interestingly, the students who were significantly influenced by this message and talked in detail about it were the ones who already considered it an aspect of their identities as mathematics learners. In the interaction with this message they both (Jason and Owen) managed to move into the transitional zone.

6.2.4 Discussion with peers $M_{1.4}$

The last message in this category was transmitted by Lecturer A and was concerned with the mathematical discussion among peers. This was a strongly classified and framed message through which the lecturer attempted to stress the importance of communicating mathematical ideas in advanced mathematics. Almost all the students referred to this message and the majority of them recognised the benefits of having mathematical conversations.

Pritchard (2010) argues that the group discussion which takes place during lecture time encourages the formation of a learning community which aims to have a shared exploration of the subject. The dialogic pedagogy has attracted particular attention in the field of mathematics education (Alrø & Skovsmose, 2002). The dialogic teaching and learning stresses the central role of the dialogue in the establishment of critical thinking in mathematics and in the joint construction of mathematical meanings and ideas (Lerman, 2014). Hence, students' learning can be facilitated through their involvement with dialogue and argumentation in mathematics. This is also confirmed in this study where most of the students reported how their understanding was facilitated by engaging in this sort of conversation and most importantly they described how their learning was enhanced. A rather characteristic example is Lesley who described that exchanging ideas with her peers was helpful for

her understanding, and also a fairly familiar practice that was employed in the school mathematics classroom as well. The high level of control transmitted through this message and the familiarity of the practice made her feel rather comfortable and by engaging in discussions she moved into the transitional zone. In her case there are two interesting things worth discussing. Firstly, Lesley through the narration of her story showed that she was more willing to take action from strongly framed messages. This fact indicates clearly that she wanted her learning to be controlled by the lecturer. Secondly, she often mentioned how hard it was for her to cope with university mathematics which differed so much from school mathematics. This resulted in her engagement with practices that were similar to the school ones (such as the discussion among peers). Moreover, taking into consideration that at school level almost everything is designated by the teacher it is apparent that Lesley's identity as a mathematics learner is formed in this way. Thus, this explains the fact that she enjoyed practices entirely controlled by the lecturer and shows how difficult it was for her to take initiatives and work independently in the new context.

On the other hand, there were students who felt constrained with the high degree of control transmitted through this practice. Both Jeremy and Jason admitted that they did not like to engage in conversations with people around them during the lectures and that they preferred to sit on their own and work through the tasks. From the beginning of the semester these two students expressed strong mathematics learners' identities and on every given occasion they showed explicitly that they were confident about their mathematical knowledge and skills. Alrø and Skovsmose (2002) emphasise that the involvement in the dialogic process presupposes that the individuals accept and respect one another; in this way they are able to help each other through

the dialogue without though trying to change the other person. Thus, the students in Alrø and Skovsmose's (2002) study by acting respectfully to each other promote a continuing process of inquiry which contributes to the enhancement of their learning. What happens though when the students do not hold their peers in sufficiently high regard that they believe they can benefit from engaging with them? The answer to this question can be found in Jason's and Jeremy's story where none of them engaged in conversations with other peers. Jason stated clearly that he considered conversations around him "silly" and Jeremy did not even think of talking to other students, as he believed his mathematical knowledge to be superior to that of his peers.

With the strong control exerted through this message both students moved into the discomfort zone because there was not enough space provided to act independently, something that complied with their identities as mathematics learners. At the end of the semester, both of them did relatively well in the examination of Module A, but not exceptionally well. This could be explained by the fact that there were particular aspects of their identities, built throughout the previous years of schooling, which made them believe strongly in their abilities and prevented them from engaging with new practices. Consequently, these aspects prevented them from advancing their mathematical knowledge even more and from expanding their comfort zones.

6.3 Assessment

The last two messages in the first quadrant of Figure 5.1 are the ones which were concerned with the assessment practices. They were both strongly classified and differed in the degree of framing; the message transmitted

by Lecturer A with the use of class tests ($M_{4.1}$) was strongly framed, and the message transmitted by Lecturer B through the coursework ($M_{4.2}$) was weakly framed.

Previous literature suggests that students recognise easily the difference in the assessment practices between school and university (Thomas & Klymchuk, 2012). Students can adjust to the new assessment requirements but how they will actually respond to them is dependent on their previous experiences, their motivations and their perspectives (Sambell & McDowell, 1998). I will explore now how the different assessment practices influenced students' transition in the context of my study.

6.3.1 Class test $M_{4.1}$

Firstly, I will discuss the message conveyed through the use of class tests. As I described in the Results section the lecturer employed regular tests throughout the semester in order to encourage the students to keep up with the module and to review systematically the material taught. The message was strongly classified with clear boundaries which distinguished this particular practice from the rest of the practices used in the course, and it was also strongly framed with a high level of control which regulated students' thinking over their learning habits. A high level of control from lecturers is common in university mathematics assessment practices. Thomas and Klymchuk (2012) found that university lecturers have more control over the ways they will choose to assess the students as opposed to the school teachers.

Most of the students who commented on the use of this practice perceived the class tests as a way of keeping up with the module, something that was in accordance with Lecturer A's initial intentions. This is also supported by previous work in the field, such as in Thomas and Klymchuk's (2012)

work, where they mention that first year students appreciated the regular assessment practices throughout the semester and considered them as beneficial. In my study though, the beneficial aspects of this practice sometimes conflicted with students' previous experiences, such as in Eric's case.

Eric initially struggled to put in work for the tests which were so much more regular compared to school. As the semester progressed he realised that the use of class tests was rather helpful for students' understanding and he engaged in the practice. Previous literature confirms the fact that students can be affected in their approaches to the new assessment practices due to their previous experiences. Sambell and McDowell (1998) mention that the ideas that students have in their minds until the moment they arrive at university regarding the assessment methods can act as a filter of how they will eventually get involved with the new assessment practices. This is confirmed in Eric's case but only for the beginning of the semester. During the adjustment to the new context the control exerted through the use of class tests was more influential on Eric's thinking than his previous views about the assessment procedures. Thus, he was prompted to put in work when otherwise he would not have done so. While interacting with this message Eric reformed his identity as a mathematics learner and managed to move from the discomfort to the transitional zone.

Other students also talked about the importance of keeping up with the material while reviewing for the tests but also about the significance of getting feedback throughout the semester. With the regular feedback students were given the chance either to try harder and put in more effort or to feel confident that they could achieve a good mark in the examination at the end of the semester. For instance, Kenny described how his initial failure in the first two class tests made him realise that he had to change his ways

of working, to become more independent, to put in more work and to take responsibility for his learning. In the interaction with this strongly framed message Kenny seemed to move from the discomfort zone, where he initially positioned himself by doing poorly in the tests, to the transitional zone, where he put in more work for the next tests. Despite this effort Kenny failed to pass Module A as the realisation that he had to work harder came late in the semester (around the middle). Although he was feeling confident because he was working more and he believed that he could still make it, it was rather late for him to cover all the previous material and catch-up also with the new content. On the other hand, Alex perceived the feedback provided through the class tests as an opportunity to reassure his identity as a mathematics learner. He talked about how monitoring his progress during the semester made him feel more confident about his mathematical knowledge and encouraged him to believe that he would be able to deal with the final examination. Alex's engagement with the class tests moved him eventually into the transitional zone.

Sambell and McDowell's (1998) work regarding how students deal differently with new ways of assessment in the university context is confirmed through these two characteristic cases. The authors mention that students' different motivations and orientations to study affect the ways that they act upon messages transmitted through the assessment practices. This is apparent in this study where we see Kenny feeling threatened by the idea of failing and eventually through interacting with this message he puts in more work (although he was unsuccessful at the end) and, on the other hand we see Alex being motivated and feeling confident by the feedback received through the class tests.

6.3.2 Coursework $M_{4.2}$

The message transmitted by Lecturer B through the use of coursework was strongly classified and weakly framed. The lecturer set clear limits about the use of this practice by explaining explicitly what he expected the students to do. The level of control that he exerted varied from strong, over the selection and evaluation of the tasks included in each piece of coursework, to weak, over the ordering and the pacing of the tasks. The lecturer intended to show his students that in order to master the material taught they needed to spend individual study time outside lectures practicing.

The benefits of the use of coursework in the learning of mathematics have been illustrated by previous research in the field of mathematics education. For instance Hernandez-Martinez et al. (2011a) mention that the mathematical activity prompted from the use of coursework in their study - e.g. students taking control over their learning, discussing the tasks with their peers, seeking help when needed, trying to find different solutions, etc. - promoted deep learning and understanding of the material taught.

The implementation of yet another new assessment method caused different reactions to the students who participated in this study. Like previously, with the use of class tests, there were students who recognised the benefits to their learning and in the interaction with the message transmitted through the use of coursework they managed to enhance their learning and to move into the transitional zone. We see this in the case of Alex who saw the coursework as a chance to practice the concepts during the semester before the final examination. Other students, like Owen, recognised the use of coursework as the biggest difference from school; now at university students do not have to cram in everything for the final examination, they can work consistently during the semester and comprehend the concepts as they

progress through the semester. In other instances, students mentioned how helpful it was to work in groups with their peers, something that agrees also with Hernandez-Martinez et al.'s (2011a) work.

The low level of control transmitted through this message provided students with space to act independently and to take responsibility for their learning. We noticed this in the case of Jason who stated how fulfilling it was for him, as a mathematics learner, to seek answers for the coursework's questions. Similar findings are supported by previous studies in the field which consider the use of coursework a student-centred activity allowing students to explore problems themselves in their own time and at their own pace (Hernandez-Martinez et al., 2011a) something that enhances their confidence, motivation and understanding (Swan, 2006). By engaging in this practice Jason reassured his identity as a mathematics learner and moved into the transitional zone.

Another very influential factor in students' interaction with this message was the exchange value that the coursework offered. As has been reported in a previous study by Jaworski, Robinson, Matthews, and Croft (2012), when a piece of work is officially assessed some students might focus strategically in achieving the best possible outcome at the expense of deeper understanding. This emphasises the role of students' epistemological positions in the interpretation of the transmitted message. A characteristic example from my study is Lesley's case. In the interaction with this message Lesley stated how troubling it was for her to adapt to the new assessment approaches and positioned herself in the discomfort zone. In order to become more effective she developed strategical ways of approaching her learning, e.g. by focusing during lectures only on clues of the type of questions that might be asked in the coursework. In this way an aspect of her mathematics learner identity

was reassured by giving correct answers in the coursework. This approach though does not entail necessarily deep understanding of the concepts. As is supported by previous studies in the field, when something gets assessed students focus strategically towards achieving the best outcomes at the expense of a deeper understanding (Jaworski et al., 2012).

6.4 Things that students should do outside lectures

I will continue now with the messages that lie in the fourth quadrant of Figure 5.1. These messages were all strongly classified and weakly framed. I will begin with the message transmitted with the use of problem sheets ($M_{2.1}$) and the message transmitted with the use of textbooks ($M_{2.2}$).

6.4.1 Problem sheets $M_{2.1}$

With the use of problem sheets the two lecturers wanted the students to invest time outside the lectures for practising the material taught and comprehending the concepts in depth. Despite the fact that they provided the problem sheets in different ways (Lecturer A included them in the set of gappy notes, Lecturer B uploaded them on the module's webpage) they were both explicit about the use of this practice by classifying it strongly from the rest of the things that they expected the students to do. The low level of control that they exerted by using the problem sheets gave the students control over the ordering (which problem they should solve first, second, etc.) and the pacing (how much time should they spend on each task). In this case there was not a direct evaluation purpose, something that played a very

important role in students' interpretations of this message.

When the students were asked to work with the problem sheets they were actually asked to deal with the features of independent learning required when studying mathematics at university level. Seven of the participants talked about this practice and in the interaction with the transmitted message they made apparent the influences of the school practices regarding the ways of working with mathematics. For instance, some of them described that they struggled coping with the problem sheets because when they were at school they were used to doing all the required work for mathematics during class hours. This agrees with Breen et al.'s (2013) work where the authors report that students in their study felt strange with the fact that they were free to organise their personal study timetable without the framework of daily homework assignments. Similar results are also mentioned in older and recent studies of the secondary-tertiary transition where students seemed to struggle to allocate sufficient time for practicing outside lecture time (Pongboriboon, 1989; Alcock, Hernandez-Martinez, & Godwin Patel, 2016).

Apart from the low level of control transmitted with the use of problem sheets which provided the students enough space to take responsibility for their learning there was another significant aspect that influenced their interaction with this message. The absence of evaluation purpose was a decisive factor on how students responded to this message. For instance, Jeremy admitted that he did not put in work for the problem sheets at all because they were not assessed. In the interaction with this message he positioned himself in the comfort zone. This positioning did not influence his overall performance and this can be explained by the fact that the work that he put in for the things that counted towards the degree was enough to have a good performance throughout the semester.

Other students, like Elsa, recognised the benefits of working outside the lectures with these tasks - such as managing the work on their own, becoming more independent learners, etc. - but they chose deliberately to put more effort into the things that counted towards the degree. This was not effective though to the same extent for every student. For instance, Eric took advantage of the low level of control exerted though this practice and he prioritised the work that gets assessed. This positioned him in the discomfort zone, something that he realised while the semester progressed and he was not performing as initially expected. As a result he admitted that for the following semester he would have to change his study habits and work more regularly with the problem sheets.

The lecturers' intention to give control to the students to manage the required work in their own terms did not work as they envisaged. Given the choice, the majority of the students preferred to prioritise the piece of work that got evaluated. In this case we see how the use value of this practice (working with the tasks to acquire deeper understanding of the concepts) is diminished and the exchange value prevails, in the sense that most of the students think that the work that needs to be done is the work that gets eventually assessed. The conflict between the use value and the exchange value of mathematics is a topic often discussed in the literature. Williams et al. (2009) report that on certain occasions the exchange value can be a motivational factor for students to enhance their engagement with mathematics. This result is confirmed in this study by the engagement of the students with assessed coursework although we also see that most of them would not engage with the problem sheets if these are not part of the evaluation of the module.

6.4.2 Textbooks $M_{2.2}$

The lecturers' suggestion of the use of additional mathematics textbooks was strongly classified and weakly framed. The lecturers suggested to the students alternative sources for consultation during studying, in case students needed more/different explanations. Both lecturers selected a number of textbooks to recommend and they made explicitly clear to the students how they would benefit by reading these textbooks. With the low degree of control they provided a lot of space for the students to decide whether or not this was a suitable practice for them to use. It would be entirely up to the students to determine how to employ the books and the lecturers had no control over this at all.

The use of textbooks in the context of university mathematics is considered as an influential factor in students' adjustment to the new setting. During the transitional phase scholars emphasise the importance of the different kind of language that is used to introduce concepts in the mathematics textbooks used at school and those used at university (Raman, 2002; Clark & Lovric, 2008; Gueudet, 2008; Randahl, 2012). At school, the mathematical language is more informal (intuitive/every-day language) and at university it becomes formal (axioms-theorems-proofs). As Raman (2002, p. 136) puts it: "emphasising the informal at the expense of the formal and vice versa".

The majority of the students that talked about their transitional experience did not refer to the recommended textbooks from their lecturers' lists. Only four reported on this suggestion, and from them only two actually used the textbooks while studying. The lack of control in the transmission of this message made the suggestion seem quite optional, as Lesley reported: "They've not said you must go." The vast majority of students disregarded this message with potentially serious negative consequences for their mathe-

matical learning. This stresses the fact that students are used to being told explicitly what they need to be doing. The solution to this issue is not as straightforward as making the control of this message stronger, as I next discuss.

The only student who described in detail how she used the textbooks was Elsa. She mentioned that she sought plenty of them in the library in order to improve her understanding on constructing proofs. She was among the few who recognised the benefits of having the control over her learning by using additional books and tried to make the best out of it. The narration of her experience with the textbooks contrasts with previous findings in the field which suggest that the non-use of textbooks by the lecturers may result in learning discontinuities for first year students (Thomas & Klymchuk, 2012). By taking advantage of the space provided by her lecturers, Elsa attempted to get more acquainted with the formal language used at university and to master it in order to be able to construct proofs on her own. This moved her eventually into the transitional zone.

Moreover the transmission of this message and students' interaction with it contrasts with findings in Clark and Lovric's (2008) work. The authors argue that in the transition to university mathematics the lecturers offer so many different resources to the students that they do not give them enough space to act independently and seek resources themselves. In the context of this study we see the exact opposite happening. Despite the fact that the lecturers exerted low level of control conveyed through the message regarding the use of additional textbooks, and although the students had all the required space to act independently, only a few of them were prompted to do so. Therefore, we see the importance of seeing this issue as relational, i.e. some students will react positively to a weakly controlled message, hence using

and developing their autonomy as learners, while others will react negatively to the same message by disregarding it completely.

Most of the students did not seem ready in this phase to take control over their learning. The different practices employed in the new context, the influences which are still existent in their mindset regarding how work should be structured and the lack of control in the transmitted message about the things that they should be doing outside lecture time played a crucial role here. The majority of the participants appeared quite reluctant to take responsibility for their learning and to employ the suggested practice.

6.5 General study habits

In this section I will discuss the messages about general study habits that were transmitted by Lecturer A. All of these messages are depicted in the fourth quadrant of Figure 5.1 as they carry high level of power and low level of control.

6.5.1 Time-management $M_{5.1}$

Lecturer A attempted to raise students' awareness regarding how to organise their time effectively. She explained to them clearly that at school their teachers monitored their work much more than would be the case at university and how this changes at university where the lecturers have less say on whether and how they should be doing the required work. Moreover, she emphasised how students should take responsibility for their learning in order to deal with the new requirements. Therefore, she showed them that the development of effective time-management skills is crucial for the adjustment to the new setting. The transmitted message was strongly classified, with

clear boundaries from the rest of the advice that she gave them regarding the study habits, and it carried a low level of control over its sequencing and pacing.

The literature on the secondary-tertiary transition recognises the lack of study and time management skills as an important factor for students' difficulties during the first year at university (Pyke, 2012). For this reason various institutions employ different remedial practices in order to support students during this phase and enhance their organisational techniques (Wingate, 2007).

The message was received by the majority of the students, with some of them explaining how it motivated them to become more proactive and organise their study time more effectively. For instance, Kenny in the interaction with this message got informed for the first time about what time-management is. He admitted that Lecturer A was the first one among the lecturers who explained in detail what exactly time-management is concerned with. By going through the time-management reading that Lecturer A provided, he managed to organise his study time more effectively, adjust better to the new setting and move into the transitional zone. Similarly, Carin, by employing her lecturer's suggestion, made weekly timetables and tried to keep a balance among all the modules. In this way, by taking action from this message she moved into the transitional zone as well. On the other hand, Alex, despite the fact that he had the intention to employ Lecturer A's advice and to share his time equally among the modules, admitted that he struggled and many times this resulted in him prioritising Module A which he considered the hardest. By the time of the interview, he was in the process of adjusting, going from the discomfort zone to the transitional zone, albeit with not much success.

There were also students who ignored this message, or who were already competent in organising their study time and the message did not make any difference to them. We see this in the case of Jason who said that he was already informed by his school teachers about how to be efficient with his organisational skills. Although he recognised this message it had no effect on his learning, as it comprised already an aspect of his comfort zone. Finally, Eric, disregarded completely the transmitted message despite the fact that he admitted that Lecturer A was the only one to provide time-management information. Finding a balance between the responsibilities of the new life that he had to undertake (e.g. living alone, away from home for the first time) and the requirements of university life (e.g. regular coursework, lectures time-schedule, etc.) was hard for Eric. Even though he expressed openly his struggle to organise his personal and study time he ignored the message and positioned himself in the discomfort zone.

The high level of power exerted through this message made it easily recognisable to the majority of the students. The low level of control on the other hand had different impact on different students. Some students were prompted to take advantage from the space that the lecturer provided them with and to implement the advice in their daily study schedule. On other occasions, the low level of control prevented other students from taking action in furtherance of their learning despite the fact that they openly admitted they struggled to organise their study time.

6.5.2 Definitions list $M_{5.2}$

Another piece of advice that Lecturer A gave to her students in order to facilitate their study time was the creation of lists of definitions. The message that she conveyed through this advice stressed the important role that defini-

tions play in the learning of mathematics at this level. The strongly classified message was distinguishable from the rest of the advice, and the low level of control that it carried over the sequencing and the pacing gave enough space to the students to act independently and to consider themselves how to use it.

The advice stresses the importance of good organisational skills when studying for a mathematics degree. The message that is transmitted through this advice emphasises the importance of definitions and of the mathematical language used in advanced mathematics. This is a topic arising often in the transition literature. Various researchers recognise that with the move from school to university mathematics there is a move from informal to formal language which often causes difficulties to students (Brandell et al., 2008; Gueudet, 2008; Clark & Lovric, 2009; Bardelle & Di Martino, 2012; Randahl, 2012). Moore (1994) mentions that among the difficulties that students encounter when they work with proofs at university is that they do not know the definitions and then they do not know how to use them in order to work with proofs. Because of their school experiences when students come to university they might think that is more important to pay attention to the problems and how to find ways to give appropriate answers to them rather than focusing on the definitions (Engelbrecht, 2010).

With the transmission of this message the lecturer attempted to stress the importance of the use of definitions and facilitate students' thinking regarding how they should be working with them. With the high level of power that the message carried, it put clear boundaries about the practice of making lists of definitions which would help the students during their study time. The low level of control over the sequencing and the pacing of this practice gave the students enough space to decide how they would work with the practice on

the occasion that they would decide to employ it.

The students that received this message and talked about it got influenced in various ways in their study habits. For instance, Alex in the interaction with this message focused mostly on the organisational aspects that it carried and got inspired to improve the ways of organising his study material and change the ways he used to work until that point. The power of this message was strong enough to influence his whole "work pattern" as he said. The space provided by the lecturer gave him the chance to do this at his own pace and terms. Alex recognised that aspects of his identity as a mathematics learner acquired throughout his previous years of schooling were not adequate for the studying of mathematics at this level and thus by taking action from this message he changed his ways of working and moved into the transitional zone. Something similar happened also with Carin who, by receiving this message, employed the practice, recognised its benefits and decided to use it in the rest of the modules as well. The space provided by the lecturer motivated her to take responsibility for her learning, not only for this module, but also for the whole course. Hence in the interaction with this message she was prompted to adjust her study approaches and to move into the transitional zone.

6.5.3 Keep up/Do not fall behind $M_{5.3}$

The independent character of the learning of university mathematics can be often problematic for first year students who until the moment of transition are used doing mathematics in a more controlled (by both their parents and teachers) environment. Not having someone to check upon them whether they work or not throughout the semester can be quite risky for freshmen, as they are more prone to procrastinate and to not put work in until the final

examination at the end of the semester. With their move to the new setting students are required to switch from their old experiences, where learning was entirely monitored and controlled by their teachers, and become independent learners (Wingate, 2007).

With the transmission of this message Lecturer A tried to facilitate this shift and gave to her students a clear picture of how they should work in the new setting. The message was strongly classified and explicit regarding the extent to which students should be attentive during the semester in order to be consistent and efficient with their studies. The degree of control was fairly weak as the lecturer provided space to her students to put into action her advice, act independently and become entirely responsible for their learning. Therefore, by giving them this piece of advice on the one hand she emphasised the importance of keeping up with the material (high degree of power) and on the other hand she gave them space to judge when they should put in work and how (low degree of control). This act, of creating "independent judgement" is crucial for developing the sense of ownership of mathematical knowledge, a finding which is supported by previous studies in the field (e.g. Solomon & Croft, 2015).

This message was rather influential for Alex who mentioned that throughout the semester he always brought it to his mind and tried to put in work immediately only because of recalling it. In the interaction with this message Alex admitted that he felt petrified by the idea of falling behind and tried to do the required work straight away. We see how this powerful advice conveyed from his lecturer, and the space provided by her, gave him the chance to develop his identity as a mathematics learner and moved him into the transitional zone.

Others, like Owen, when talking about keeping up with the material did

not refer explicitly to the advice but to the class tests that the lecturer employed in order to motivate the students to work during the semester. In this case, the exchange value of the test had more power over Owen's thinking and it was more controlling compared with the lecturer's advice.

Finally, on certain occasions some of the students received the transmitted message but it did not prompt them to make any changes to their study habits. We see this in the case of Jeremy who admitted that although he had received the message and acknowledged that he should be putting in more work, was feeling rather confident with his identity as a mathematics learner and did not implement any changes in his ways of studying. In the interaction with this message Jeremy remained in his comfort zone. This did not seem to influence his overall performance in Module A, where he achieved 73%.

6.5.4 It's ok if you don't understand everything $M_{5.4}$

The last message in this category was transmitted through the lecturer's advice to her students about not feeling bad when they do not comprehend straight away everything that is taught. This message aimed to reassure students that they were not expected to understand instantaneously, and that not understanding is a normal situation. In this way the lecturer attempted to address affective issues that first year undergraduates encounter with their relationship towards mathematics during the transitional phase.

Daskalogianni and Simpson (2002) argue that the transition to advanced mathematical thinking includes several affective aspects. These aspects - which include self-efficacy beliefs, engagement, motivation, etc. - are significant in the success or failure in the learning of mathematics (Abdulwahed, Jaworski, & Crawford, 2012). When students come to university to study

mathematics some of their previously acquired beliefs regarding the learning of mathematics might not be appropriate in the context of university mathematics. This mismatch in the beliefs can cause difficulties in the adjustment to the new setting and it is very likely that it will develop negative attitudes towards university mathematics (Daskalogianni & Simpson, 2002).

With the strongly classified message transmitted with this advice this is what the lecturer tried to prevent. The strong classification made the message easily recognisable by the students and put clear boundaries regarding what is considered as legitimate or not in the learning of mathematics in this context. With the low level of control, over the sequencing and the pacing, the lecturer gave the students the chance to think over the material taught and comprehend it in their own time and at their own pace.

In the interaction with this message many students expressed a feeling of relief; in the sense that they acknowledged that they were all in the same position and there was nothing wrong with not understanding immediately everything. Emily commented upon the mismatch in beliefs between school and university context, where in the former she had to understand everything in order to succeed in the exam, but in the latter it was fine to take her time and process things through. By receiving this message she developed her identity as a mathematics learner, recognised the requirements of the new context and moved from the discomfort to the transitional zone. Likewise, for Carin it was initially hard to accept this. She struggled when she could not comprehend and she felt frustrated. Interacting with this message made her reconsider her previous beliefs and by doing so she also moved from the discomfort zone to the transitional zone.

Eric on the other hand reacted differently when he received this message. Acknowledging the fact that it is ok not to understand everything, conflicted

with his previously formed identity as a mathematics learner and positioned him in the discomfort zone. He could not accept the fact that this is a legitimate situation as in school the exact opposite was happening.

Finally, for Owen this message entailed that he had to become more independent in his learning and to put in more work outside the lectures. By taking action from it, he changed his ways of working, developed his previously formed study habits and moved into the transitional zone. The same happened with Elsa, who said that not understanding does not make you stupid, with hard work it will all be comprehended in the end.

6.6 Things that students should do when they feel stuck

The last category of messages that we meet in Figure 5.1 is concerned with the messages regarding the things that students should do on the occasions that they feel stuck. The first message (Ask the lecturer) was transmitted by both lecturers and was strongly classified and weakly framed and the second message (Tutor/MSC/Friend) was transmitted by Lecturer A and it was again strongly classified and weakly framed. I will discuss them in more detail below.

6.6.1 Ask the lecturer $M_{3.1}$

The two lecturers, by inviting the students to ask them questions, wanted to show that they are supportive and willing to help them to understand and clarify any kind of misconceptions that might have been created during their teaching. The message was strongly classified; they were both rather explicit

about it from the beginning of the semester. At the same time the level of control that they exerted was weak; they gave the chance to the students to act independently and to raise questions whenever and if they considered appropriate.

The secondary-tertiary transition literature recognises as a root cause of students' difficulties the change in the teaching-learning interactions between students and lecturers. The teaching at university becomes more impersonal (Pampaka et al., 2012; Thomas & Klymchuk, 2012) and the cohort size of the lecture theatre often intimidates students to refrain from raising questions when they do not comprehend (De Guzman et al., 1998; Thomas & Klymchuk, 2012).

The students in my study also found this impersonal atmosphere and intimidation in lectures, but what is interesting is how those who acknowledged the message acted upon it. Only two of them described explicitly how they addressed questions to the lecturers. For instance, Elsa mentioned how intimidated she felt initially raising questions. Despite the sense of discomfort that was created due to the changes, by receiving this message she overcame the feeling of intimidation and communicated her questions. In the interaction with this message the low level of control gave her enough space to reflect, to put her anxiety aside and eventually to ask her lecturers. In this way she managed to move into the transitional zone.

On the other hand, Owen, reacted differently. He recognised the transmitted message but he admitted that instead of asking questions he preferred to write emails to his lecturers whenever he needed help. In this case we see that he was not ready to expose himself during the lectures and he preferred a safer way to get his questions answered. Interestingly, the low level of control gave him the chance to choose how he would communicate his questions

which eventually worked in his favour and moved him from the discomfort zone to the transitional zone.

However, apart from Elsa and Owen, the other students did not ask questions in spite of the clear message from their lecturer. The fact that not many students commented on this message confirms the previous results in the literature that students, due to the changes in the teaching-learning interactions, face difficulties in the adjustment to the new context. In this specific case, the feeling of shyness that the students have at the beginning of their studies combined with the lack of control conveyed through this message constrained them and it was not easy for them to ask questions. Despite the fact that the lecturers provided space to the students to discuss matters that confused them and showed explicitly their willingness to assist them, the majority of the students felt reluctant to ask directly. A change in the framing of the message (stronger control) could result in it being perceived easier by the students who were used to having a closer relation with their teachers back at school. These students might translate the more controlling attitude as more supportive on behalf of their lecturers. At the same time though, the high level of control could constrain the students who need space and are more keen on having a say on their learning habits. Therefore, a mixed framing approach might be more effective in this situation. Lecturers should act more diplomatically and show that they are both supportive and open to help students but at the same time that they also offer them more choices, like using the support centre, or asking their tutor, etc.

6.6.2 Tutor/MSC/Friend $M_{3.2}$

In addition to asking her direct questions, Lecturer A suggested alternative sources of help to the students in order to use whenever they felt stuck.

She recommended that students consult their personal tutor, their fellow peers or to use the facilities of the university's mathematics support centre. The message transmitted through this suggestion was strongly classified and weakly framed. The options that she offered to the students were rather clear and she left all the control to them to decide which one to use. Students had the entire responsibility of taking action and accessing the suggested sources of help.

Several students during the interviews referred to this message and the different kinds of help that they could access. They described how they reacted differently to each suggestion and here I will discuss a few characteristic examples for every recommended source of help (e.g. tutor, MSC or friends).

As with the previously discussed message, with the lecturers' suggestion to ask questions directly, some of the students, such as Kenny, felt intimidated to raise questions even during the tutorial sessions. Despite the fact that he recognised the message and he was willing to ask for help he felt intimidated and he did not attempt to ask until the point that he felt comfortable. Previous studies in the field confirm the fact that students might feel exposed to raise questions during these sessions and for this reason tutorials are considered as risky places (Solomon, Croft, & Lawson, 2010). Kenny managed to overcome this constraint and brought questions to the tutorial session but only when there was just him and one other student attending. In this case we see that the weak control allowed him enough space to move into the transitional zone, once he felt ready to ask questions. After the first time he asked a question, he felt more comfortable to do this regularly.

Other students mentioned that they used the mathematics support centre when they needed help, but only Elsa described in detail in what ways she used this suggested source of help. She said that she would go to the mathe-

matics support centre when she had a "proper problem" that she needed to go through or a proof that she did not at first understand. On such occasions she needed some time to sit down for a while and have it explained. The development of mathematics support centres and their use by students have been the focus of much research interest in recent years. The one-to-one tutor-student interaction in assisting students to solve their problems has been reported as being their greatest benefit. Further, the general atmosphere and learning environment that are created increase students' control and prevents time pressure (Lawson, Croft, & Halpin, 2001). This is also evident in the story of Elsa who went to the centre whenever she needed one-to-one interaction and enough time to go through problems or through the proofs with the tutor. By receiving the message from her lecturer, she acted independently, took control over her learning and used the support offered by the centre whenever she considered it necessary. In this way elements that she did not understand initially were clarified and she was able to move into the transitional zone.

Finally, some of the students admitted that when they struggled while studying they consulted their friends for assistance. For instance, Emily said that whenever something seemed hard to understand she first attempted to deal with it herself and then the next option was to ask a friend. Similarly, Carin admitted that when she faced difficulties one of the actions that she would most likely take was to ask a fellow peer. Other students mentioned that they collaborated with their peers mostly when a piece of coursework was due.

The benefits of the collaborative work amongst peers is often cited in the literature. For instance, Solomon et al. (2010) argue that the peer-interactions play an important role for success in mathematics. Except for

the collaborative aspect of working together, some students also appreciate that in this way they have the chance to work at their own pace. By providing support to each other, peers can also play an important role in building mathematical arguments (Solomon & Croft, 2015). Moreover, Duah et al.'s (2014) work emphasises how peer assisted learning can contribute to prevent students from losing motivation and interest in their studies.

With the transmission of this message the lecturer offered a variety of options which attracted students' interest. With the low level of control that was exerted through the message, and thus with the space provided, some students realised that they had to be more independent and responsible for their learning. We see this in the following comment from Carin: "...I think it has made me more independent and... made me find out ways to work [it] out myself..." On certain occasions students' decisions regarding how they would employ the suggested help were also influenced by the assessment approaches employed at university, with the majority of the students being willing to consult their friends when a piece of work was due for assessment.

Overall, with the transmission of this message the students had to choose from a variety of options to get assisted in their learning whenever they struggled. All of these options were less formal compared to asking the lecturer directly during the lectures. This fact made the students pay more attention and react more positively to this message than the one previously described ($M_{3.1}$). The flexibility conveyed through this suggestion and the low level of control exerted by Lecturer A played an important role in how students interacted with the message. Although not many of them described in detail how they used the recommended support options those who did use at least one of these sources of support benefited in their ways of studying and by taking action from this message managed to move into the transitional

zone.

In the next chapter, I will draw my overall conclusions and suggest some recommendations for policy and practice.

CHAPTER 7

Conclusions

The transition from school to university mathematics has been the focus of many studies in the field of mathematics education over the past years. Despite it being researched extensively and despite many attempts to alleviate these difficulties (bridging courses, support centres, etc.), problems persist. This indicates that there are various aspects of the transition that the previous works implemented in the field have not addressed yet.

The vast amount of research in this area focuses on the difficulties that students encounter when they study mathematically demanding subjects. These difficulties are often rooted in the discontinuity in the ways that mathematics is taught between the two different educational contexts. These discontinuities include the difference in the content of the subject, the language used in the new setting, the new ways of thinking and communicating mathematics, the change in the teaching approaches and the change in the

social context. Both quantitative and qualitative approaches have been used by scholars to investigate the issue, with the qualitative ones being more predominant in the field.

After a thorough research in the literature I identified some breaches that I intended to address with this work. In contrast to the majority of the previously implemented studies I do not only attempt to pinpoint and analyse the difficulties that students face during this phase. I focus my attention on problematic aspects of the secondary-tertiary transition by employing a different approach and shedding light on the discourses that frame the shift in the teaching-learning interactions. I consider the complex relations between students' agency and institutional structures. Most research, so far, has studied the outcomes of practices and discourses on students (as if students were empty vessels or manipulable objects) but not the teaching-learning interactions that happen when students react and change the conditions of their engagement, something that happens to a large extent during the transitional phase.

Hence, with my work I want to capture the whole picture of the trajectory and examine how students react to the things that their lecturers tell them about the content of mathematics and the learning of mathematics at this level (both in implicit and explicit ways) while they interact with each other. In the investigation of this trajectory I take into account students' previous experiences with mathematics and their previously formed identities as mathematics learners, the current influences from the new context and the further impact on the transitional experience that the various interactions in the new setting can cause.

In the following I summarise the concluding remarks of my study which answer each one of the initially posed research questions.

7.1 How do students interpret the different messages they receive within the university community?

Through the practices and the discourses that frame the teaching-learning interactions in the new setting the lecturers transmitted a variety of messages about the content of mathematics and its learning. Every single transmitted message carried a certain level of power and control which eventually defined the power-control relations in the teaching-learning interactions between lecturers and students.

The findings of this study suggest that the level of power and control exerted through the messages has a significant impact on students' interpretations and on the actions that they take in furtherance of their learning during their transition. How big or small is this impact varies from student to student and this is something that characterises this crucial phase in a student's life. Through this work I emphasise how every single student's trajectory from school to university is a unique case and it should be addressed as such. This is strongly evident in the variety of students' responses to the exact same message.

On certain occasions students are more influenced by messages that are strongly classified and framed. This can be explained by the fact that until that point they are used to function in a highly controllable environment while studying, by both their parents and their teachers. When they move into the new context many of the students expect to be controlled to the same extent by their lecturers and when this does not happen they struggle. For instance, Emily described how, at university, being no longer controlled by her parents caused her difficulties handling the coursework ($M_{4.2}$). Similarly,

Kenny was in favour of more controlling practices, such as with the use of gappy notes ($M_{1.1}$), where he admitted that by having designated by the lecturer what he needs to be doing and when, motivated him to put in more work.

On the other hand, a number of students were more willing to take action from messages that were strongly classified and weakly framed. These students seemed to appreciate the space provided by the lecturers whenever they conveyed messages with low level of control. In this way they were given the chance to act independently and take responsibility for their learning. We see this in the case of Jason who was rather happy to devote his study time coping with the tasks and trying to find answers for the coursework ($M_{4.2}$). Or in the story by Elsa in which she described how the weakly framed message transmitted through the lecturer's suggestion about additional reading motivated her to seek books in the library in order to enhance her learning ($M_{2.2}$).

In the findings of this study we can see also cases where a number of students encountered difficulties with the strongly classified and framed messages. For instance, Owen expressed a sense of discomfort with Lecturer B's practice of requiring students to copy the notes from the board ($M_{1.2}$). He needed more space and time to comprehend the concepts on his own and the strong control exerted by Lecturer B prevented that. Similarly Jason, struggled when he was asked explicitly by Lecturer A to have mathematical conversations with his peers ($M_{1.4}$). Spending a specific amount of time during lectures to discuss mathematics with other students irritated him because, as he argued, his peers did not take the work as seriously as he did.

Finally, on certain occasions the messages that lacked control ended up being entirely ignored by a number of students. Something similar happened

with Eric. Although he admitted he struggled to organise his study time, he disregarded the message transmitted through Lecturer A's advice regarding the time-management ($M_{5.1}$). Likewise, the weakly framed message about the use of problem sheets ($M_{2.2}$) was also ignored by many students. The students who talked about it admitted that they did not get involved with these tasks because they were not getting assessed.

In addition to the underlying structures of power and control that played a significant role in the interpretation of the messages there were also other aspects in students' responses which I identified as very influential in this phase. One of the most important aspects, which is also recognised by previous studies in the secondary-tertiary transition literature (Hourigan & O'Donoghue, 2007; Breen et al., 2013), is the school influences that are still evident in students' mindsets and comprise already a very important part of their identities as mathematics learners. This will be analysed in more detail in the answer to the next research question.

Another rather influential factor is the exchange value that the university assessment practices offer. In this study it was evident that despite the fact that students answered differently in the different level of control exerted through the two distinct assessment approaches (strong level of control transmitted with the use of class tests and low level of control transmitted with the use of coursework) eventually they all put in effort to achieve a good mark and they recognised a number of benefits in the new ways of getting assessed. The beliefs about the evaluation methods are also a part of students' identities as they are created and developed during the previous years through schooling.

Overall, through students' responses to the different messages we see a great variety of reactions which on every occasion are affected differently

according to the level of power and control that is conveyed through the messages. In the interaction with the messages it is apparent that students' identities as mathematics learners mediate differently the interpretation of the messages. In the following I will explain and conclude the findings of this study which stress the importance of students' identities in the discourses that frame the teaching-learning interactions at this level and give an insight into the secondary-tertiary transition.

7.2 How are these interpretations shaped by their individual backgrounds and previous experiences?

Students' previous experiences with mathematics were fundamental in their transition to university mathematics. A crucial role was also played by their individual backgrounds. Both previous experiences and individual backgrounds influenced highly their interactions with the transmitted messages during this phase. These experiences were shaped throughout the previous years, influenced highly by the practices used at school while doing mathematics and by the family environment. The discontinuity in the practices used in the two different educational settings is what often caused difficulties in students' adjustment to the new context.

In this study it was evident that an important role in students' responses was played by the relations that they had established with their mathematics teachers while being at school. A few of the students described how they were inspired by their mathematics teachers and how they instilled in them the love for mathematics. Others talked about good study habits that their

school teachers used to employ and that they still remembered and wanted to implement at university (e.g. time-management skills). The role of the family environment in this phase also appeared to be of great significance. Some students referred to the impact of their families' educational backgrounds in their decision to study mathematics and others referred to the impact that the lack of parental control had on their studies (e.g. being more prone to skip lectures, not do enough work at home, etc.).

Students' previous experiences while doing mathematics both can comprise and shape their identities as mathematics learners. The findings of this study offer a clear understanding of how and why each student's identity played a significant role in the interaction with the transmitted messages. We saw previously how the power and control conveyed through each message affected students' different responses in the interpretation of the transmitted messages. The underlying structures of power and control defined one aspect of the teaching-learning interactions which was concerned with the lecturers, and how they framed the interactions with the students by exerting certain levels of classification and framing through the messages. In order to depict the whole interaction between lecturers and students and understand the impact of the messages on the transitional experience I accounted for another very important aspect, students' identities as mathematics learners.

The change in the teaching practices between school and university was often an emerging theme in this study. On many occasions the students interpreted the transmitted messages highly influenced by their previous experiences with school mathematics and the teaching practices used at that time. Additionally, many students appeared influenced by their school mathematics teachers and their wider family environment. The extent to which these influences impacted upon the transition was dependent on students'

identities and the degree of power and control that the messages conveyed.

Through students' stories I identified various aspects of the teaching practices that differed between the two educational settings and affected the ways that they approached their studies. These differences included the extent to which students get monitored at university, the pace of teaching, the study habits during and outside lectures, the absence of designated textbooks, the different assessment methods, the extent to which the lecturers are approachable and the content of mathematics (e.g. many students referred to university mathematics as more theoretical as opposed to school mathematics which was more practical).

All these different practices had a different impact on each students' transition which was on the one hand dependent on their previously formed identities as mathematics learners and on the other hand on the degree of power and control that the transmitted messages were carrying. A wide spectrum of interpretations arose by shedding light on these two aspects of the teaching-learning interactions. Hence, by considering both students' identities and the underlying structures of power and control through the transmitted messages I identified four possible outcomes on students' transition:

- Students who in the interaction with a message that carried a high level of power and a low degree of control felt constrained and were not prompted to take action (e.g. Lesley with the use of textbooks)

- Students who in the interaction with a message that carried a high level of power and a low degree of control felt comfortable and were prompted to take action (e.g. Jason with the use of coursework)

- Students who in the interaction with a message that carried a high level of power and a high level of control felt constrained and were not

prompted to take action (e.g. Jeremy with the discussion among peers)

- Students who in the interaction with a message that carried a high level of power and a high level of control felt comfortable and were prompted to take action (e.g. Kenny with the use of gappy notes)

The practices and messages at university shaped students' developing identities in different ways. This different formation was highly dependent on the variations in the degree of control in the transmitted messages. From the above distinction we notice that on certain occasions students' identities as mathematics learners are affirmed by weakly framed messages. This happens because the weak framing presents individual challenges, provides students with more space and initiatives to be responsible for their own learning. Students who feel comfortable with these practices as a consequence are more willing to take action in furtherance of their learning from these kinds of messages. On the other hand, a significant number of students feels constrained with the messages and practices that exert a low degree of control at university. The lack of control makes them feel uncomfortable because it leaves room for independence and they are not ready for that yet.

Moreover, the results of this study suggest that strongly framed messages more likely appeal to students who think that university mathematics (both content and practices) is a continuation of school mathematics. Students who hold this view attempt to find similarities between the two contexts and are keen on taking actions from messages with a high degree of control because they can regulate explicitly their thinking. This agrees to some extent with Hernandez-Martinez's (2016) study where students entering university were alienated because their identities did not resonate with the new practices. Contrarily, the students who want to develop their mathematical knowledge

and want to evolve their identities as mathematics learners might feel constrained by the degree of control that strongly framed messages exert. On this occasion they are willing to find alternative ways of creating the required conditions to take control over their learning themselves.

We notice also a number of students being willing to take action from both strongly and weakly framed messages. These students are happy to expand their mathematical horizons and evolve as mathematics students from whatever is beneficial for their learning, despite the degree of control that it carries. The only occasion where the degree of control was not an influential factor was with the messages transmitted through the different assessment practices. Two differently framed messages were conveyed via the assessment methods that the two lecturers used. We saw earlier examples of students who felt constrained because of the low level of control with the use of coursework (e.g. Lesley, who was used to one examination at the end of the semester) but at the same time examples of students who felt comfortable with the low level of control (e.g. Jason, who approached it as a challenge). Regardless of the different degree of control, in this case it was the exchange value of the assessment methods that influenced students' reactions. Whenever a message referred to something that counted towards the degree that message would be easily perceived and would have impact on students' thinking. One explanation might be that students come from a highly assessment-driven context (from school or college) and these influences are still evident when they are at university.

The above cases show how students in the interaction with messages that carry different degrees of power and control react in different ways according to their individual identities. Therefore, it would be wrong to suggest that, for example, only strongly classified and framed messages should be trans-

mitted by lecturers. The implication of this study is that university actors should account for the learners' identities and agency when designing educational practices. This confirms Pampaka, Williams, and Homer (2016) work on current debates on the "what works" agenda where the authors stress the need to consider the learners' agency in policy and practice in mathematics education. Moreover, great importance should be given to the discourses taking place in the teaching-learning interactions during the transitional phase (Kouvela, Hernandez-Martinez, & Croft, 2017). Taking these into account it is easier to explore in what ways messages transmitted by university actors position students in relation to the practices of the new institution and how this shapes their identities during their transition to university.

7.3 How do they facilitate or hinder students' transition?

With the two previous research questions I investigated how students' reactions to the messages conveyed through the teaching-learning interactions were impacted initially by the degree of power and control that the messages carried and then by their identities as mathematics learners. In order to monitor the overall impact of the messages on students' transition I examined in what ways the transmitted messages triggered their positioning in the new setting. For this reason I considered three possible zones (comfort zone, transitional zone and discomfort zone) in which the students could possibly locate themselves. This positioning was triggered by the messages carried through the teaching-learning interactions.

The results of this study suggest five possible outcomes regarding students' positioning in the interaction with the transmitted messages which

are directly influenced by the degree of classification and framing of the messages, and by students' previous experiences with mathematics. This positioning plays a significant role in understanding how students' transition can be facilitated or hindered.

In two of these possible outcomes the transmitted messages can trigger movement between two zones - from the comfort zone to the transitional zone and from the discomfort zone to the transitional zone. For instance, we notice students who by interacting with messages conveyed through practices that were already familiar in the school context were willing to expand their comfort zone and move into the transitional zone. This movement entailed a better adjustment to the new context. We see this in the case of Emily who described that the managing of her study time was already a part of her study routine from school and by receiving the weakly framed message about time-management from Lecturer A she developed her identity as a mathematics learner, expanded her comfort zone and positioned herself in the transitional zone.

On other occasions, a number of students positioned themselves in the discomfort zone due to the changes in the teaching practices employed in the new context which conflicted with the ones they were previously using when doing mathematics. These students, by receiving a message from their lecturers, were prompted to take action and move from the discomfort zone where they were initially positioned into the transitional zone. For instance, Eric initially felt very uncomfortable with the use of regular class tests in Module A. By receiving the strongly classified and framed messages transmitted through this practice he recognised the use value of the practice and managed to move from the discomfort into the transitional zone. Likewise, Carin felt at first constrained when she did not understand everything in the

first place during the lectures and positioned herself in the discomfort zone. By receiving the strongly classified and weakly framed message through her lecturer's advice her thinking was challenged and she realised that not understanding everything straight away can be a legitimate situation at this level, as long as she tries to put in work later. With this realisation her identity as a mathematics learner evolved and she managed to move from the discomfort zone into the transitional zone.

In addition to the occasions that students were eager to move from one zone to another, as a result of the interaction with the transmitted messages, there were also instances that the result of this interaction was an immediate positioning in one of the three zones. Hence, the three remaining positionings which arose from students' interactions with the transmitted messages are the following:

- The received message by the student has no effect on them and leaves them in the comfort zone.
- The received message by the student has a direct effect on them, prompts them to take action in furtherance of their learning and moves them immediately into the transitional zone.
- The received message by the student makes them feel constrained and in the interaction with it they position themselves in the discomfort zone.

An example of the first case is evident through Jason's narration in which he described how the message transmitted by Lecturer A regarding the time-management did not have any affect on his thinking because effective management of the study time was already taught to him by his school teachers. In this case the suggested practice was already an aspect of the student's

identity as a mathematics learner and in the interaction with it he remained in his comfort zone.

Another characteristic example of a transmitted message that positions immediately the student in a specific zone, comes from Eric's story. Eric described how the strongly classified and framed message transmitted through the lecturer's suggestion about having mathematical conversations with other peers during lecture time benefited his learning and prompted him to change his ways of working. This new practice that was not used at school, contributed to his movement into the transitional zone. Likewise, we noticed an immediate move into the transitional zone from Elsa, as a result of receiving the strongly classified and weakly framed message through Lecturer A's suggestions about visiting the university's mathematics support centre. Taking action from this suggestion gave to Elsa enough space to look for further answers in her queries and in this way to expand her mathematical knowledge.

Finally, there were instances that students by receiving specific messages positioned themselves promptly into the discomfort zone. We see this in the case of Jeremy who felt uncomfortable discussing mathematics with his peers during lecture time. The strongly classified and framed message conveyed through this practice positioned him in the discomfort zone, where he chose to remain silent and go through the tasks on his own. Similarly, Lesley by receiving the strongly classified and weakly framed message transmitted with the use of coursework, which stressed the change in the assessment practices, made her feel constrained and so she positioned herself right away into the discomfort zone.

7.4 Final Remarks

With this study I pinpointed the influences that the exerted power and control conveyed through the discourses and practices can have on students' transition to university mathematics. I stressed that taking into account only these two underlying structures that the practices and discourses at university carry it is not possible to understand and explain the transitional experience. A significant role is played by students' identities as mathematics learners in the interaction with the various messages. The result of this interaction (student-message) affects students' positioning in the new context.

The data of this study suggest that messages which exert weak control give more independence to the students. The effect that these kinds of messages can have on students depends highly on their previously formed identities as mathematics learners. On certain occasions students, due to the lack of control, felt either constrained and positioned themselves in the discomfort zone or ignored the message and remained in their comfort zones. On the other hand, there were students that embraced the independent character of these messages and by interacting with them were eager to move into the transitional zone.

The messages that were strongly framed took away the responsibility from the students. In this case, the high degree of control was more appealing to a number of students because of their previous experiences with school mathematics. Therefore, they moved easily into the transitional zone by interacting with strongly framed messages. Similarly, on several occasions messages acquired through school years - including the strong influence from assessment - came to the fore and persisted in being influential in this phase. Finally, from students' stories it was apparent that the high level of control conveyed

through the discourses in university mathematics can be a barrier for those students who need space and want to learn and work with mathematics in a more independent context. The interaction with strongly framed messages moved these students to the discomfort zone.

The results of this study suggest that many students during the transitional phase get influenced by the degree of power and control in the transmitted messages. A very important aspect in the interaction with the transmitted messages is the extent to which they make the students feel comfortable or constrained in this phase and eventually how this interaction impacts on their positioning. I recognise that it is a complex and challenging task to find a balance of control and independence expected for the university actors that transmit the messages. Once this balance is found though the students can expand the boundaries of their comfort zones, shaped throughout the previous years through schooling, challenge their thinking and integrate smoothly in the university context.

Hence, I suggest that the types of discourse that take place in teaching-learning interactions during the transitional phase should be given upmost importance. Moreover, we should always keep in mind that every student forms her/his identity as a mathematics learner in a very unique way before coming to university through various experiences while engaging with mathematics. The ways that students' identities are shaped are very crucial for their further steps at university, and this is an emerging theme through this study from the ways that students interpreted the transmitted messages. But on the other hand, all students are subjected to similar cultures and rules, e.g. assessment practices that carry exchange value, that shape their identities in similar ways (every student acknowledges the value of the examination). This explains why this is a very complex issue. One can never know whether

students will react in similar ways (structural) or in different ways (agentic); at the end of the day it is really a combination of both. And this is what I want to stress through this work; the complexity of the interaction between the agency of the student and the structure of the institution.

Moreover, great attention should be paid to students' identities in this trajectory. I acknowledge that this is a hard thing to do as a lecturer cannot get to know 200 students and at the same time their identities. There are though some initiatives that if employed can make more feasible lecturers' acquaintance with their students' learning habits. For instance, the measure for mathematical identity developed by Kaspersen, Pepin, and Sikko (2016) could be used so lecturers can have a broad idea of what kind of students they are interacting with. Or research instruments like Social Network Analysis to understand the social behaviours of undergraduate students (Alcock et al., 2016).

In the interaction with the different levels of power and control conveyed through the messages students (re)shape their identities and as a result their positioning as mathematics learners in the new context is highly influenced. Therefore, university actors should make a greater effort to consider the kind of control and power they exert through the messages in order to facilitate students' transition to university mathematics. For example, they should be able to articulate the benefits and provide convincing arguments of why particular practices are more effective when employed in this context (e.g. mathematical discussion among peers) but at the same time they should recognise the possibility that a number of students might not want, or not be ready yet, to engage with these practices and therefore provide them with the opportunity of a choice.

7.5 Limitations, Future Research & Reflection

The time restrictions imposed by the nature of the PhD programme created some limitations in the conduct of the study. A bigger cohort of students and a longer time period (the whole first year and the beginning of the second year) would be more resourceful for the data collection. Unfortunately in order to be efficient with the planning of the study I had to keep the numbers of participants and time down.

For future research I would suggest a replication of this study using a bigger cohort size and in a longer time period. Moreover, it would be interesting to replicate the study in different universities in various countries and compare the results. On the occasion that similar results occur in other institutions a further step for this work would be to explore ways to facilitate students' transitional experience.

The theories used in this work served entirely the purpose of the research. A more thorough aspect of the issue could be given with additional use of quantitative methods, something that was not feasible here due to time restrictions. Despite this fact the data collected in this study, the theories and the methods that were used for the analysis contributed fruitfully to the exploration of the initially posed research questions.

References

Abdulwahed, M., Jaworski, B., & Crawford, A. R. (2012). Innovative approaches to teaching mathematics in higher education: a review and critique. *Nordic Studies in Mathematics Education*, *2*, 49–68.

Alcock, L., Hernandez-Martinez, P., & Godwin Patel, A. (2016). Study habits in undergraduate mathematics: a social network analysis. In *Proceedings of the 40th annual conference of the international group for the psychology of mathematics education.* Szeged, Hungary: PME.

Alrø, H., & Skovsmose, O. (2002). *Dialogue and learning in mathematics education: Intention, reflection, critique (mathematics education library)* (1st ed.). New York, Boston, Dodrecht, London, Moscow: Kluwer Academic Publishers.

Archer, L., Dawson, E., Dewitt, J., Seakins, A., & Wong, B. (2015). "science capital": A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts. *Journal of Research in Science Teaching*, *52*(7), 922–948.

Ashwin, P. (2009). *Analysing teaching-learning interactions in higher education : accounting for structure and agency.* London and New York: Continuum International Publishing Group.

Bardelle, C., & Di Martino, P. (2012). E-learning in secondarytertiary transition in mathematics: for what purpose? *ZDM*, *44*(6), 787–800.

Bernstein, B. (1971). On the classification and framing of educational knowledge. In M. F. Young (Ed.), *Knowledge and control* (p. 47-69). London, UK: Butler and Tanner.

Bernstein, B. (1980). *Codes, modalities and the process of cultural reproduction: A model.* Department of Education, University of Lund.

Bernstein, B. (1996). *Pedagogy, symbolic control and identity.* London:

Taylor and Francis.

Bernstein, B. (2000). *Pedagogy, symbolic control, and identity: theory, research, critique*. Rowman & Littlefield.

Biza, I., Giraldo, V., Hochmuth, R., Khakbaz, A., & Rasmussen, C. (2016). *Research on teaching and learning mathematics at the tertiary level: State-of-the-art and looking ahead*. Springer International Publishing.

Black, L., & Hernandez-Martinez, P. (2016). Re-thinking science capital: the role of 'capital' and 'identity' in mediating students engagement with mathematically demanding programmes at university. *Teaching Mathematics and its Applications*, *35*, 131–143.

Black, L., Williams, J., Hernandez-Martinez, P., Davis, P., Pampaka, M., & Wake, G. (2010). Developing a 'leading identity': The relationship between students' mathematical identities and their career and higher education aspirations. *Educational Studies in Mathematics*, *73*(1), 55–72.

Bosch, M., Fonseca, C., & Gascón, J. (2004). Incompletitud de las organizaciones matemáticas locales en las instituciones escolares. *Recherches en didactique des Mathématiques*, *24*(2–3), 205–250.

Bourne, J. (2004). Framing talk: towards a radical visible pedagogy. In B. D. Johan Muller & A. Morais (Eds.), *Reading bernstein, researching bernstein* (p. 61-74). London, UK: Routledge and Falmer.

Brandell, G., Hemmi, K., & Thunberg, H. (2008). The widening gap - a swedish perspective. *Mathematics Education Research Journal*, *20*(2), 38–56.

Breen, S., Shea, A. O., & Pfeiffer, K. (2013). The use of unfamiliar tasks in first year calculus courses to aid the transition from school to university mathematics. In . M. M. B. Ubuz, Ç. Haser (Ed.), *Proceedings of the*

8th conference of european research in mathematics education (p. 2316-2325). Antalya, Turkey.

Brousseau, G. (1997). *Theory of Didactical Situations in Mathematics.*

Bruner, J. (1996). *The culture of education.* Harvard University Press.

Cheng, D., & Walters, M. (2009). Peer-assisted learning in mathematics: An observational study of student success. *Journal of Peer Learning*, *2*(1), 23–39.

Cherif, A., & Wideen, M. (1992). The Problems of Transition from High School to University Science. *Catalyst*.

Chevallard, Y. (1992). Fundamental concepts in didactics: perspectives provided by an anthropological approach. *Research in Didactique of mathematics*, 131–168.

Clark, M., & Lovric, M. (2008). Suggestion for a theoretical model for secondary-tertiary transition in mathematics. *Mathematics Education Research Journal*, *20*(2), 25–37.

Clark, M., & Lovric, M. (2009). Understanding secondarytertiary transition in mathematics. *International Journal of Mathematical Education in Science and Technology*, *40*(6), 755–776.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education.* London: Routledge.

Crawford, K., Gordon, S., Nicholas, J., & Prosser, M. (1994). Conceptions of mathematics and how it is learned: The perspectives of students entering university. *Learning and Instruction*, *4*(4), 331–345.

Darragh, L. (2016). Identity research in mathematics education. *Educational Studies in Mathematics*, *93*(1), 19-33.

Daskalogianni, K., & Simpson, A. (2002). "Cooling-Off": The Phenomenon of a Problematic Transition from School to University. In *Proceedings*

of the 2nd international conference on the teaching of mathematics at undergraduate level.

De Guzman, M., Hodgson, B., Robert, A., & Villani, V. (1998). Difficulties in the passage from secondary to tertiary education. In *Proceedings of the international congress of mathematicians* (pp. 747–762). Berlin.

Duah, F., Croft, T., & Inglis, M. (2014). Can peer assisted learning be effective in undergraduate mathematics? *International Journal of Mathematical Education in Science and Technology*, *45*(4), 552–565.

Eco, U. (1979). *The role of the reader: explorations in the semiotics of texts.* Bloomington: Indiana University Press.

Engelbrecht, J. (2010). Adding structure to the transition process to advanced mathematical activity. *International Journal of Mathematical Education in Science and Technology*, *41*(2), 143–154.

Farmaki, V., & Paschos, T. (2007). The interaction between intuitive and formal mathematical thinking: a case study. *International Journal of Mathematical Education in Science and Technology*, *38*(3), 353–365.

Furinghetti, F. (2000). The history of mathematics as a coupling link between secondary and university teaching. *International Journal of Mathematical Education in Science and Technology*, *31*(1), 43–51.

Gronbaek, N., & Winslow, C. (2007). Developing and assessing specific competencies in a first course on real analysis. *Issues in Mathematics Education*, *VI*, 99–138.

Gueudet, G. (2006). Using Geometry to teach and learn Linear Algebra. *Research in Collegiate Mathematics Education VI*, 171–195.

Gueudet, G. (2008). Investigating the secondary-tertiary transition. *Educational Studies in Mathematics*, *67*(3), 237–254.

Gueudet, G., & Pepin, B. (2016). Didactic contract and secondary-tertiary

transition: a focus on resources and their use..

Halliday, M. A. K., & Hasan, R. (1989). *Language, context and text: aspects of language in a social-semiotic perspective.* Oxford: Oxford University Press.

Harris, D., Black, L., Hernandez-Martinez, P., Pepin, B., Williams, J., & with the TransMaths Team. (2014). Mathematics and its value for engineering students: what are the implications for teaching? *International Journal of Mathematical Education in Science and Technology*, *46*, 321–336.

Hernandez-Martinez, P. (2016). "Lost in transition": Alienation and drop out during the transition to mathematically-demanding subjects at university. *International Journal of Educational Research*, 231–239.

Hernandez-Martinez, P., & Williams, J. (2013). Against the odds: resilience in mathematics students in transition. *British Educational Research Journal*, *39*(1), 45–59.

Hernandez-Martinez, P., Williams, J., Black, L., Davis, P., Pampaka, M., & Wake, G. (2011a). Mathematics coursework as facilitator of formative assessment, student-centred activity and understanding. *Research in Mathematics Education*, *13*(2), 197–212.

Hernandez-Martinez, P., Williams, J., Black, L., Davis, P., Pampaka, M., & Wake, G. (2011b). Students' views on their transition from school to college mathematics: rethinking transition' as an issue of identity. *Research in Mathematics Education*, *13*(2), 119–130.

Hoffkamp, A., Paravicini, W., & Schnieder, J. (2013). Mathematical Enculturation and Proof at the Transition from School to University. In . M. M. B. Ubuz, Ç. Haser (Ed.), *Proceedings of the 8th conference of european research in mathematics education* (pp. 2356–2365). Antalya,

Turkey.

Holland, D., Lachicotte Jr., W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Harvard University Press.

Holmegaard, H. T., Madsen, L. M., & Ulriksen, L. (2013). A journey of negotiation and belonging: Understanding students' transitions to science and engineering in higher education. *Cultural Studies of Science Education*, 1–32.

Hourigan, M., & O'Donoghue, J. (2007). Mathematical under-preparedness: The influence of the pre-tertiary mathematics experience on students' ability to make a successful transition to tertiary level mathematics courses in Ireland. *International Journal of Mathematical Education in Science and Technology*, *38*(4), 461–476.

Hoyles, C., Newman, K., & Noss, R. (2001). *Changing patterns of transition from school to university mathematics* (Vol. 32) (No. 6).

Jablonka, E., Ashjari, H., & Bergsten, C. (2016). Much palaver about greater than zero and such stuff: First year engineering students' recognition of university mathematics. *International Journal of Research in Undergraduate Mathematics Education*, *3*(1), 69–107.

Jaworski, B., Robinson, C., Matthews, J., & Croft, T. (2012). An activity theory analysis of teaching goals versus student epistemological positions. *The International Journal for Technology in Mathematics Education*, *19*(4), 147–152.

Jooganah, K., & Williams, J. (2010). The transition to advanced mathematical thinking: Socio-cultural and cognitive perspectives. *Proceedings of the British Society for Research into Learning Mathematics*, *30*(1), 113–120.

Jooganah, K., & Williams, J. S. (2016). Contradictions between and within

school and university activity systems helping to explain students' difficulty with advanced mathematics. *Teaching Mathematics and its Applications*.

Kajander, A., & Lovric, M. (2005). Transition from secondary to tertiary mathematics: McMaster University experience. *International Journal of Mathematical Education in Science and Technology*, *36*(2-3), 149–160.

Kaspersen, E., Pepin, B., & Sikko, S. A. (2016). Measuring STEM students' mathematical identities. *Educational Studies in Mathematics*(1). doi: 10.1007/s10649-016-9742-3

Kouvela, E., Hernandez-Martinez, P., & Croft, T. (2017). "This is what you need to be learning": An analysis of messages received by first-year mathematics students during their transition to univeristy. *Mathematics Education Research Journal*, *(accepted)*.

Lawson, D., Croft, T., & Halpin, M. (2001). After the diagnostic test what next? *MSOR Connections 1*(3), 23–26.

Lerman, S. (2000). The social turn in mathematics education research. In J. Boaler (Ed.), *Multiple perspectives in mathematics teaching and learning* (p. 19-44). Westport CT, London: Ablex Publishing.

Lerman, S. (2001). Cultural, discursive psychology: A sociocultural approach to studying the teaching and learning of mathematics. *Educational Studies in Mathematics*, *46*(1), 87–113.

Lerman, S. (2014). *Encyclopedia of mathematics education* (S. Lerman, Ed.). Dordrecht: Springer Netherlands.

Leviatan, T. (2008). Bridging a cultural gap. *Mathematics Education Research Journal*, *20*(2), 105–116.

Luk, H. S. (2005). The gap between secondary school and university math-

ematics. *International Journal of Mathematical Education in Science and Technology*, *36*(2-3), 161–174.

Moore, R. C. (1994). Making the transition to formal proof. *Educational Studies in Mathematics*, *27*(3), 249–266.

Morais, A., Neves, I., & Pires, D. (2004). The what and the how of teaching and learning: going deeper into sociological analysis and intervention. In B. D. Johan Muller & A. Morais (Eds.), *Reading bernstein, researching bernstein* (p. 75-90). London, UK: Routledge and Falmer.

Nardi, E. (1996). *The novice mathematician's encounter with mathematical abstraction: Tensions in concept- image construction and formalisation* (Unpublished doctoral dissertation). University of Oxford.

Oikkonen, J. (2009). Ideas and results in teaching beginning maths students. *International Journal of Mathematical Education in Science and Technology*, *40*(1), 127–138.

Pampaka, M., Williams, J., & Homer, M. (2016). Is the educational 'what works' agenda working? Critical methodological developments. *International Journal of Research & Method in Education*, *3*(39), 231–236.

Pampaka, M., Williams, J., & Hutcheson, G. (2012). Measuring students' transition into university and its association with learning outcomes. *British Educational Research Journal*, *8*(6), 1041–1071.

Pongboriboon, Y. (1989). Transition from Senior Secondary to University Mathematics: A case study. In *Conference proceedings* (pp. 439–448). Hawkaid Conference Centre, University of Western Sydney.

Pring, R. (2004). *Philosophy of Educational Research Second Edition.* London: Continuum.

Pritchard, D. (2010). Where learning starts? A framework for thinking about lectures in university mathematics. *International Journal of Mathemat-*

ical Education in Science and Technology, *41*(5), 609–623.

Pyke, R. (2012). Addressing first year university mathematics and the transition from high school at Simon Fraser.

Raman, M. (2002). Coordinating informal and formal aspects of mathematics: Student behavior and textbook messages. *Journal of Mathematical Behavior*, *21*(2), 135–150.

Randahl, M. (2012). Approach to mathematics in textbooks at tertiary level exploring authors' views about their texts. *International Journal of Mathematical Education in Science and Technology*, *43*(7), 881–896.

Sambell, K., & McDowell, L. (1998). The Construction of the Hidden Curriculum: messages and meanings in the assessment of student learning. *Assessment & Evaluation in Higher Education*, *23*(4), 391–402.

Senninger, T. (2000). *Abenteuer leiten, in abenteuern lernen.* Oekotopia Verlag.

Solomon, Y. (2007). Not belonging? What makes a functional learner identity in undergraduate mathematics? *Studies in Higher Education*, *32*(1), 79–96.

Solomon, Y. (2009). *Mathematical literacy: Developing identities of inclusion.* Routledge: Taylor and Francis.

Solomon, Y., & Croft, T. (2015). Understanding undergraduate disengagement from mathematics: Addressing alienation. *International Journal of Educational Research.*

Solomon, Y., Croft, T., & Lawson, D. (2010). Safety in numbers: mathematics support centres and their derivatives as social learning spaces. *Studies in Higher Education*, *35*(4), 421–431.

Strauss, A., & Corbin, J. (2008). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (Vol. 3).

Swan, M. (2006). Learning gcse mathematics through discussion: What are the effects on students? *Journal of Further and Higher Education*, *30*(3).

Tall, D. (1991). *Advanced Mathematical Thinking* (D. Tall, Ed.). Springer Netherlands.

Thomas, M. O. J., & Klymchuk, S. (2012). The school-tertiary interface in mathematics: Teaching style and assessment practice. *Mathematics Education Research Journal*, *24*(3), 283–300.

Ulriksen, L., Holmegaard, H. T., & Madsen, L. M. (2013). Weaving a Bridge of Sense: Students' narrative constructions as a lens for understanding students' coping with the gap between expectancies and experiences when entering higher education. *European Educational Research Journal*, *12*(3), 310–319.

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity.* Cambridge: Cambridge University Press.

Williams, J., Black, L., Hernandez-Martinez, P., Davis, P., Pampaka, M., & Wake, G. (2009). Repertoires of aspiration, narratives of identity, and cultural models of mathematics in practice. In M. Cesar & K. Kumpulainen (Eds.), *Social interactions in multicultural settings* (p. 39-69). Rotterdam: Sense Publishers.

Wingate, U. (2007). A Framework for Transition: Supporting 'Learning to Learn' in Higher Education. *Higher Education Quarterly*, *61*(3), 391–405.

Winslow, C. (2013). The transition from university to high school and the case of exponential functions. In . M. M. B. Ubuz, Ç. Haser (Ed.), *Proceedings of the 8th conference of european research in mathematics education* (pp. 2476–2485). Antalya, Turkey.

Wood, L. N., & Solomonides, I. (2008). Different disciplines, different transitions. *Mathematics Education Research Journal*, *20*(2), 117–134.

Appendices

APPENDIX A

First appendix

A.1 Narratives of the rest five students

A.1.1 Alex's narrative

Alex always loved mathematics and this was a decisive factor in his decision to follow a degree in mathematics: "I liked maths since I was... since I can't remember... I always wanted to do a maths degree". He expected mathematics at university to require more independent study but he also believed that the mathematics taught at school would be applicable in the majority of the modules. Eventually, he found university mathematics being harder than he initially expected: "...we got here in the first week it wasn't that tough, second week wasn't that tough, and the third week was like a kick in the face."

In the following I will present more information from his background story

which appears to be important in the formation of his identity as a mathematics learner. In addition, I will talk about the messages that influenced him the most during this journey and the effect that the interaction with them had in his transition.

A.1.1.1 Background information

Alex wanted to study mathematics since he was young and mathematics was the subject that he loved doing the most throughout school. In his story there were parental influences for the interest he developed in mathematics, but not explicit ones. He described his father's academic background, with a joint degree in Mathematics, as an influential factor for his love for the subject: "My dad was doing a maths degree and so I think that's why I like maths..." In the interview he described these influences in more detail: "He said it was hard, but I am sort of expecting that because it is a degree, he loved every bit of it and he was telling me about some of the... you know just some of the lectures and he showed me some of his notes that he still has, he is sort of I wouldn't say a hoarder but kind of a sentimental person so he kept them all 'cause he still works in computers so he utilises his degree. But yeah he really likes it, but he stayed away from like the origins of maths and things. So he did mechanics, stats, and mainly methods in Calculus. Things along that line."

During his time in the sixth form Alex took A Level Further Mathematics and on many occasions he used to work together with his friends. There were times that he felt the content was particularly difficult and on such occasions he used to turn for help either to his friends or his school teacher. Before coming to university he expected studying mathematics at this level to be about proving theorems and to require independent study. He mentioned

that at school students were led to believe that the A Level Further Mathematics would apply to the modules taught at university: "Well I mean we are only a short bit in [to the module] but I don't think that a lot of the stuff we covered in Further [Mathematics] applies to the other subjects that we are doing as much as we were led to believe that it would."

He expresses a deep interest for the subject of mathematics itself, and he enjoys when this interest comes to the fore from his lecturer: "Lecturer A mentioned [in] week 1 that week 10 it's going to be her favourite lecture and she said: 'If you are a true mathematician you'll find it the most interesting thing and I thought at the time in week 1, I thought 'Nah, it's probably some random thing that [she] is getting over obsessed about' and it came to week 10 and I was generally like shocked by that and also happy, I messaged my mum and I told her the theory..." His favourite approach for learning during the lectures is based on two elements: at first, writing down the notes in order to pay close attention to the content and then taking short breaks to discuss with his peers in order to understand what is being taught. Alex's confidence level while he is doing mathematics is not very high. This is apparent when he describes that he works rather easily with Module A, which comes as a surprise: "I am doing things well but the fact that I am doing them right, it doesn't feel right, I feel like I shouldn't be getting so much with a try, without trying to sound arrogant I don't know why I am understanding and learning all of it so well. I usually struggle to pick up on things..."

A.1.1.2 Experiencing university mathematics

Alex referred to four out of the six categories of messages as these emerged from the data. He talked about messages regarding assessment, general study habits, things that students should do during lectures and things that stu-

dents should do outside lectures.

Assessment

One of the messages that influenced Alex in his transition has to do with the assessment required for the two modules that were observed. He described how the different assessment practices used at university affected the ways he studies: "[At school] I spent the whole year just doing past papers and now... [at university] you do something and then you wait a bit and then you do another test... So you've got to change your way of working around, learning for each module, for each test rather than just for one test." At school there was only an examination at the end of the year and his work was mainly focused on past papers. The layout of the assessment at university, with the courseworks and the tests spread during the semester, made him change his approaches to studying. Instead of working on past papers for the final examination, now he has to break down the covered content and study for each test during the semester.

Another positive influence from the assessment comes from the feedback students receive following each of the tests: "I think it was because I actually had high scores in my tests [in Module A] that I begin to believe that I can do maths ... We had tests in weeks 3, 6 and 9 each of those tests I've got over 70% and I am really happy with that, so having a progress check along the way makes you more confident for the exam." By achieving high scores in the tests Alex admitted that he felt more assured about his mathematical competence and about the forthcoming examination at the end of the semester. He mentioned also that his success in the tests of Module A would not divert his attention away from working for this module.

Despite the different degree of control that the two lecturers transmitted

through the use of class tests and coursework (Lecturer A demonstrated a high level of control by employing the tests and on the other hand Lecturer B's practice with the coursework conveyed a low level of control to the students, Section 5.1.4), Alex got influenced from both messages. This is evident if we look closely at how he approached his work and learning, after receiving the messages. The regularity of the assessment methods throughout the semester made him change his previous ways of studying; instead of solving only past papers now he directed his attention to study within each module a number of different topics separately, guided by the testing and coursework schedules imposed by the lecturers. Furthermore, the strong control carried through Lecturer's A message and the use of class tests made him realise the benefits of monitoring his progress. Drawing from the two different messages Alex reshaped his identity as a mathematics learner; he changed his working practices and felt more comfortable doing mathematics by receiving encouraging feedback. This reshape, influenced by the transmitted messages, shows a smooth move from his comfort zone to the transitional zone.

General study habits

The next category of messages that Alex referred to extensively is that of general study habits. He talked about time-management, keeping up with the module and creation of definitions lists.

Time-management

Alex recognised the message transmitted by Lecturer A about time-management but he was not able to follow the advice completely. He struggled to find enough time during the week to study for all the modules: "But I have like productive weeks and then weeks of just shame that I don't do anything at all... it doesn't go quite smoothly as I hoped it would." Despite the dif-

ficulties he faced in sharing his time effectively among all the modules he acknowledged that the message about time-management prompted him to take action and to make a plan for his study time: "When I think 'Ok, I will do some work now' I have like a list of the six modules in which order I should do them and the bottom two never really get worked on. I am too busy focusing on Module A."

The information that Lecturer A conveyed about time-management had an impact in Alex's thinking but not to a great extent. It is evident that the high level of power made the message easily recognisable and he was keen to organise his study time accordingly. But the low degree of control over the sequencing and the pacing, and therefore the space that the lecturer provided for taking initiatives, constrained Alex. Although he was willing to change and make a plan for his study, at the end of the day this was not effective. He showed eagerness to reform his identity as a learner and adjust to the new requirements but the heavy workload restrained him. This put him into the discomfort zone. Despite the fact that the powerful message tended to move him into the transitional zone, the weak framing that it carried did not make it effective and Alex found himself in the process of adjusting between the discomfort and the transitional zones.

Keep up / Do not fall behind

Keeping up with Module A was the second message that Alex received from the study advice that Lecturer A gave. It was a powerful and explicit message for him as he talked about it in every phase of the study (questionnaire, focus group, interview). Here he describes in detail how it has influenced him: "[It] was sort of brought to us from day one... she said: 'Module A will wipe the floor with people that don't keep up well' and so from that moment on whenever I had Module A work to do I instantaneously did it the next day

because I am actually petrified of falling behind in it simply because of how much she tells us not to... I have not fallen behind... and I am really glad... because it's enhanced my learning... so she was right. And I've tried to keep that with the other ones but I haven't done it as rigidly."

There was a clear impression created in Alex's mind from this message. The strong power that it carried and the selection of the words that the lecturer used for its transmission controlled his thinking about Module A. It also confirmed what he previously said about the management of his study time where he put more emphasis on prioritising Module A. The space that the lecturer provided to the students with the weak control over the organisation and pacing of the study of the module made Alex feel quite proactive and he saw it as a chance to put in work. He felt confident through the enhancement of his learning. We can see also the greater influence that the received message had on his studies and his identity as a mathematics learner; he took action immediately for Module A and intended to do the same for the rest of the modules, even if he did not manage to accomplish that until the time the interview took place. By putting this message into practice we notice a move from his comfort zone (and all the things that he was used to doing until this point) into the transitional zone.

Definitions lists

The last message that Alex received from this category was about the creation of definitions lists: "So again from Lecturer A she recommended that we make list of definitions, and I've done so for each [one] of the topics and... I just flicked through whenever I am doing like coursework or when there is nothing to do... and try to keep up with the learning... I changed my work around that, I am a lot more organized than I have ever been before with keeping my work in a certain place." The lecturer made clear to the students how

important it is to have all the definitions organized in one place where they would be easily accessible during study time. Alex received the message and admitted that from that moment onwards he realised that he had to change the way of organizing his study material, which eventually he did.

As with the rest of the advice given by Lecturer A, by receiving the message he was encouraged to change his study routine. The power of the advice was strong and made the message easily understandable. The mixed framing gave him enough space to act independently and to take the initiative of organising his whole working pattern in a more efficient way. In this case Alex seems comfortable having the control over this practice. The actions that he took, prompted by this message, added new elements to his identity, and enriched it by making him feel more comfortable about his study habits. He positioned himself in the transitional zone where he was eager to embrace and employ changes in order to integrate better in the new context.

Things that students should do during lectures

The main message that Alex got from the teaching practices that Lecturer A and Lecturer B used (Section 5.1.1) was that he had to be consistent with the writing of the notes and to discuss mathematics with his peers: "...with Module A... and Module B... you don't really put your pen down through the whole lesson... [they] run smoother than the other [ones]... I think that is much better to be well involved with your lectures... that's why I prefer Module B... and Module A... you are given like a minute or two to discuss a problem on the board and it gets you away from just staring at black and white in your paper and it gets you to really think about what you actually just learned, so you don't need to spend all that time afterwards processing it if you were paying attention in the whole lecture, it saves you time and

it actually makes you learn better I'd say... I learn more from writing and doing and I understand the stuff as we are going along."

Alex's performance during lecture time was influenced by the ways the two lecturers taught the modules. Although they both used different approaches while teaching Alex classified them as similar. The similarities had to do with the level of interaction that the students had with their peers during lecture time and the fact that they had to write down their notes. The high degree of power and control carried through the practices used during the lecture time affected Alex's thinking. He perceived as helpful to engage in well defined practices with a fair distribution of time between writing and communicating mathematics. Becoming involved in writing the notes and talking about the tasks re-assured his identity as a mathematics learner and enhanced his learning. The strongly framed practices employed by both lecturers made Alex feel comfortable and that he gained from the time spent in the lectures. This contributed to his move from the comfort zone into the transitional zone where he integrated to the new practices used during lecture time and he invested his time readily in his learning.

Things that students should do outside lectures

Another change in the ways he used to study came as a result of the things that the lecturers suggested the students do outside lecture time (work with the problem sheets and further reading from recommended textbooks, Section 5.1.2). More specifically from the engagement with the problem sheets: "I honestly think I do more work now than I did at A Levels outside of lessons. I used to do the class work and then do the past papers in the lessons and then do nothing when I went home... here I do more work outside the lectures than I thought I'd actually end up doing. So I think the way of studying has

changed..." We see Alex admitting that now at university he has to spend more time working outside lectures, something that did not happen back at school. In a later stage he described in more detail the new things that he started doing at university while studying: "All I did [at school] was past papers... [Now] I do problem sheets... Ok I don't do problem sheets, I learn the logic behind the content and if I don't understand something then I will do a problem sheet... Honestly it's usually just the coursework that I do, and then I do... some work for the lectures but like I mentioned I am surprisingly keeping up so I don't do a huge amount of work on stuff I understand."

It is evident that the power carried through the message with the use of the problem sheets influenced Alex's thinking towards his learning. He recognised that there is work to be done after lectures and that this is something entirely different from school. Although he admitted that he had to put in more effort at university compared to school, when he described what is exactly the work that he did he said that it is to 'learn the logic behind the content'. This is because he has a feeling of understanding of what is going on. This feeling is re-assuring his identity that he is keeping up and he does not have to put in extra effort in addition to what he is already doing. The results from his final examination in Module A will prove him wrong as we will see in the following. With the lack of control in this message Alex seemed unwilling to engage properly with the problems. He had a go with the problems only when he felt that there was a concept that he did not fully comprehend and therefore his mathematics competence was at risk. He seemed to be at the boundary between the discomfort and the transitional zone, where he understands that the practices from school change and more work needs to be put in. But his feeling of confidence that he could grasp the meanings kept him from trying and neglected to work regularly with the

problem sheets.

A.1.1.3 Overall impact

The messages that influenced Alex and prompted him to take action were mostly the ones carrying a high degree of power and control, such as the message transmitted through the use of gappy notes. However, he recognised also messages that were weakly framed, such as those concerning time-management, but they did not have the same effect on his learning. The space that was provided through the low level of control did not always make him feel comfortable. Although he was willing to take the opportunity and improve his learning he was not entirely successful in adopting the new study habits. In the following table I present an overview of the received messages.

Message	Classification	Framing	Positioning
Class test ($M_{4.1}$)	$+$	$++++$	Transitional zone
Coursework ($M_{4.2}$)	$+$	$++--$	Transitional zone
Time-management ($M_{5.1}$)	$+$	$++--$	Discomfort/Transitional zone
Keep up ($M_{5.3}$)	$+$	$++--$	Transitional zone
Definitions lists ($M_{5.2}$)	$+$	$++--$	Transitional zone
Taking notes ($M_{1.1}, M_{1.2}$)	$+$	$++++$	Transitional zone
Discussion with peers ($M_{1.4}$)	$+$	$++++$	Transitional zone
Problem sheets ($M_{2.1}$)	$+$	$++--$	Discomfort/Transitional zone

Table A.1: Messages received by Alex

In conclusion, Alex was mostly influenced by the messages that were strongly classified and framed. He seemed to feel more comfortable whenever he had to follow practices entirely defined by his lecturers. Recall, for

example, the message that Lecturer A transmitted regarding the assessment which made him change the ways he used to work for similar situations back at school. We can see from what he said how a strongly classified and framed message affected his identity as a mathematics learner and moved him from the comfort zone to the transitional zone.

On the other hand there were times that Alex positioned himself in the discomfort zone. That was mainly caused when the messages transmitted from the lecturers gave him more control over his learning. For instance, when he talked about the message regarding the time-management. In this case Alex tried to find a balance between the discomfort zone and the transitional zone. He tried to organise his study time but he ended up being ineffective because he exhausted all his time in studying one module. Despite the fact that he felt constrained he made an effort to adjust and move into the transitional zone.

At the end of the semester Alex had still not fixed his position in the transitional zone. Although he passed both modules - 50% in Module A and 77% in Module B - he admitted that there were more things to change as a result of what the lecturers suggested. He said: "More problem sheets, just attending lectures and thinking about your work isn't enough, you have to apply what you learn and apply yourself to the work."

A.1.2 Carin's narrative

Carin studies for a joint degree in Mathematics with Mathematics Education. She described how she always wanted to be a mathematics teacher and that her choice was highly influenced by her school mathematics teacher: "Well, I've always wanted to be a maths teacher, since I was little so a maths degree was sort of always [what] I wanted to do, it was more where I would go. Yeah,

I think she probably did influence, I like University X, I didn't come because she liked it but she has been here so that made me feel like, obviously if she managed to become a maths teacher then I can go to University X and so I can be a maths teacher as well." She expected studying mathematics at university to be more independent but eventually was more difficult than what she initially had envisaged: "There is a huge difference in difficulty and loads of theorems".

In the following I will present some aspects of Carin's identity as a mathematics learner as these arose through our discussions. I will also demonstrate the messages that she received during the first semester at university and how the interaction with these messages influenced her settling in at the new context.

A.1.2.1 Background information

Carin had an interest in becoming a mathematics teacher since she was young. She seemed rather determined about it and admitted that the fact that her school mathematics teacher had attended the exact same course was a motivation to pursue it. There were not influences from her family environment regarding the degree choice, but mostly about the location of the university that she would choose: "My dad always wanted me to be in a campus based uni rather than one that is spread out all over the place. But inevitably if I wanted to go in a non-campus based he wouldn't have said no. But we came to the open day and both my mom and dad really liked it so they were happy for me to come here as well."

While she was at sixth form she had taken A Level Further Mathematics and there were times that she considered particularly difficult the Mechanics. On these occasions she sought help from her school teacher. Usually she

did not work with her friends while doing mathematics. Before coming to university she expected mathematics at this level to be mostly about solving real world problems. Furthermore, she expected studying mathematics at university level to require independent study. Her expectations were mainly based on information that her mathematics teacher shared with her: "...my maths teacher actually came to University X and she was like telling me what it was like... She was saying what to expect and it's not going to be as bad as you think..." She referred in detail to what exactly she expected studying at university be like from the information that she had received: "I heard it's like a lot more self-taught, obviously at school you've got a teacher in one class and the teacher knows everyone in the class and then I didn't quite anticipate how the lectures [would be] here. I thought there was going to be like maybe 50, 60, not like 200 in one room and the lecturer just like obviously is talking and you are expected to like take away what you want to and then do whatever you want to do to help yourself... Like if you don't understand something, 'cause it is up to you to go and like make sure you do understand it the lecturer won't come up to you be like: 'Did you understand that?' It's up to you to decide what you do and didn't, like quite get..."

When Carin came to university she recognised that there were differences from school in respect of the time distribution (time spent for lectures, time spent for individual study, etc.): "I didn't expect quite as many lectures as we have. I knew that it was going to be like intense but I thought it was going to have more time to ourselves, to do independent revision. Is reasonably structured I think, like, obviously you don't have to go to your lectures but if you do go to all of them there is only a couple of days when you got actually free time. And I didn't expect it to be quite as intense as it is."

In order to cope with the different approaches employed at university

Carin had to change her previous ways of working: "...you don't understand it but it's ok and that's a normal thing in a maths degree, whereas like at A level obviously everything was very much alike, here is a question and looks like you should need to do it this way, whereas here is a bit more like, when you see the question you have to sort of think about what do you expect to happen before you even start. And I think that's like the biggest for me, that's like I prefer to just get going whereas I have to actually like stop and make sure I think about what I am doing before I do it because at A level it's quite like methodological and each thing is just going like: do this, do that, do the other. But like here you do it like for one question you might do this and for that question do this and each one is so different. Whereas at sixth form was quite like you can always guarantee what question was going to come up, just do it with different numbers, but here I think like it is different to that."

A.1.2.2 Experiencing university mathematics

Carin talked about the things that students should do during lecture time, the general study habits, the things that students should do when they feel stuck, and the assessment of the modules. Almost in every case she referred to messages that were transmitted by Lecturer A. This can be explained by the fact that Lecturer A was her personal tutor and therefore they spent more contact hours together. In the following I will describe how she interpreted each message that she received and in what ways these messages affected her adjustment to the new context.

Things that students should do during lectures

Taking notes

Carin expressed her thinking regarding the ways the lecturers provided the notes: "...Lecturer A prints out like [notes] with gaps because she likes to be able to wander around and use hand gestures as opposed standing there and writing on the board from a piece of a paper. And then obviously just to fill in the gaps we can copy out but I feel like she is more... I don't know like active in the lectures. Whereas some of them just like sort of sit on their chair and this is what [they] do. And I think like it depends on, like what they feel will give us the best, they think that writing all helps us remembering it..." Carin understood Lecture A's motives for using the gappy notes. She stated that she preferred writing down the notes instantaneously because in this way she could take in more from the lectures: "Personally when [the] lecturer writes on the board and I copy it, it goes in more..." She admitted that this is an influence carried from the school years where students had to keep notes while the teacher was writing on the whiteboard: "I think that's because like from school and sixth form all we did... we weren't given like a booklet of notes, it was all copied from the white board and I think that's just like I don't know, natural for me now to just do that."

The message transmitted by both Lecturer A and Lecturer B with the writing of the notes carried high degree of power and control, in most of the cases. We have seen earlier that on certain occasions Lecturer A gave more space to the students to treat the notes the way they wanted but this is not touched upon Carin in our discussion. In the previous excerpt Carin talked about Lecturer's A attitude with the use of gappy notes; she recognised as the main reason for using them that the lecturer wanted to be more active while teaching. Moreover, in another instance during the

interview she described as her favourite way of getting the notes Lecturer B's practice. Carin felt more comfortable when the practice of having the notes was entirely controlled by the lecturer; the lecturer writes on the board and explains while the students copy. The same practice, which was also employed in the mathematics classroom at school, consisted already a part of Carin's identity. Hence, in the interaction with the message transmitted through the writing of the notes it was evident the influence of the previously used practices. The strongly classified and framed message of writing the notes (either the gappy notes or just the written notes) reassured her identity as a mathematics learner and moved her into the transitional zone. Carin considered that this practice enhanced her understanding and that writing down the notes during the lecture it was a 'natural' thing to do.

Discussion with peers

The next message that Carin received regarding the things that students should be doing while they attend the lectures was concerned with the mathematical discussion: "...when I sit next to some of these ones that are more intelligent than me, speaking to them and understanding the way they are approaching it it makes me think: 'Ok, maybe I should try approach things that way'. And then obviously it benefits me but then I am not sure how much it benefits them... but then if you are both of the same sort of level and you are bouncing ideas back and forth it is really... useful... like constructive because you do not only remember the right way to do it, you remember when you said like... when you thought it was this and it wasn't, or you remember when you were wrong as well when you were right, and obviously that helps if you have a question, in like a test or problem sheet or something like that and you think: 'Oh yeah, I remember talking about that in class...' "

Carin talked about the benefits that this practice had on her learning. She argued that it was beneficial exchanging ideas with her peers and that her study time or an examination performance could be improved just by bringing in her mind things that she had discussed with other students previously. By employing this practice, apart from being more confident with her mathematical communication skills, she also had the chance to learn more. The strongly classified and framed message transmitted by Lecturer A influenced Carin's thinking and affected the way she performed during the lectures. She embraced the practice and tried to take the most out of it. Carin seemed rather comfortable discussing with her peers. Her interaction with the message positioned her in the transitional zone. By taking action from such a strongly classified and framed message she attempted to adjust to the new practices used at university context.

General study habits

Carin's personal tutor was Lecturer A and she was highly influenced by the messages that she transmitted. In this category she referred to the messages that Lecturer A communicated regarding the definitions lists, the time-management and, the fact that is ok when students do not understand everything straight away. I will explore them in more detail below.

Definitions lists

In the focus group Carin mentioned that after receiving Lecturer A's message she started making lists of definitions in order to facilitate her study: "...initially I just had one for Module A 'cause Lecturer A told us to do it and then I began to realise that it is actually beneficial to have them across modules as opposed to just like having a different technique for each module."

The strong power transmitted through this message made it easily recog-

nisable. Despite the weak framing that it carried Carin was willing to take her lecturer's advice and make lists of definitions to advance her learning. She grasped the opportunity of the space provided by the lecturer and she used the practice not only for Module A but for the rest of the modules as well. In that case the lack of control in the transmitted message motivated her to take action and she became entirely responsible for her learning. By employing this practice she positioned herself in the transitional zone.

Time-management

Carin was among the students that got influenced from the information that Lecturer A gave regarding the time-management. She argued that Lecturer A helped her organize an efficient time-table for her study by making clear that some of the techniques applied at school would not be applicable at university anymore. Moreover, the lecturer emphasised that every person has different times that can be productive during the day: "So I've done... I've listened to Lecturer A and... I've blocked out my time that suits me..." Another benefit that she recognised by organising her time was that she could distribute her time evenly between coursework and problem sheets: "I've made myself a weekly timetable to ensure that I am not spending all my time on the coursework... I am trying to make sure that I keep up with the coursework as well as the problem sheets which I think is quite difficult... I think I am learning to balance it now... I feel like I am making progress." Carin admitted that initially it was hard for her to find a balance, but she trusted her lecturer's advice: "I'm not saying it's easy 'cause I obviously hate leaving the questions undone but you just got to do it and I am just going to have trust in the fact that she is obviously successful and that she would tell me things that actually work so..."

The message about time-management had a real impact on Carin's think-

ing about how she should structure her study time. Although it was weakly framed she was happy to take the control provided by Lecturer A and manage her study time in her own terms. Carin seemed to rely a lot on her lecturer's authority and this was enhanced through the high degree of power that this message carried. Even on the occasions that the lecturer suggested things which made her feel uncomfortable (e.g. not working with every question of the problem sheets) she still welcomed the advice because it was given by someone who was already successful in the field. This confirmed the perspective that she had expressed earlier about her school teacher (in order to succeed as a mathematics teacher she should follow the same degree that her school teacher had obtained and she considered as successful). By putting in practice Lecturer's A advice regarding the time-management Carin moved into the transitional zone and adopted an effective time-planning.

It's ok if you don't understand everything

Another message that Carin received from Lecturer A was that it is fine when students do not understand everything straight away during lecture time. The lecturer made clear that students would be making mistakes but that this is a necessary procedure that they had to go through during their learning experience. Carin talked about this and she described how it prompted her to change her approaches. She admitted that at the beginning when she did not understand everything straight away she felt frustrated: "I think like from A level I was very... I am quite hard to myself as a person so like not getting it it's like quite frustrating for me and I think like coming to uni obviously in the first few weeks they were like you don't have to get everything... but now I think like it is sticking more and more that I am not going to understand everything and no matter how hard I try there might be things that it's easier, it's better for me to just brush over to make sure I get

really good marks on the other areas and I think that's like a real difference from sixth form to university."

Initially Carin felt constrained when she did not understand everything in the lectures. The different practices from school challenged her thinking and as a result she positioned herself in the discomfort zone. By taking into account the weakly framed message transmitted by her lecturer she felt more comfortable and made the move into the transitional zone. This was also apparent in the last questionnaire that she completed - after the end of the first semester - where she referred to this message as the most important one that she had received during the semester: "I am less worried about getting things wrong and give harder questions a good go even if I may be wrong, before seeking help."

Things that students should to do when they feel stuck

Tutor/MSC/Friend

Carin referred to the options that Lecturer A suggested regarding the things that the students should do when they feel stuck. She identified immediately the differences from the approaches used at school on similar occasions: "I think, it made [me] more independent in my mathematics... like I'd say slow down and make sure I try everything first... whereas at school it would have been like I'd rush up, ok I'll be stuck on that I put my hand up. I wouldn't think about what was wrong, what went wrong..." She elaborated further on the issue and described how Lecturer A's suggestions made her change her approaches: "So I think it has made me more independent and made me not necessarily work [it] out myself but made me find out ways to work [it] out myself, whether that be [that] I have to go to the library and get a book and try to work [it] out, whether that be [that] I have to ask someone else or

going to the mathematics support centre. So I think it definitely made more independent in my studying in general..."

Carin received the strongly classified and weakly framed message transmitted by Lecturer A regarding the things that students should do when they feel stuck. The message prompted her to take action and to change her previous approaches in similar situations. We observe Carin following Lecturer A's advice despite the low level of control that the message carried. The biggest influence that this message had on her learning was that she became more independent. By responding to this message Carin positioned herself in the transitional zone. She welcomed the different practice and tried to make the most out of it.

Assessment

The last message that Carin commented on referred to the assessment practice that Lecturer A used in her module: "I think it's obviously very very important, 'cause it is very easy in a place like this, where no-one is on your shoulder all the time, 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..." She believed that the tests played an important role in the course because they helped students to keep up with the material throughout the semester. She considered that it is easier for students at university to fall behind because they are not checked often whether they do the required work or not. Thus the class tests contributed to prevent this from happening.

The high degree of power and control conveyed through the message with the use of class tests influenced Carin. She recognised the benefits of being assessed regularly during the semester; she perceived the class tests as helpful

for keeping up with the material and for hampering students falling behind in their studies. She seemed rather comfortable with this practice and she positioned herself in the transitional zone.

A.1.2.3 Overall impact

In the following table (Table A.2) I present the messages that influenced Carin the most during the first semester of her studies. She referred mainly to messages transmitted by Lecturer A, who at the same time was her personal tutor. Despite the differences in the level of control that these messages carried Carin seemed to be influenced to a certain extent by all of them. A possible explanation to that can be that there were all conveyed by the same lecturer with whom she spent a lot of contact hours and who generally was an advice-giver. Generally she found herself rarely in the discomfort zone from which she moved rather easily after receiving certain messages.

Message	Classification	Framing	Positioning
Taking notes ($M_{1.1}, M_{1.2}$)	$+$	$++++$	Transitional zone
Discussion with peers ($M_{1.4}$)	$+$	$++++$	Transitional zone
Definitions lists ($M_{5.2}$)	$+$	$++--$	Transitional zone
Time-management ($M_{5.1}$)	$+$	$++--$	Transitional zone
It's ok if you don't ($M_{5.4}$) understand	$+$	$++--$	Discomfort/Transitional zone
Tutor/MSC/Friend ($M_{3.2}$)	$+$	$++--$	Transitional zone
Class test ($M_{4.1}$)	$+$	$++++$	Transitional zone

Table A.2: Messages received by Carin

Through her story is apparent that Carin was influenced by her school mathematics teacher, who she recognised as a role model. One reason for choos-

ing this university and following this specific degree was because her school teacher did the same one and succeeded as a mathematics teacher. In her narration we can easily identify similar influences in the university context from Lecturer A. Even in cases that certain practices conflicted with her identity as a mathematics learner - for instance when Lecturer A advised the students that on certain occasions for the sake of time-management could be useful to leave parts of the problem sheets unanswered - eventually she did employ them because they were suggested by the lecturer. Her thinking was influenced directly from what Lecturer A recommended because her (lecturer's) success instilled in her a feeling of trust.

In conclusion, responding to the majority of the messages that Lecturer A transmitted had a positive effect on Carin's transitional experience. Being ready to put into practice her lecturer's recommendations which were beneficial for her learning positioned her in the transitional zone. Carin approached the discomfort zone only one time as she described, and immediately after she moved into the transitional zone by grasping Lecturer A's advice regarding not being frustrated for not understanding everything straight away.

Her final score in Module A was 54% and in Module B 68%.

A.1.3 Emily's narrative

Emily had an interest in mathematics since young and this is why she decided to study it at university: "I have loved maths since primary school and it seemed like a smart decision." Before starting the degree she expected that studying mathematics at university would require independent study, that it would be much harder than at school and, that it would "go into more detail on certain topics/modules". When she came at university things were not as she expected them to be. In the following I will explore the differences that

she recognised between the two educational settings.

Moreover, I will present elements of Emily's identity as a mathematics learner which influenced the ways that she interpreted the transmitted messages by the lecturers. The actions that the messages prompted her to take and the impact that they had in her transitional experience will be also discussed in more detail below.

A.1.3.1 Background information

Emily described her relationship with mathematics throughout school: "...when I was little I loved maths anyway and then I pretty much loved maths when I was going to the secondary school and in the sixth form... I was doing geography and then in my AS I got a C in geography and so I thought yeah I have to drop it... so then I went up to maths to continue on." She also developed her thinking about what she envisaged herself following as career path after completing the degree: "I am thinking maybe becoming a teacher but I am not entirely certain so like if I do... one of my teachers had to do a PGCE and then they offer to do I think there is the master's here as well so in total it will be like three years and if I do a placement year will be like seven years kind of education and I am just like it's kind of a long time I am just thinking like doing the one year PGCE... or I can just... don't do a placement year or just... do a PGCE I'll get a year experience anyway..."

Her parents had not obtained a university degree and did not have any influences in her decision for the degree choice. Her cousin though had studied for a mathematics degree in another university and gave her a lot of information. Emily and her cousin were the first ones in the family to study for a university degree. She referred to him, and his girlfriend (who also studied mathematics), as the main source of information about the course: "[He] was

probably the main influence and his girlfriend as well... she said is going to be really really hard and just to make sure you put in time, there is party time and then there is work time and make sure you know [how] to balance it out."

While she was at school Emily had not taken A Level Further Mathematics and she never considered that the mathematics were particularly difficult. She often used to work with her friends while doing mathematics.

Emily expected mathematics at university to be about solving real world problems but apart from that she said that she was not sure what to expect. When she arrived at university things were different from what she had initially thought: "In the past (A-level Maths), there wasn't much emphasis on proofs and theorems. As well there wasn't much emphasis on the thought process involved mathematics." This realisation led her to leave behind the old learning habits and to acquire new ways of thinking in order to be more effective in her learning: "...is so much different to how they taught it in A levels, so like remember the main concepts and... other than that just learn a new method because that's how you are going to be learning for the next few years so everything you have done in the past put it behind you and start completely fresh."

Emily has dyslexia, and the university offered one-to-one tutorial sessions in order to assist dyslexic students. She seemed to enjoy these sessions and she considered them to be helpful and supportive: "...when I go there even if I have the stupidest of questions I can ask her... she can't help me directly in my coursework but it's like even helping me plan out when am I going to do things, like how am I going to do it... it's like helpful organising it all out and actually which ones I know or struggle with which ones I won't... it's a lot more helpful that way, it's a lot more supportive that way."

A.1.3.2 Experiencing university mathematics

The messages that Emily referred to during our discussions and which influenced her learning were concerned with the general study habits, the assessment, the lecturer's intrinsic enthusiasm for the content of mathematics and the things that students should do during and outside lecture time. I will explore them now more thoroughly.

General study habits

In this category Emily talked about the advice transmitted by Lecturer A regarding the time-management and that it is ok when students do not understand everything.

Time-management

Among the most important messages that Emily received from Lecturer A was the one referring to the management of the study time. She described how her lecturer's words had influenced her thinking about organising effectively her time: "[She] told me like in the lectures... [that] you have to prioritize what is important to you... if I am doing work the entire day the chances are that I am going to collapse... so be realistic, you can't do that much, you've got to work out which one is more important to you." While our discussion progressed Emily revealed that this message complemented an already existing practice that she used back at school while she was studying: "I think the whole thing about me picking certain days and... do work is kind of what I did before, like in A levels... I just kind of brought that kind of idea with me in [the university], so I'd be like certain days I got my stuff with me so I may do that subject for several hours, another day I'll just do the same kind of thing... is just... a merge of what, who I am as a person in generally and then what she just told me and then I just kind of combine

them in a sense..."

The message about time-management had an impact on Emily who identified it immediately and was eager to put into practice her lecturer's advice. The strong power that it carried made it easily recognisable and the weak control gave Emily the space to organise her study the way she considered better. The interaction with this message brought to the fore elements of her identity which influenced eventually the way she responded to it. Emily was already familiar with blocking her time out for different modules because this is how she used to work at school. Hence, it was easier for her to perceive the message and put it into practice by building up on her previous routine. She developed her identity as a mathematics learner by using practices already familiar from the school context which she expanded at university. This contributed to the growth of her comfort zone and helped Emily to position herself in the transitional zone.

It's ok if you don't understand everything

Emily referred to the message that Lecturer A transmitted about not feeling bad when students do not understand everything. This particular message helped her to change the way she was thinking until that point about acquiring understanding of the concepts taught: "...at the end of A Level at the exam you just like need to answer everything... so you come at your first year of degree and it is just like... as long as you go through it and you try to understand it that's the best you can do... 'cause like after A levels you are always in a way of thinking [that] you have to understand everything and if you don't understand something you just start panicking in your head so it's just like you can't really think when you are panicking so I think that helped a bit 'cause is like helping you staying like calm most of your time trying to think and learn." In a later stage she stressed the fact that this

message helped her to change the way she dealt with her studies when the workload increased: "I kind of developed an understanding that if you are going to panic you are just going to make it worse, like in panic you are not going to be in the mental mode to revise, you just need to calm down..."

The belief created at school level regarding what effective learning is, was still existent in Emily's mindset. This consisted a part of her identity as a mathematics learner and when she came to university constrained her and positioned her in the discomfort zone. She described feelings of panic when she could not comprehend everything straight away. The strongly classified message transmitted by Lecturer A made her recognise that the things at university did not work the same way. The interaction with this message made her realise that at university students are not expected to cover a specific material in order to be able to answer successfully all the questions in the examination, at university students are expected to learn and think. Emily took advantage of the space provided from this weakly framed message. She attempted to integrate it into her learning habits and this resulted in her move from the discomfort zone into the transitional zone.

Assessment

Coursework

An implicit message that Emily received during the first semester of her studies was through the assessment practices, particularly from the coursework: "I've been trying to catch up but then we had the coursework and it was just like how can I do my revision if they give me the coursework at the same time... is not as if you have your parents there telling you 'You got to do your revision, you got to do that, this or the other'. It is very independent... you've got to make sure you are doing your work..." She described

her attempt to manage the workload throughout the semester. When the coursework was due she realised that she had to take responsibility for her learning and to act independently because there was no-one on her shoulder to check up on her whether she was working or not.

Lecturer B's message was strongly classified and carried low level of control over the ordering and the pacing of the communicated knowledge. Emily recognised it and by engaging with the coursework she acknowledged that she had to take control over her learning. Although initially she felt constrained because of the workload, the interaction with the message made her realise the responsibilities that she had to undertake for the course. The message transmitted with the use of coursework prompted her to move from the discomfort zone into the transitional zone, where she improved her ways of learning and became more independent.

Lecturer's intrinsic enthusiasm for the content of mathematics

Emily was among the students who received Lecturer B's message through his intrinsic enthusiasm for mathematics. She talked about the example with the weighing scale and the pig (Section 5.1.6) which made her feel "like maths can be quite fun again". She referred to it extensively and argued that these kinds of examples transmitted the lecturer's enthusiasm about the subject, they helped the students in difficult moments during their studies and finally, they put concepts into a context where they were more easily comprehensible: "...he is throwing a pig on a weighing scale in lectures and it actually does make sense what you are doing. But then you have other moments where... you have done six hours of revision and you are just like so tired and you don't feel any smarter, you don't feel like you understood anything more and you are just like I don't want to do this anymore... It's just like... I think

overall... maths as a degree is just a roller coaster, if you survive the first year you will know that it will be amazing."

Lecturer B's enthusiasm transmitted through his lively examples had a clear impact on Emily's thinking. The strong power transmitted through the message made it easily recognisable. The high level of control made her think about mathematics in a specific way, as she pointed out, that mathematics can be fun again and distracted her attention from troubling situations. This statement emphasised also the fact that Emily, before coming to university, considered working with mathematics as a joyful activity. This feature of her identity shaped her interaction with this message and she felt once again comfortable working with mathematics. Therefore, on certain occasions when she found herself distressed her lecturer's enthusiasm moved her from the discomfort zone into the transitional zone.

Things that students should do during lectures

In this category of messages Emily referred to the mathematical discussion among students during lecture time and the writing of the notes.

Discussion with peers

Emily commented on the discussion among peers during Lecturer A's lectures. She argued that the lecturer, by inviting the students to interact, tried to make them acquire understanding during lecture time, something that differed from the rest of the lecturers. Emily considered this way of communicating mathematics beneficial: "...even if you are not the kind of person who likes to discuss things you are not going to get it the same [way] as another person will... so I think is kind of necessary to discuss it because then you can bounce ideas with each other and develop points [in] this way."

She thought that the mathematical conversations with her peers were

helpful and her understanding was enhanced during lecture time by engaging in such discussions. The strong control exerted through this message made her feel comfortable. She employed the suggested practice and recognised its benefits. By employing this practice she felt well integrated in the setting of the lectures and she moved into the transitional zone.

Gappy & written notes

Another topic that emerged during our discussions was about the ways that the lecturers provided the notes. Emily said that she was happy whenever Lecturer A suggested to the students to concentrate in what she was saying and copy the notes later. She argued that being dyslexic affected the levels of her concentration in the lectures; it was not easy for her to pay attention to what was said and at the same time write the notes. This was also the main reason that at the beginning of the semester she did not like Lecturer B's practice. However, she changed her mind later on when she realised that he included a lot of examples in his teaching which helped her to understand the material taught: "I think the fact that I am getting tested with dyslexia might link with that [kind of teaching] because the fact that I struggle to write stuff and understand it at the same time would affect me more in certain modules, so for Module A it affected me more but then I stopped writing and the fact that we get everything online it just helps me keep up in a sense. But then in Module B despite the fact we have to write so much is quite example based and... So for Module B I work a lot better because it has examples even though [it] has so much writing."

The space that Lecturer A provided to the students to treat the notes in whichever way they thought better, helped a lot Emily and made her feel comfortable. She had the opportunity to be focussed on the lectures and to understand as much as she could and then to go home and make her version

of the notes. We notice here how on particular occasions the space that was provided with the use of gappy notes benefited Emily and reassured her identity as a mathematics learner. By taking action from this message she felt comfortable in her learning and she moved into the transitional zone. On the other hand, the strong control exerted through Lecturer B's practice made her feel initially constrained. The interaction with this practice positioned her in the discomfort zone because she was not able to be attentive and write at the same time. Later on in the semester, after interacting for a while with this practice, she changed her thinking about it when she realised that the lecturer used a lot of examples, with which she felt comfortable because she acquired a better understanding. Thus, she moved from the discomfort to the transitional zone.

Things that students should do outside lectures

Problem sheets

In the focus group Emily discussed about how the lecturers expected the students to work outside lecture time: "...you should just cope in first place, you should just get them [the problems] and then is good to have a go by yourself and then after that go to your friends and then go to your mathematics support centre or this kind of thing." She argued that the way she works now at university is influenced by the way she used to work at school. She built up on the old practices by integrating means that were not provided back then like the internet, the tutor or the support centre, and she created a new version of her study habits: "...at school their version was you can use textbooks and you [can] talk to your friends and then if you have problems then you [can] talk to the teachers. Here... I don't really use the textbooks... 'cause quite often it's just kind of pointless... [with] some modules it works,

[with] some modules it doesn't... the main is friends and internet, internet probably first and then friends, and then my one-to-one support person and then [the] mathematics support centre staff and then probably lecturers."

Emily seemed willing to take control over her working practices outside the lectures. The space that both lecturers provided with the weakly framed message transmitted through the use of the problem sheets, gave Emily the opportunity to choose how to organise her work. In the practices that she chose to employ were evident also influences from the school context, features already existent in her identity as a mathematics learner which as she argued she improved by incorporating new ones in order to be efficient in the new context. She felt comfortable with the required independence and from her description she showed that she was well integrated in the new context and positioned herself in the transitional zone.

A.1.3.3 Overall impact

Emily's thinking about how to study for the degree and how to adjust to the new context was highly influenced by the messages that she received from her lecturers. On particular occasions, when the exerted control was weak, she positioned herself more easily to the discomfort zone but then by taking action from the transmitted message she was eager to move into the transitional zone. Moreover, in the narration of her story it was evident that powerful messages received at school had still an impact on her thinking and her ways of working. Finally, the fact that she is dyslexic played an important role in her story and her interaction with the transmitted messages.

In the table that follows (Table A.3) I present the messages that she received and the degree of influence that these messages had on her transitional experience.

Message	Classification	Framing	Positioning
Time-management ($M_{5.1}$)	+	$++--$	Comfort/Transitional zone
It's ok if you don't understand ($M_{5.4}$)	+	$++--$	Discomfort/Transitional zone
Coursework ($M_{4.2}$)	+	$++--$	Discomfort/Transitional zone
Lecturer's intrinsic enthusiasm (M_6)	+	$+++$	Transitional zone
Discussion with peers ($M_{1.4}$)	+	$++++$	Transitional zone
Gappy notes ($M_{1.1}$)	+	$++++$	Transitional zone
Written notes ($M_{1.2}$)	+	$++++$	Discomfort/Transitional zone
Problem sheets ($M_{2.1}$)	+	$++--$	Transitional zone

Table A.3: Messages received by Emily

At the end of the semester Emily scored 60% in Module A and 76% in Module B. She seemed to be willing to move from her comfort zone, developed during the school years, into the transitional zone. Although she decided to be consistent with some of the practices that she used to employ at school which they still had great influence on her - for instance the planning of her study time outside lectures - she was open to broaden her horizons and adopt new approaches at university. For example, when she talked about being realistic and prioritising the things that could enhance her learning, a message that she received from Lecturer A.

On some occasions the difficulties that she faced at the beginning of the course - like panicking when she did not manage to catch up with the revision - moved her towards the discomfort zone. But by listening to Lecturer A's message she was prompt to move into the transitional zone. Generally Emily took action from all the messages she referred to as important for her, re-

gardless of the degree of framing that they were carrying. When the control exerted by the message was weaker she tended initially to feel constrained and to position herself in the discomfort zone, but after receiving the message and taking action from it she was feeling comfortable and moving to the transitional zone. When the control was stronger the movement to the transitional zone was easier.

A.1.4 Owen's narrative

One of Owen's main motivations for choosing to study for a mathematics degree was the job prospects that the degree offers. In the first questionnaire he listed it as the most influential factor for his decision: "Career prospects as I want to have the best possible chance of getting a good job." Before coming to university he believed that the content of university mathematics would be a continuation of A Level Further Mathematics. During the first weeks of the semester he realised that it was not as he expected it to be. This realisation caused him some difficulties which I will explore in more detail in the following.

In what follows I will introduce some aspects of his identity as a mathematics learner which emerged through the narration of his story and which I consider important in the interpretation of the transmitted messages. Moreover, I will present the messages that he received during his first semester at university, the way that he interpreted these messages and the impact that they had on his transitional experience.

A.1.4.1 Background information

Owen liked mathematics as a subject and he thought that a mathematics degree would offer him good career opportunities: "...I am not really sure

what I want to do in the future but maths is my favourite subject, it is my best subject as well, so I thought doing a maths degree... job prospects are quite good when you are getting a maths degree as well."

He expected mathematics at university to be about solving real world problems, proving lots of theorems and more abstract ideas. His expectations were not met when he arrived at university as he considered that the content of mathematics was completely different from the content of A Level Further Mathematics: "I thought it would be sort of almost like a continuation from A level, obviously a step up but sort of just following on, maybe harder integration, differentiation, that sort of thing." Furthermore, he expected studying mathematics at university to be more personal than at school, to require independent study and to spend less hours in the lectures: "I thought I'd have less contact time in lectures so I thought we would be doing more individual work like on our own rather than having three hours of lectures per each module and then tutorials as well." All these expectations were based on information that he gathered when he visited the University Open Day event and from his research on the university's website.

Owen did not take A Level Further Mathematics during his time at sixth form. There were times that he thought mathematics became particularly difficult at school and on such occasions he turned for help to his school teacher or to the internet. He also stated that he did not use to work with his peers when doing mathematics.

When he first came at university he faced difficulties which were based on two factors; the content of university mathematics, and the responsibilities of the new life, such as living alone for the first time. This struggle made him enjoy less the degree but eventually he found his way to deal with it: "I'd say at the start 'cause I found it quite hard, it sort of made me think...

I mean I still obviously want to continue doing that... [it] made me sort of enjoying it a little bit less just because I found it really hard, but now sort of coming get to grips of things a bit more. I'm starting to enjoy it much more again so yeah."

A.1.4.2 Experiencing university mathematics

Owen referred to five of the categories of the transmitted messages. He commented on the things that students should do during and outside lectures, the assessment, the general study habits and the things that students should do when they feel stuck.

Things that students should do during lectures

When Owen described the messages that he received regarding the things that students should be doing during lecture time he did not refer to them separately (e.g. writing the notes, talking with peers, etc.). He made only a distinction between the approaches that the two lecturers used. He referred to what he understood from Lecturer A's practices and respectively to what he understood from Lecturer B's practices. This is also how I will present them below, through his narration.

Messages received from Lecturer A's lectures (Gappy notes, Hand gestures, Discussion with peers)

From early on Owen admitted that Lecturer A was his favourite lecturer. Despite the fact that he considered her module as the most difficult: "... [it] was such a different module compared to anything we have done before, so that's actually the one I was most stuck with... [...] It's all theorems and proofs rather than integration, differentiation..." He liked the fact that Lecturer A was giving the students time to think during the lectures and she

did not only expect them to catch up with the writing. Generally, he was in favour of the way that she was delivering the lectures. Lecturer A provided the students with a variety of ways to comprehend the concepts taught, such as the use of the hand gestures and the graphs in the air, the time for thinking and the encouragement for discussion amongst peers. Owen believed that due to the difficulty of this module the lecturer employed techniques that would make the concepts more comprehensible during the lectures: "She wants you to sort of understand it a bit in the lecture... we have never done a lot of that before and then she might feel like we have to have a bit more thinking time in lectures to get our head around it..."

Owen was benefited by the strongly classified and framed message that the lecturer transmitted with the use of hand gestures. Acknowledging that he himself is a visual learner he argued that was very helpful seeing her using her hands to explain concepts: "...I think I am more a visual learner... I remember different things so like if she does something a bit different it would be like with the hand gestures. Compared to a lecturer [who is] writing down I am more likely to remember the hand gestures than a sentence that the lecture has on the screen." The high level of control conveyed through the extensive use of hand gestures made him feel comfortable. By acknowledging this practice he managed to overcome his initial distress which was caused by the level of difficulty of this module. And although at the beginning he felt uncomfortable, by receiving this message he managed to move from the discomfort zone to the transitional zone.

Similarly, he talked about the mathematical conversation among peers. Owen considered that with this practice (combined with the use of gappy notes where students could take small breaks to discuss various tasks) Lecturer A introduced a new way of learning: "...then she says use your time

to talk to the other person about, like a little question that she has written in the notes and things like that so I kind of like that 'cause it is a different way of learning really rather than just scribe it all down." He felt rather comfortable with the use of these two practices as well. The novelty that they brought in the old ways of learning, with which he was familiar, contributed to his view that the use of different practices can enhance students' understanding.

Therefore, Owen initially talked about the difficulties that he faced with the content of Module A, which positioned him in the discomfort zone. By receiving the messages while attending Lecturer A's lectures he made the move into the transitional zone and he settled in better in the new context.

Messages received from Lecturer B's lectures (Written notes)

Owen disliked Lecturer B's teaching practice. He considered Module B hard because its content differed a lot from the mathematics taught at A Level Further Mathematics and it also included a lot of proofs: "I'd say Module B is probably the hardest in that sense because it is just sort of looking at things in different ways as well. So it's a little bit different to what we have been doing previously in A level, so that proving things that we have just been taught, we know that π and e are irrational and having to prove them that's quite tough, you have to write down a lot, a lot of words for that." Given its difficulty Owen argued that students should be provided with more time to understand it and process it during the lectures. This was not feasible though because the students had to copy the notes from the board and Lecturer B's pace was rather fast. He felt constrained with this practice because he did not have enough time to process the concepts: "...he uses the writing down technique and going through it really quickly but I

don't think it works as well as it does in [other modules]..." This eventually led him to invest more time outside the lectures to understand what has been taught: "... I am definitely putting more time into thinking outside the lectures so I [can] understand what is happening."

The high level of power and control transmitted during Lecturer B's lectures with the practice of copying the notes, in combination with the level of difficulty that the module had, distressed Owen. He believed that there should be given some space to the students to understand the material taught, during the actual lecture time. He felt uncomfortable and positioned himself in the discomfort zone. To overcome his struggle he tried to spend time reading the notes after the lectures in order to have an actual grasp of what it has been discussed.

Things that students should do outside lectures

Problem sheets

Owen talked about the ways that the lecturers expected the students to work outside lectures: "...by giving you problem sheets in every lecture they sort of showing you that's what you need to do really." He was among the few students who reported that he tried to keep up the work with the problem sheets: "I was trying to do every single problem on the problem sheet whereas in one of the tests I didn't do very well... [I was] focussing most of my time in the problem sheets rather than revising for the test... but now I realised that you don't actually have to do every problem on every problem sheet to understand what's happening. So when I will be getting the [questions] right in the problem sheet I put it to one side... so that I have time to focus on other things like class tests, courseworks and things that count for each module..."

The message conveyed with the use of problem sheets was easily recognisable due to its high level of power. Owen recognised it and he was willing to take action from it and work with the problems. The low level of control that the lecturers exerted through this message provided him with enough space to decide how he should deal with the problems. Initially he tried to do every problem sheet but this resulted in not having enough time for studying for the tests or the courseworks. The control that he had over deciding how he should work and where he should direct his focus on gave him the opportunity to change his first approach and put all of his effort towards the pieces of work that got assessed. He seemed comfortable having the control and managing the work in his own terms. He described his plan as an efficient one for his learning. The message transmitted with the use of the problem sheets positioned Owen in the transitional zone where he was willing to acquire a better understanding by putting in work outside lecture time.

Assessment

One of the topics that emerged during our discussions with Owen was the different assessment practices employed at university: "I am more of an exam person, so I'd rather have everything in one exam at the end but I think this semester sort of made me realise that the class tests and the courseworks they definitely do help 'cause it means like you are forced to keep up, obviously you are going to want to do well in the coursework and class test 'cause it is a percentage of your module at the end so you are going to want to do your best on them so you are going to have to keep up so you understand things..." From what he described there were obvious influences in his thinking from the school approaches. In spite of his previous beliefs the message transmitted through the assessment practices made him realise

that there was an important reason for having the assessment scheduled in this way.

Owen talked about both practices - use of tests and use of courseworks - without making any kind of distinction between them. The lecturers framed differently the messages transmitted through these two practices. The fact that Owen did not distinguish them indicates that the variation in the degree of control did not have an impact on his thinking. What really prompted him to regard these messages and to change his ways of working was the exchange value that the tests and courseworks offered. Owen admitted that the regular assessment gave the students the opportunity to keep up with the content of the modules. Although there was a strong impact from the previous experiences created at school context (one examination at the end of the year) by receiving these messages he considered the changes in the new setting and tried to include them in his learning habits. By putting the messages into practice prompted him to move into the transitional zone.

Despite the fact that the differently framed messages conveyed through the use of class tests and courseworks fell both in the same category in a different instance during our discussions Owen distinguished a message that he received from the use of coursework. He talked about the group work that Lecturer B required for the second piece of coursework: "...it made me see things from a different perspective... it means that you are with people, that definitely helps, 'cause as I said before when you have problems you can ask them and then when they have problems they can ask you and that will help you... 'cause sort of explaining to them makes you realise it a bit more... it's like revising in a way... definitely I'd say that, you do have to have people around you to be able to do [mathematics]. I am still doing it in group, I would be definitely struggling a lot more if I didn't have that people around

me."

Owen was influenced from Lecturer B's suggestion about working in groups. Through this weakly framed message Lecturer B gave all the space to the students to organise their work and to follow the pace they thought it would be more suitable for them. Students had all the control over the coordination of their work and the formation of the groups. Owen felt comfortable taking over the control and by employing this practice he moved into the transitional zone. The message prompted him to change his ways of working, but also to change his thinking about how mathematics can be a social activity.

Things that students should do when they feel stuck

When Owen talked about the things that students should do when they feel stuck he focused mostly on the differences that he recognised between school and university: "...university campus is pretty big... compared to school... at school... is just like one building it's not really too hard to find the teacher if you need to, but here... you can spend ages just trying to find one person to help you understand." While the semester progressed Owen changed completely his mind about approaching lecturers and asking questions. He reported that the lecturers encouraged the students to ask questions when they did not understand something or to visit the mathematics support centre and ask there for help: "To be fair they mainly say if you are stuck come to the mathematics support centre between these hours... they obviously do give you their email [and] I find that is a helpful way to contact them and obviously you do if you want to email them..."

The differences between the two educational contexts regarding lecturers' approachability troubled Owen at the beginning of his studies. This resulted

in his positioning in the discomfort zone. The message transmitted through the lecturers' suggestions regarding the things that students should do when they feel stuck was strongly classified and Owen perceived it. This weakly framed message, with the lack of control that it carried, it gave him the option to choose how to contact his lecturers. This prompted him to take action and to find a way to get his questions answered. Owen chose to email his queries to his lecturer, and once his lecturer replied he kept using the same approach in similar situations. He found that to be more helpful instead of visiting the mathematics support centre. By grasping the opportunity to contact the lecturers - even by email and not in person - he moved into the transitional zone and adjusted to the practices of the new context.

General study habits

It's ok if you don't understand

In this category of messages Owen referred to the advice that Lecturer A gave to the students about not being stressed when they do not understand everything during lecture time. He reported that by accepting this as a legitimate situation the students were motivated to put a lot more effort for working outside the lectures: "...I definitely have done more independent study here than I have done previously at school. At school you sort of have a class and I understood most things there, I didn't necessarily do a lot of work... But now because I don't understand everything makes me realise I do have to do a lot of work outside as well."

The message was clear and it was easy for Owen to comprehend it. The high level of power that it carried contributed to this. On the other hand, the low level of control transmitted through this advice gave him enough space to act independently and to take control over his learning in order to

understand the things that he did not comprehend during lecture time. He emphasised once again the contrast between school - where everything had to be understood during the lesson - and university - where it was fine to revisit the material taught afterwards. By grasping this message he moved into the transitional zone, where he was willing to spend individual time after the lectures to process and understand the concepts.

A.1.4.3 Overall impact

During the first semester of his studies Owen paid attention to a variety of messages transmitted by the two lecturers. These messages carried high degree of power but differed in the degree of control. On many occasions he talked about the differences in the practices between school and university. In the following table (Table A.5) I present the messages that he received and the impact that these had on his transitional experience.

Message	Classification	Framing	Positioning
Gappy notes ($M_{1.1}$)	$+$	$++++$	Discomfort/Transitional zone
Hand gestures ($M_{1.3}$)	$+$	$++++$	Discomfort/Transitional zone
Discussion with peers ($M_{1.4}$)	$+$	$++++$	Discomfort/Transitional zone
Written notes ($M_{1.2}$)	$+$	$++++$	Discomfort zone
Problem sheets ($M_{2.1}$)	$+$	$++--$	Comfort/Transitional zone
Class test ($M_{4.1}$)	$+$	$++++$	Transitional zone
Coursework ($M_{4.2}$)	$+$	$++--$	Transitional zone
Ask the Lecturer ($M_{3.1}$)	$+$	$+--$	Discomfort/Transitional zone
It's ok if you don't understand ($M_{5.4}$)	$+$	$+--$	Transitional zone

Table A.4: Messages received by Owen

At the end of the semester Owen achieved 57% in Module A and 64% in Module B. He often talked about the strong influences from the practices employed during the previous years through schooling - for instance, all the work was done during the classes, there was only one examination at the end of the year, teachers were more easily accessible, etc. - but he was willing to change his approaches in order to adjust to the new setting. These changes came as a result of the actions that Owen took upon his lecturers' suggestions.

Owen moved from the discomfort zone to the transitional zone fairly easily. The impact that the interaction with certain messages had on his identity contributed to this move. He responded to both strongly and weakly framed messages and tried to adjust his old study habits to the new requirements in order to settle in and acquire the new ways of learning. The only time that one of the messages that he referred to did not prompt him to take any kind of action and constrained him, was when Lecturer B did not provide enough time for copying the notes and understanding the content taught. On these occasions he tried to invest more time outside the lectures in order to revisit the notes.

A.1.5 Kenny's narrative

Kenny decided to study for a Mathematics degree because of his interest in the subject. He liked mathematics since he was young and his 'super enthusiastic' mathematics teacher inspired his love for the subject: "All way back at secondary school I would say it was when I decided I want to come to university, 'cause my maths teacher, he was like super enthusiastic and I loved it, and he kind of, sounds a bit weird, but he inspired me to do maths..." He anticipated university mathematics to require independent work. When he arrived at university he realised that the amount of independent work it

was more than what he initially expected it to be. This fact, in addition to the different practices employed at university troubled him at the beginning of his studies.

In the following I will describe some information from the narration of his background story which emphasize aspects of his identity as a mathematics learner. I will also present the messages that he received from his lecturers in the university context, the interpretations that he made and eventually the impact that these messages had on his transition.

A.1.5.1 Background information

Kenny described an interest in the subject of mathematics throughout his whole schooling which became stronger towards the end of the sixth form: "Ever since I've been like in primary school, secondary school, I've always loved maths, maths is my subject and then I followed it through 'cause I've loved it and then seemed like the next step I guess. Once I've done A level maths and further maths, this is what I wanted to do... It's much harder [now] but I still like it, love it, it's good." Moreover, he referred to his school teacher who influenced this interest: "My school teacher sparkled my interest in maths early on."

Kenny took A Level Further Mathematics during his time in the sixth form. Whenever he faced difficulties with mathematics he turned for help to his school teacher. Before coming to university he expected mathematics at university to be mostly about proving lots of theorems which eventually it was, as he stated. Additionally, he expected studying mathematics at university to progress at a faster pace, be much harder than school and require independent study. He received the majority of information regarding how it is to study for a university degree from his school teachers: "A lot of

my teachers said that it was going to be a lot more independent like when I was in my final year [they said]: 'There are things that you should do by yourself 'cause it's going to be like this at university.' " Although Kenny was prepared to encounter an independent context he admitted that when he arrived at university it was a lot more independent from what he expected it to be.

While Kenny was trying to adjust to the new practices he faced difficulties mainly caused by the different ways that the two educational settings function. He reported that the cohort size of the lectures and the lack of the one-to-one interaction prevented him from raising questions whenever he did not understand something during lecture time. This led to the realisation that he had to spend more time working on his own after the lectures in order to comprehend the concepts. Additionally, he found unusual the fact that students were never checked upon whether they attended the lectures or not: "...if I don't turn up for any lectures, for the next like two weeks, nobody would say a word and I'd be ignorant."

A.1.5.2 Experiencing university mathematics

Kenny referred to five categories of the transmitted messages; the things that students should do during and outside the lectures, the assessment methods, the things that students should do when they feel stuck and the general study habits required for studying mathematics at this level.

Things that students should do during lectures

Gappy notes

Kenny recognised a lot of benefits in the use of gappy notes. Firstly, he talked about the different mathematical tasks that were included in the notes and

more specifically the true or false questions: "...when we have the true or false [questions it is] kind of making sure that we keep up with the work, which forces you to learn 'cause you realise that you are behind and that's one big thing..." He contrasted this practice used in Module A to the rest of the modules, where it was not used, and according to him it was not easy for the students to judge whether they were doing good or not.

Another benefit that he recognised in the use of gappy notes was the reading sections that were included: "I think the reading makes you constantly thinking about Module A, whereas in my other lectures often it is: 'Ok, I had the lecture and I will have another [one] on Monday...' so then I can just completely forget about that and move on... if you don't do the reading or you don't understand the reading you are going to have no idea what's going on the next lecture... she is giving me something to make me think about and then I am learning more I guess, that's good."

The message transmitted with the use of gappy notes influenced Kenny's learning practices. The high level of classification and the (almost always) strong framing that the lecturer conveyed through them, with the mathematical tasks and the weekly reading sections made him feel comfortable in the attendance of this module. He considered that in this way the lecturer supported the students. Despite the level of difficulty of the module, he acknowledged that Lecturer A's practices kept him up to date with his learning, as opposed to the rest of the lecturers: "Being more up to date is one for sure because I am further behind with my other lectures than I am with Module A... [the other lecturers] force me to be a lot more independent than Lecturer A... I have to figure out myself what to do." It is clear that Kenny felt more comfortable with this practice where the lecturer had all the control and in this particular case he moved into the transitional zone where

he was more engaged with Module A and acquired a better understanding.

Things that students should do outside lectures

The use of textbooks was another practice that Kenny commented about in our meetings. He mentioned that throughout his whole schooling he never used mathematics books while studying and he expressed his thinking about using them at university: "I wouldn't even know what textbooks to look for, I am sure they are on [the university's webpage] but I've never ever used textbooks through my whole learning. I've always been on google... I mean people say just look through the textbook but I find that such a waste of time often 'cause I am not very good on reading textbooks and I don't know, I guess one book doesn't really have what the whole internet has."

The high level of power that was transmitted with the recommendation of the textbook lists made Kenny recognise the message easily. With this practice the lecturers encouraged the students to take action themselves and seek additional learning sources in furtherance to their learning. The weak level of control that both lecturers exerted while they talked about the use of textbooks, in combination with the unfamiliarity of the practice, impeded Kenny from using the books. He felt more comfortable looking for help on the internet, something that he used to do already, before coming to university. On this occasion, despite recognising the message, he did not take any kind of action and he remained in his comfort zone where he continued using the previously familiar practices.

Things that students should do when they feel stuck

Kenny described in what ways he dealt with the things that made him feel stuck during the first semester of his studies. Initially, he did not feel comfort-

able to communicate his queries to his tutor. The presence of other students in the tutorial sessions made him feel uncomfortable. A few weeks later he took the chance to talk to his tutor. Ever since he kept asking for help whenever he did not understand something: "I had this tutorial session where there was just me and another guy and the tutor and then we talked properly so that made it better. Before when I was in like a group of eight sitting there... I just didn't feel comfortable to like talking in front of everyone else I guess... Now it's fine, now I know properly, it's much more comfortable asking questions..." Furthermore, he recognised his lecturers' suggestion for visiting the mathematics support centre but he did not attempt to go: "I still don't go to the mathematics support centre... I don't think anyone really told me about these times, it's not been given to me clearly anyway... Neither has been emailed to me."

In both cases (through the lecturers' recommendations of asking questions to the tutor when feeling stuck and visiting the mathematics support centre) the power of the transmitted message was strong. The control conveyed through the lecturers' suggestions regarding these two practices was rather weak. Lecturer A communicated clearly the options to the students and gave them space to choose whichever suited them best. This lack of control and the change in the approaches used between school and university created a sense of discomfort to Kenny. At first he felt intimidated to express his queries in front of his peers. He overcame this difficulty only when he was left almost alone with the tutor. Additionally, the fact that he was not told explicitly when and how to use the mathematics support centre prevented him from using it. Therefore, although initially he positioned himself in the discomfort zone and felt constrained asking questions, when he felt that the time was right he employed the suggested practice. This moved him

into the transitional zone where he found a way to get his questions answered.

Assessment

Class tests

Kenny talked about the differences in the assessment approaches between school and university. He considered the class tests as a useful way to keep up with the content of Module A: "...when you are given a test every like three weeks... you keep up rather than just cramming in the last minute... I prefer having a test every other week... Back at college I would just have one big exam in the end and... maybe because I understood much more... the content was easier to keep up, was a bit slower." After doing poorly in a couple of tests Kenny became more diligent; he tried to organise his study time more effectively and to make sure that he was not falling behind. Another factor that contributed to this change was the fact that at university students were not checked upon regularly: "I started realising that I am falling behind, and then I just started making sure as I said doing the half hour a week for each module questions... I just kind of figured out that if no one else is going to do it for me I have to do it... To be fair what triggered it was me doing really poorly in a couple [of] tests, the first two, so then after that I was like I really need to make sure I am doing the work 'cause no one else is going to do it for me."

Moreover, the feedback from the tests helped Kenny significantly to build on his skills for working with proofs: "...the feedback we get from the test, either [I am] right or wrong, is very helpful, like builds on my skills of doing proofs which was kind of not existing before. Because again my other lecturers if I've done something wrong I don't really know until two or three weeks later when they've given back the results and then I don't really care

about that... Whereas with her is a lot more immediate like the feedback on what we have done." Finally, another aspect, more strategical, arose in Kenny's thinking with the use of tests and the feedback that Lecturer A provided. Knowing exactly his progress in this module helped him to balance the amount of time that he put in to work for each module: "...I've got a better level of knowing where I am compared to the rest of the class, so then that neither makes me study more or study less, so I keep a level which is passing. Whereas I'd say in the other ones I've got no benchmark where I should be, so I don't know how much work to do, if I should do more or less, which ultimately this means slacking."

The strongly classified and framed message transmitted with the use of class tests influenced Kenny in many different levels. He felt comfortable being tested regularly during the semester. With the class tests the work was designated by the lecturer and he was obliged to keep up with the material. He realised that after doing poorly in the first class test. Although initially he considered unusual being examined so often, the fact that the tests helped in keeping up with the material and the constructive feedback provided by Lecturer A enhanced his learning and contributed to his better integration in the university context. Moreover, with the use of class tests he created strategical ways of thinking regarding the distribution of his study time. Kenny considered important to keep a 'passing' level for all of his modules. Despite the fact that the change in practice positioned him initially in the discomfort zone, by receiving the message transmitted with the use of class tests he managed to move into the transitional zone and to invest more time in studying and keeping up with the module.

Courseworks

At the beginning of the semester Kenny admitted that he did not really have

actual mathematical conversations with his peers. This changed during the semester when he reported that with Module B's coursework he was motivated to work in groups with other students: "...I think teaching people how to do stuff really makes me understand it more, and then when I am talking to my friends I am taking in more... I guess I give my friends more credit than the lecturers, even though they are much smarter than my friends... because it's more personal... Without the coursework I would have been further behind, but then when there is no coursework to do it's not really important for me to ask questions to my friends that much... I don't know, why bother..?"

The high degree of power transmitted with the use of coursework made Kenny recognise and employ a practice that was unfamiliar to his previous study habits. The weakly framed message motivated him to take this opportunity and work with other students. The lecturer gave space to the students regarding the sequencing and the pacing of the required work, but he framed strongly the group formation. Kenny took this opportunity and he moved from his comfort zone into the transitional zone. He recognised a sense of intimacy in the group work, like the one he used to have at school, which was hard until that point to find in the university lectures. This contributed to his understanding as it prompted him to keep up with the content of the module and have mathematical conversations with his peers.

General study habits

Time-management

One of the most important messages that Kenny received from Lecturer A concerned the time-management: "...now is do more work regularly and often, I guess that's what that reading kind of told me, because before everyone

just says manage your time better. And what am I supposed to do then? I have never heard of time-management so..." This information prompted him to change his ways of working and to become more efficient in the planning of his study time: "Well I changed... now instead of just on the deadline, doing whole day's work I'll do like two hours work on each bit of coursework every week so then when I get to the deadline I don't have so much to do. And then it was the problem sheets that they give you every week, I spend half hour on each one now so I am not as far behind. And the coursework is easier, everything is easier. "

Kenny recognised the strongly classified message and argued that it was the first time he was getting actual information about time-management. Despite the weak framing conveyed through this message he was eager to take action from it. It is the only case that a message with low level of control prompted him to modify his previous study habits. The amount of work and the number of responsibilities that he had to undertake were structured appropriately with the use of an efficient study plan. The conveyed message moved him into the transitional zone. He felt comfortable when he understood what time-management was concerned with, and he sought to use this advice in order to advance his daily work.

A.1.5.3 Overall impact

The most influential messages on Kenny's story were the ones carrying a high degree of power and control and were transmitted by Lecturer A. He referred only once to a message transmitted by Lecturer B (the group work for the coursework). On many occasions he commented on the differences in the practices used between school and university and on the impact that these had on his thinking during this phase. In the following table (Table

A.6) I present the messages that Kenny talked about and the impact that they had on his transition.

Message	Classification	Framing	Positioning
Gappy notes ($M_{1.1}$)	$+$	$++++$	Transitional zone
Text books ($M_{2.2}$)	$+$	$++--$	Comfort zone
Ask the tutor ($M_{3.2}$)	$+$	$+--$	Discomfort/Transitional zone
Class test ($M_{4.1}$)	$+$	$++++$	Discomfort/Transitional zone
Coursework ($M_{4.2}$)	$+$	$++--$	Transitional zone
Time-management ($M_{5.1}$)	$+$	$++--$	Transitional zone

Table A.5: Messages received by Kenny

Kenny achieved low marks in the final examination of the two modules. In Module A he scored 29%, and in Module B 46%. The majority of the messages that influenced him were transmitted by Lecturer A and were strongly classified and framed. Many times he moved from the discomfort zone into the transitional zone because of a perceived message. For instance, by grasping the opportunity given by Lecturer A's tests he realised that he needed to be more active and not cram in all the work at the end of the semester. He was willing to change his way of studying and he felt more confident about his learning by taking action from certain messages while the semester was progressing. This was a sign of integration to the new context, regardless of his marks in the final examinations which were relatively low. The low marks could be explained by the fact that it was already late in the semester when he actually realised that he had to put in work for the modules.

The messages that Lecturer A transmitted had a great influence on his Kenny's thinking regarding the studying of mathematics at university. The fact that were all strongly classified and framed made him believe that the

lecturer was more supportive compared to the rest of the lecturers: "...I'd say because Lecturer A is always building up a little bit, the other ones are either you are learning yourself or you don't..." Although Lecturer A attempted to advise the students and to prepare them for the level of independence required at university context, Kenny perceived the advice as some kind of support and that the rest of the lecturers tried more to make them independent. This is a indication that despite the fact that strongly framed messages with the control that they exert on students' thinking can be more influential, at the same time they do not leave enough space for initiatives and independent actions to be taken from the students.

APPENDIX B

Second appendix

B.1 First Questionnaire

Questionnaire

General information

1. Gender

Female ..... ☐ Male ..... ☐

2. Age

_____

3. Ethnicity

White ..... ☐ Mixed ..... ☐ Asian or Asian British ..... ☐
Black or Black British ..... ☐ Chinese ..... ☐ Other ..... ☐

4. I follow a single honours degree in mathematics

Yes ..... ☐ No ..... ☐

5. If I think about all the information I have received during these two first weeks from the department, my lecturers, my tutors and my friends, the most important message I got about studying mathematics at university is:

_____

_____

_____

_____

School Mathematics

6. I have taken Further Mathematics

AS Level ..... ☐ A Level ..... ☐ No ..... ☐

7. There were times during my A Level where my mathematics became particularly difficult

Yes ..... ☐ No ..... ☐

7a. If yes, for these particular difficulties I turned for help to:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Family members	☐	☐	☐	☐	☐
Friends	☐	☐	☐	☐	☐
School teacher	☐	☐	☐	☐	☐
Tutor	☐	☐	☐	☐	☐
Textbook	☐	☐	☐	☐	☐
Internet	☐	☐	☐	☐	☐
No one	☐	☐	☐	☐	☐
Other (please state)					

_____

8. Most of the times when I was doing mathematics I worked with friends

Yes ..... ☐ No ..... ☐

Degree Choice

9. My choice to study mathematics at university was influenced by:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
School teacher	☐	☐	☐	☐	☐
Family member	☐	☐	☐	☐	☐
Friend	☐	☐	☐	☐	☐
University open day	☐	☐	☐	☐	☐
Internet/ Media	☐	☐	☐	☐	☐
Personal interest	☐	☐	☐	☐	☐
Department's reputation	☐	☐	☐	☐	☐
Career opportunities	☐	☐	☐	☐	☐
Other (please state)					

_____

10. For the one that was most influential write a few words about the way it has influenced your choice:

_____

_____

11. I chose [redacted] University because of:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Course content	☐	☐	☐	☐	☐
Ranking	☐	☐	☐	☐	☐
Graduate employment rates	☐	☐	☐	☐	☐
Facilities	☐	☐	☐	☐	☐
Location	☐	☐	☐	☐	☐
Suggestion (friend/family/teacher)	☐	☐	☐	☐	☐
Other (please state) _____					

Transition Experience

12. Before coming to university I expected mathematics at university to be about:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Solving real world problems	☐	☐	☐	☐	☐
Proving lots of theorems	☐	☐	☐	☐	☐
More abstract ideas	☐	☐	☐	☐	☐
Other (please state) _____					

13. It was what I expected it to be

Yes ..... ☐ No ..... ☐

13a. If no, in what ways was it different?

_____

_____

14. I expected studying mathematics at university to:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Require independent study	☐	☐	☐	☐	☐
Be more personal than at school	☐	☐	☐	☐	☐
Progress at a faster pace	☐	☐	☐	☐	☐
Be much harder than at school	☐	☐	☐	☐	☐

Other (please state)

_____

15. My expectations were based on information from a:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
School teacher	☐	☐	☐	☐	☐
Friend	☐	☐	☐	☐	☐
Member of staff	☐	☐	☐	☐	☐
Family member	☐	☐	☐	☐	☐
University open day	☐	☐	☐	☐	☐
University website	☐	☐	☐	☐	☐

Other (please state)

_____

16. My lecturer in this module has encouraged me to:

	Disagree	Agree
Discuss ideas with my neighbour during the lecture	☐	☐
Visit the MSC	☐	☐
Work with my peers	☐	☐
Seek advice from my tutor	☐	☐
Visit the library	☐	☐
Read textbooks	☐	☐
Other (please state) _____		

End of Questionnaire

Good luck with the prize!

We are very interested in following up your experience during the first year of your studies. If you are keen on contributing further to this study of the transition from school to university mathematics please provide your email address. Students who will participate in the study will take part in a 45 minutes focus group and an interview, and will receive an inconvenience allowance of £8 for each one.

Email address: _____

B.2 Second Questionnaire

Questionnaire 2

Investigator's name: Eirini Kouvela

Participant's name:

When I use the term "message" I refer to any kind of information you received from your lecturers, explicitly or implicitly, during lectures regarding studying mathematics at university.

1. If I think about all the information I have received from my lecturer during my Analysis 1 course the most important message I got and which influenced me was:

2. If I think about all the information I have received from my lecturer during my Mathematical Thinking course the most important message I got and which influenced me was:

3.My (overall) mark in Analysis 1 was:

4.My (overall) mark in Mathematical Thinking was:

5.Something that I do differently now in the second semester as a consequence of a message that I received in these two modules during the first semester is:

APPENDIX C

Third appendix

C.1 Transcript from the interview with Lecturer A

The following extract refers to the message transmitted by Lecturer A through the use of gappy notes ($M_{1.1}$).

3. E. So is the reason that is important for you to follow this kind of teaching plan? That you already have the things arranged beforehand? Or is it something else as well?
4. L.A. Yeah, I mean I like to have everything planned, I like to know what is going to be happening when and to have the activities built in and that has to be prepared before so.. sorry I feel like I am not answering. Do you want to say that again?

5. E. So the main reason that you do that. Why is it important for you to follow this teaching plan and not something else?

6. L.A. This particular teaching plan or this whole style of teaching?

7. E. This teaching plan during the lectures?

8. L.A. Well is just how I do it! [laughs] Well a lot of the work of teaching is not done in the classroom is done in the [plain], is done in the deciding... I suppose I think of it as my part in it is only part of what happens so really is not about what I think or say is about what the students think and say during the lecture and I want to promote certain types of thinking and saying of things and giving them opportunities to do that, so that's all thought about in advance. So I mean like everybody else 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. Yeah I guess that's the reason I think is important to think about what they are likely to think in response to something and to plan for that. But I still do make stuff on the spot[...]

C.2 Transcript from the lecture observation of Module A

The following extracts are from the lecture observation of Module A. They are different instances from the first lecture of the semester where Lecturer A refers to the use of gappy notes.

-[before the lecture starts] Grab some notes on your way in guys...

-Alright, this is a great start, thank you all for being here on time, thank you for sitting nicely in the rows...
-Welcome to your first university lecture!
-The set that you have are your notes. You will end up with a version [of notes] that looks like mine but it 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 this is your notes you can write on them any way you want.
[...]
-We are going to vote, we are going to do lots of voting in this class, every time I do not care who is right and who is wrong, I just care that everyone is thinking about it and then if someone gives you a good reason to change your mind if you are willing to do that. So, with that in mind votes for the first one...

C.3 Identification of the transmitted message

In the above extract from the interview, the lecturer is explaining why she chooses to employ gappy notes for her lectures. Including this sort of notes in her teaching she gives the students the opportunity to interact among them, to be a part of the construction of the notes and thus during this process to have some time to think about what they are actually taught. This is the main motive for this choice, and eventually the message that she conveys to the students. This is confirmed also during the lecture observations. In the extract from the first observation the lecturer makes explicit to the students that it is their responsibility to complete the set of notes in whatever way they think it is useful for their learning. Moreover, with the activities that she includes in the notes and with the true or false questions gives the students

time to think and reflect on what they have just been taught. All this agrees with what she said in the interview and makes clear the message that she wants to convey to her students through the use of gappy notes.

APPENDIX D

Fourth appendix

D.1 Transcript from Jason's interview

1. E. Let's talk a bit about you, who is Jason and how come did you decide to come here and study maths?

2. J. Who is Jason is too much a big question, I think mathematically I've always.. my whole family has done maths, write down and quizzed me on maths, my uncle.. in the [...] at school, when my nanny was taking me we were doing times tables and various different maths kind of problems so she always shout out 7 times 8 and I had to answer very quickly.

3. E. The 7*8 is so common, they all ask the same.

4. J. Yeah, my grandad was a physicist [...] he did for a career but he

taught me a lot of physics, he has always done maths with me, as a kid growing up.. I don't know, a real memory of mine is when my uncle taught me how to calculate every square number by the previous square number which is really simple when you think about it. When I was 10 I was really smart at it, I always stark out, I've always known my times tables, I've always been the kid in the class that knew the 15 squared, this in primary school, so.. it's not that impressive anymore. I think it's always been there and I've never really taken so much attention to it. I mean I was in [...] once in year 11 for A level, but I messed around a lot as a kid at school, didn't do any work, it was a bit of a problem, I was messing around the class. But I didn't realised that I had maybe a better mathematical understanding than most kids 'cause I didn't do any work and the work what I was doing was fine, doing the homework but I still got the same grades as everyone else that was working hard. And I think it took a really good teacher at A level who took me on and said that I was the worst students they ever had.

5. E. She said that?

6. J. She said that yeah, no no they said that afterwards, after a few years, you know when you came to us you were the worst student we ever had but I know I wasn't that good but she made me one of the pretty hard working and it worked and I think it's the combination of family, I'm sure if my parents read literature to me and made me more you know english based that I might have done that but it's always been maths.

7. E. Both your parents have studied for maths?

8. J. My mom is an artist and my dad is a computer programmer so he is obviously very mathematical, I mean growing up, going to his office he

has three screens and it's green, it's all the green typing and I tried to ask him to tell me about it but it's way too complicated. But I mean the combination of the two was very good, 'cause then I had to draw and all these things, like appreciate those things you know, it helped me with my diagrams mathematically, if you can draw out what you are trying to picture then it makes a big difference. Especially I love mechanics, I did M1 the [four] which is most people but if you have the diagram right then everything else follows you in picture and you know what is accelerating and what's moving.

9. E. So you think you've been influenced by your mom in that case?

10. J. Yeah, I think having been able to draw well and picture things is a real advantage in maths.

11. E. When you filled out the questionnaire and I asked you about the messages you said that the most important message that you got back then which was quite in the beginning, that it's not easy but it can be overcome if you work more and pay attention in the lectures. And then in the focus group you said that it was a message that a friend of yours gave you, not to do what he is doing because he was slacking and things like that. Would you like to comment a bit on those two?

12. J. What were the questions again? Cause I remember you said.. yeah, it's a friend of mine who when I first got here I was in the lodge I didn't get accommodation somewhere, and he was there doing maths and I thought that's a good start that I know someone who is doing maths. But he stays up until five in the morning doing nothing. I mean I don't drink or go out, I am into sport and I like being very healthy and he is the opposite. And I get a message from him every week saying

what's the answer? When is the coursework due? I mean I've done, I've helped him with a lot of his coursework which I shouldn't have.

13. E. Was he year 2 or year 1 as well?

14. J. Year 1 as well, he is just.. I don't want to be in his shoes basically, so I am trying my best not to be anything like him.

15. E. And regarding the first thing that you referred to that it's not easy but it can be overcome if you put work in.

16. J. Yeah, I think from my experience I've had some challenges and I've had some.. yeah that's a tough question but I think some people give up after maybe when they attempted and they can't do it 'cause really you know but if you continue to try and break it down I think hard work is a big fact I think, it's no longer about natural ability, like it was in GCSE and A level, you need to put hard working, go to the library, use the resources and you'll be ok.

17. E. Did you figure that out yourself while the time was going by or was it someone that more or less gave you a message about that.

18. J. No, I figured that out myself because I wasn't that good I tried to work hard and I stayed behind in class with my teacher for couple of hours and I asked for more problems and trying to correct them and I obviously I just did a little bit better and that was all from just putting some extra effort.

19. E. When you say that you are not good you mean back at school and that influenced you until now?

20. J. Yeah, I mean I did better in my A levels than I did in my GCSEs which is unusual.

21. E. And regarding the choice of the degree, we discussed about that actually before, you also told me about these quizzes that you had from your family, that your uncle was quizzing you when we were in the focus group right?

22. J. Yeah, he always asked me questions.

23. E. And you also said that your teacher made you to be in a decent maths level. How did she so that and what that decent maths level means for you?

24. J. I had two of them, I had two further maths teachers that I will always remember and they will always be an inspiration for me. They were very old fashioned, very strict and very, just very old fashioned and it is what I needed someone straight and they were very enthusiastic about.. you know they loved.. one was a statistician but she loved all further, pure and the other loved mechanics and that's where my sort of passion comes from 'cause they would write out and always be so elegant and lovely. And I think just having two great teachers was enough for me to be inspired to want to do this for the rest of my life, or career or whatever. They really got to me as a person, they were so engaging, they were funny, they were just what I needed at that time 'cause I was going off the road a little bit. And I think.. I don't know what it is, it's just that if you have a teacher that puts the work in and speaks to you as a person, makes you want to work on, I had a lot of respect for them, I wanted to do my best for them and that was a big part of it.

25. E. Have you seen something similar here?

26. J. I am a big fun of Lecturer B, I like Lecturer B, I don't connect with any of the other teachers. Not that I connect with Lecturer B especially, but Lecturer B reminds me of both of those two teachers somehow.

27. E. What are the bits that remind you of..? The things that he does?

28. J. Funny but strict, very enthusiastic, very knowledgeable, just very thoughtful, he was exact his thinking about something and that's something I could see.

29. E. You said thoughtful?

30. J. Yeah.

31. E. How do you see that?

32. J. He is constantly thinking, he makes mistakes which is funny, I think he is similar to the teachers that I had and it inspired me.

33. E. And regarding your expectations, last time you said that you thought it would have been an extension of A level, but apparently it was not and it was a bit challenging but not too difficult.

34. J. I think everything fits and it's given nicely here, I think I said last time when something is hard that it gets better and then different topics start they are all sort of move forward in different paces whereas they come together in the end.

35. E. You mean across the modules or during a module?

36. J. No, across the modules. So Module A sort of run ahead whereas the other ones were still doing this and they were always gradually caught up to be in the same sort of difficulty 'cause we got better essentially we are all when I look at it. But yeah I was told it would be.. the first year sort of level up the people that have done maths, all types of maths if that makes sense, those that haven't done the further maths which would be lacking in quite a few. I mean I would be struggling without the further maths, I would really be so confused right now. But I think that's why I was told by people that first year it sort of level people up which it has done to a sense, I can seen a lot of my A levels here, maybe the support isn't here, you know I can't pull my hand and say that I don't get that, I have to go..

37. E. Why not?

38. J. I don't have the confidence, I don't think.

39. E. And now? So far?

40. J. I still won't interrupt the lecture. Generally speaking I don't have to 'cause I've done nicely before, but sometimes it takes me a while to look at how is going, it might go too quickly, or she might go too quickly, and then I might have go back in the evening and say ok I got that. So I get it in the end.

41. E. How did you respond to that? When you realised that it's not exactly like A levels? So it's not exactly an extension, there are some bits from further maths that you have seen before but it's not quite similar.

42. J. I didn't mind, I wanted to challenge, I didn't come here for a repeat of last year so I wanted the challenge, I wanted new material, I wanted to find how stuff works with integration, differentiation, I mean I had a basic concept but we were just told to accept, this is this and not you know dive deeper into why things work but there's nothing that has been you know, gone [...] of my head. It was a few topics in A level which have been much harder than the stuff we've done here.

43. E. Which were these things?

44. J. For me vectors but they were FP3 not just pure maths, they were very tough, I don't know if I went back now and look at them I might be able to do them but at the time, anyway, relatively speaking they were just pfff and nothing here is as quite [done] there.

45. E. And these expectations that you might had, you said that you were expecting something more challenging, do you think that you have been influenced that you had in mind that might be an extension or not?

46. J. What do you mean?

47. E. When you had in your mind that when you will come here it might be an extension of A level and eventually it was not like that was that an influence?

48. J. An influence to do what?

49. E. Influence in the way that you did deal eventually with it.

50. J. No, I think I've kept things pretty much the same, I've always.. I suppose I have done more work than I was the first week but I think relatively speaking due to more coursework I think I am keeping stuff

the same and make sure that everything gets done, I don't like to be behind and anything.

51. E. You also said in the focus group that it was not really massive surprise what you found here and last time that we talked, was it like week 6, you said that at that point you were about to find time to fit in everything 'cause you didn't really have time to deal with everything, how is that now?

52. J. That's a good question, I don't do any work on the weekends and that is the reason I have to manage my time well during the week, 'cause I go home every single weekend and see my girlfriend, occasionally I get a break and do some work but generally speaking all the work I have to do is Monday to Friday, and because I know this it makes a big difference, having five days not seven. So I have to manage my time well. I do struggle to fit things in but I prioritize so I don't feel bad. I need to exercise twice a day in the morning and in the evening and what I do is that essentially kill myself Monday to Friday and then just relax on the weekends. And that seems to work, seems like I like having to myself a nice break Saturday and Sunday 'cause it is constant on Monday to Friday. I manage well I think, I manage well.

53. E. Did you come up with this plan by yourself how to make the priorities and do the work or was it a suggestion?

54. J. No, by myself. Work has always been the main priority, and then obviously I have to.. I can't neglect my girlfriend so I have to speak to her for a certain amount of time during the day, and then I have to exercise. Work is the main focus and she understands that and I understand that I can't go to the gym instead of doing coursework, so

I come to that like conclusion, I mean this is only three years and then I got the rest of my life to stay [...]

55. E. And is it any chance that maybe.. for example I remember that Lecturer A gave you this leaflet with the time management, is there any chance that is might have influenced you a bit? Or give you a bit of ideas about how to deal with it?

56. J. I read it but I didn't take much from it, not that I didn't understand it, it's just that to me I like break everything down, all you know and just sort of look at it and try and let over things but that's what I was doing already I was taught at school you know, start with what you know and then go from there, and looking for something new. Yeah I think my teachers prepared me really well 'cause they gave me all the skills that I need, 'cause obviously they knew who I would be up against and what I will be doing so, 'cause I always know I was going to do a maths degree, so they just prepared me very well for new material I mean I didn't teach myself, but I had to partially teach myself FP2 on my own, that was a year of essentially going through the textbook and that kind of thing, so I think I am kind of used in those techniques that they suggest in the leaflet.

57. E. Regarding this thing that you said going through the textbook, was it something you were doing by yourself or..?

58. J. Yeah, I got given, essentially I got given notes and I liked to sit in the back of the class and if she had some free time she'd come up and sit next to me and talk about it.

59. E. That was something extra to the actual course that you were doing?

60. J. Yes.

61. E. And why were you doing that? Were you ahead from the rest of the people?

62. J. Yeah I was, but I wanted to do it, it had useful stuff and it had hyperbolics and it was recommended and yeah I had some free time that I could use and I thought I could do M4 and FP2 to get a better scope of mathematics.

63. E. And did you teachers back then tell you how to work, how to read through the textbook, how to use the notes or they just gave you the material?

64. J. Yeah, well no they didn't tell me how to use it they gave it to me and if I had any problems we go through it and it was quite straightforward, I mean obviously she had to teach me hyperbolics and stuff like find the differential of the tan, you can see that in page, you know, you can see how that comes nice and you don't need someone to teach you that.

65. E. We come back to Lecturer B because you said something last time in the focus group as well, that you like the way that he is funny, and that he has this bit of weird humour, and he is always smiley and generally that he has this positive attitude and you think that this is helpful for learning maths.

66. J. He and Lecturer X [another lecturer] it's almost like.. well sometimes anyway it's a show, it's a performance, and that's what you want in my opinion from a lecturer, you want to be engaged, you want to get lost in what they are saying. I'd describe as much as a performance.

67. E. Can you describe me a bit what does this performance have?

68. J. Well he is engaging, he uses examples you know the other day with the step falling into a hole that kind of thing, is very useful and everyone can picture it, makes perfect sense, fits with what we are doing, that kind of thing. Another one back in the two mathematicians and three sons of different ages, they were up in numbers of windows or so whatever I can't remember the exact thing but just little things that are very intuitive I like that example a lot, I thought was very clever. I mean he loves his subject which makes a big difference but it should be a performance in a lecture, you want to be excited you know.. I think as good as Lecturer A is, can be very blank and very same, whereas you want to be more theatricality you want a story actually.

69. E. When you say that she is blank you mean something like a pattern in every lecture?

70. J. Yeah, it's very the same which is fine 'cause the material needs to be covered, there is no way of around it and there is nothing you can do but I think there could be more you know sort of fireworks, there can be more going on, different examples. I don't know she has.. I mean we had reading the other day which was a square and inside the square was a thing we've done in the lecture you know and little things like that would make the lecture more exciting.

71. E. So you believe that bringing things like examples from real life adds something?

72. J. Picturing in your head more, you can understand it, anyway.. that's what we always do with the mechanics, we'd always have.. she would

always do a demonstration on a wooden table or something just to get picture of how it all fits in together, to me it makes a big difference.

73. But that thing with picturing in your head - I'm going to do the devil's advocate now - Lecturer A does it as well when she is drawing in the air.

74. J. Oh yeah yeah. Well she draws the graph but I'm talking more of a story, with Lecturer B walking in to his house doing steps, and walking the small bit and he is obviously going to fall into the hole.

75. E. And how does this positive attitude influence you?

76. J. Makes a big difference, makes a big difference, especially Lecturer X, he is the happiest person I've ever seen in my life and he loves doing this, I mean he is really simple basic stuff, but he still for some reason he has a passion for it, he finds hilarious, he tells a joke half way through every time and the jokes are dreadful, they are honestly the worst but that is what is hilarious about them 'cause you don't know when the [...] goes as it comes you will still waiting for it and it must just happen at some point. He always tells the story mid way through, it's like [...], he always say the story mid way through and his positive attitude towards engaging is constantly asking the audience and if they got any questions you know, if this is ok, if everyone is there. It makes a big difference, he is very live, he is very confident in doing this and that's important.

77. E. You think that this difference that you say is making a big difference is it only at the time during the lecture or generally at the knowledge you might acquire also when you are leaving the lecture?

78. J. If you are doing a problem you can picture him doing, you picture Lecturer B with the foot steps, you can picture you know every time I look at it, I think it was Q is dense in R, so I can picture Lecturer B doing the steps and make sense and Lecturer X's hand waving.

79. E. It's something that you take with you.

80. J. Yes, you remember it.

81. E. At some point when we talked about the resources I remember you mentioned the leaflet that Lecturer B gave you in the beginning, that had the truth tables and you said it was very helpful for you, right?

82. J. He gave us a big booklet, and I haven't looked at it many times if I ever been struggling I know things are in there and I can just have a look, he always has the lecture notes but it's good to have always something like a textbook just in case you are struggling.

83. E. That was the first one that he printed out for you, have you seen the rest of them online on learn?

84. J. No, I haven't looked. I haven't needed them in the sense with truth tables. It was just a.. 'cause I get a bus home, keep inside to read on the bus home and think about it, especially his lecture is the one before my bus so it's still [...] it's a three hours bus, it's a nice read on the way home but I haven't, obviously I've been considering other things recently.

85. E. Is there any chance that you have noticed, you said that is was helpful, is there any chance that might have been any other resource from any of your lecturers that might have influenced you?

86. J. Well, Module C I think we get a set of notes for what he does on the board and we have this booklet every time and we write on that, and that's really clear and really neat. Similar thing doing with Module A.

87. E. Module C is it the one with the gaps that they are in red and black and you need to know what colour to write down?

88. J. No, no it's similar with what Lecturer A gives at Module A, and same in Module D, so those three I can use those, they are really neat I know where everything is, that is really good, that is what you want from notes, it will be great to do revision of. Lecturer B isn't same, you make those gappy notes himself but I think.. I don't mind, I don't mind at all. Obviously computers it's just a bit different but yeah.. I forgot what the question was.

89. E. If from any other kind of resources that you get from your other lecturers have you been influenced?

90. J. I use them a lot, if that fits, I mean just before we were here I handed in the Module D coursework which I did before I came, and I just used my notes at the coursework in front of me picked out and just did about that so yeah I mean they are very useful.

91. E. We talked about if the way you are working has changed and you said that you haven't really changed a lot, would you like to tell me about that?

92. J. My room is a mess full of paper which I know around bits here and there and then just sort of when..

93. E. You mean when you keep notes?

94. J. No I take the notes in the class, when I am working on problems I just sort of when I am moving page I sort moving that over there and everything is just everywhere which is the same as it was for A level, my room was just a mess for the maths papers. I don't think I have changed, I don't know if I should I seem to get everything done. I'm too lazy to go to the library 'cause I think I could be working in the time I walk there and get back. But I try, I try going to the library, and get some work, I've got some really good work down there when I was doing the first Module B coursework.

95. E. The one that was in group?

96. J. No, That's this one. I went there and I was struggling on the last question and finally solved it.

97. E. Did someone suggest you to go and work there or..?

98. J. I needed a book on stats to answer the question and so I found that on library and I still didn't get my marks on that, I need to speak to Lecturer B about that.

99. E. Something else you said that has changed is that now you are doing more reading.

100. J. Yeah I am doing more reading.

101. E. And you are going a lot back and you are going through stuff again.

102. J. I make a note as I said earlier if we go too fast I'll go later in the evening and have a look back and it makes sense, 'cause sometimes I might get distracted in the class, I'll miss something so yeah I have to go back and recap things.

103. E. Was it like a need of your own or someone suggested you to work this way?

104. J. No, I am completely [inclusive] in a sense, I don't speak to anyone from the course, I go there and sit on my own and make notes. It's quite an arrogant thing to do but I find it most useful for me.

105. E. Also in the times that Lecturer A asks you to work with people around you, you are not working with them?

106. J. I've tried a few.. well I never tried, I tend to hear what's going on around me and I think is fairly obvious what the answers is and so I tend not to engage in that, in the conversation about the answer, sometimes I am wrong but sometimes it's very obvious and I don't think it worth, need a conversation. The only person I sit next to is Chris, who is the friend I have the lazy, he is not actually very good so we never [talk about anything] we don't need to I just write the answer down. I hate conversations around me, there is extremely silly, or stupid, or annoying, and I tend not to speak to people for that reason.

107. E. Why would that be silly or annoying?

108. J. Something about how drunk they were last night, or..

109. E. No no I don't mean about that, I mean when she is asking you to work and tell to the person next to you what the answer might be, you don't find this silly right?

110. J. No, no that's not silly obviously, sometimes if you both struggling you might come to something together, I just want to.. if I do that with someone they would.. I just don't know that's the end of the

conversation. No I mean no one sits next to me anyway 'cause it's quite nice I think I've learned a lot on my own space.

111. E. Ok, so you enjoy being on your own.

112. J. Yes. Even the group coursework I do it on my own.

113. E. So you don't have really maths conversation with people around you?

114. J. I have maths conversation with my uncles, my granddad and my dad obviously that's literally. I try not to speak to people. If I find someone..

115. E. Why do you try? About maths for example.

116. J. From my experience it sounds really bad, because they are not paying attention, they don't understand what's going on. I don't want constantly to have to explain something I mean I'm waiting to meet someone who is paying attention and is not better than I am, but is someone that I can learn something of. I feel if when around I am going to be constantly helping which sounds really selfish and wrong I know it is but.. like with the group coursework I know that if I find two other people to work with me I will end up doing most of the work and they will be doing nothing, and I'd rather do all on my own. It sounds really bad but for me, I'd rather work on my own than with other people.

117. E. Fair enough, if it is the way it works for you. Regarding the assessment you commented on I think it was this bit that Lecturer A gives you the questions before the test, and you said that you like to have it beforehand.

118. J. I like to challenge, I like to go away and have a think about something and then Chris points what's wrong or see a flaw in it. For this week's when I solved the actually on the way to the place, 'cause I was working on in the morning, I am not going anywhere and I just thought I need to separate it, I can't have a look at the question in front of me. But yeah, I like having a challenge to be set every week and to go away try it over. Even if I get it wrong and I get bad mark in the test you know I still enjoy.. like the best example was Lecturer B's question 4d that was really good.

119. E. What was it about?

120. J. It was induction of power sets and it was a proof by induction and that was a really challenge, I had to spend hours on that question try to get it right.

121. E. Did you make it?

122. J. I think I did, whoever marked my paper said it was wrong but they didn't understand what I did, it sounds arrogant they didn't understand where the equation was from and I obviously need to speak to Lecturer B about that 'cause I think they've misread.

123. E. Did you sort it out?

124. J. Not yet, I need to come back on Monday and speak to him.

125. E. And did you go to the library looking for books?

126. J. This is the one, the stats book.

127. E. Regarding the ways that you are working outside lectures, when we talked about the group work last time you said that is good if you are

working with someone else because they can see what you can't and is good having two perspectives.

128. J. This is Chris, he is very good, he can see where I've gone wrong but I ended up giving him too much of my own work, I don't speak too much to him anymore.

129. E. So you referred only to this case, working with this person.

130. J. I mean sometimes it is good to work with someone else but.. you have to work with the right person.

131. E. There are 200 you don't think you can find one?

132. J. I've looked, I tried, trust me.

133. E. How hard have you tried?

134. J. I don't know I don't need some of these in pure maths obviously, and there is only I think maybe 40 of us, maybe 30 attending the lectures.

135. E. Only that little?

136. J. Yeah, well everyone that comes up to Module B, I have to chose someone from there, Chris [comes sometimes] to that course, I don't know everyone seems to me in their own friendship groups, so I think I missed that [...] to find someone, but I am happy working on my own.

137. E. Regarding the things that they suggest you to do outside lectures, is it something that they have suggested and you are doing the way they said?

138. J. I can't remember the advice the lecturers have been giving to me about working outside lectures.

139. E. Why?

140. J. I don't know I haven't been given any advice ever, what have they said?

141. E. They might say go to the library, or this is the recommended textbooks list go to check this book.

142. J. I've looked in a few textbooks if I am struggling, there is a couple in the MSC not as many as I would like there is a few there which have been useful. I don't really consult a textbook if I don't understand it, so stuff I've done before I wouldn't really go over too much but the stuff it is new I tend to take a textbook.

143. E. So do you think that they don't give you advice?

144. J. I wouldn't say that, maybe I don't listen to it. I like my routine as it is. I just.. it's difficult 'cause I'd work in the library but I need a constant supply of food which I can't have, at home I can eat while I am working if I need to do.

145. E. The library example was something random that I said, you can come up with any example that they have said.

146. J. I like working in the lab upstairs, even if there is no computer work, that seems to be quite and nice, and it just have to be quite for me to work.

147. E. At the focus group you said that no one gave you a message that has been insightful.

148. J. Is that bad?

149. E. No no I just want your comment, I am not judging you.

150. J. As to how to work?

151. E. No no generally. Since day one that you are here till now. You can think of anything.

152. J. I can't think of anything I've learnt, I think I was prepared for uni well, it's how I expected it, so I haven't really got to learn anything. I never had something insightful.

153. E. What is insightful for you?

154. J. Makes me change the way I look at something, I haven't heard something that insightful. My brother is constantly telling me that the first year doesn't count. Even someone upstairs who works here said your first grade doesn't count. I was planning on going to Paris, and I booked Paris with my girlfriend but it's on the 12th and that's when the Module B [coursework] is [due] so as soon as I.. I mean I knew that it wasn't I just thought it worth asking 'cause it's going to cost a lot to change it and he said if it's me it's fine but I need to speak to [...] upstairs you can take the risk, your first year grade doesn't count towards your final grade and I am afraid that's a bad thing to say in that position. So I haven't really had any insightful information, I just watch others and I learn from that. Tends to be that people go out too much that's where I learn from. I find that insightful.

155. E. That's what you learnt not to do what they do?

156. J. Yes.

157. E. Would you like to add something?

158. J. I wanted your opinion on the working on my own if you..

159. E. It's completely acceptable, anyone can work on their own way.. When I was in your position [...]

160. J. Ok, that makes me feel better, [E. it's the way it works for you] it does, it does, I just feel incredibly arrogant refusing to work with people, not refusing they never ask but..

161. E. Maybe if someone is asking for your help, is something that you will do right or not?

162. J. The only person that asked me for help is Chris and I'm waiting for him to ask me again 'cause I am going to say no if he asks. I am not going to help someone that refuses to wake up.

163. E. If he is taking advantage on you obviously you are not going to help them.

164. J. I've been very nice to him and he puts an [effort] and expects to use my work, I mean I helped him a lot in the previous coursework.

165. E. Yes, that's not the case we are talking about someone who really needs your help.

166. J. Yeah I help anyone that asks, and [I'd wait] the same if I'd ask I don't know I feel that people around me aren't as serious as they should be sometimes. Especially in the lectures where I got tones of people and they are just all messing around, they are all in this social media [yak] talking about stuff and I am just thinking I am the only person that can't understand what's going on, so rather than doing that they should pay attention and that frustrates me people aren't serious. I

think I am looking for someone who is serious about it, about maths and enthusiastic and I just want to have time doing it, it's the reason I work alone. I've tried to find someone that was passionate..

167. E. In the same pace?

168. J. Not in the same pace, I am not brilliant.

169. E. I mean generally share the same attitude, perspective..

170. J. Yeah, someone that.. not that I am in a high level but someone at the same level as I am, obviously there are going to be better people and worse people but someone in the same level as I am, just someone similar to me basically, which seems that is no one here like doing the stuff I do.

171. E. I am not sure that you can find someone that is exactly similar like you, but someone having more or less the same view on things.

172. J. I thought Chris would be good but it just irritated me when I found out that he doesn't do any work so that was a shame. I [don't] need to work with someone who does pure maths and it's only 50 of us but I don't know, I mean you are in the class tell me what would you say, in Lecturer B's class?

173. E. I don't know because all of you that I have seen you are pure maths.

174. J. I mean that's the pure maths class.

175. E. No it's not only pure maths, there are maths ed as well. It's not like Module A for example.

176. J. I think it's 40 people in Lecturer B's class, I mean it changes week to week it just seems to go down and down and down.

177. E. Yes true, last week it was almost empty.

178. J. I know, I felt really bad and it's also worrying.

179. E. I expected to be honest, because all of this coursewrok these days.

180. J. Really? That's not a problem.

181. E. I know, for you that you prioritize..

182. J. It's not hard, not for me, that's why I am angry, they don't prioritize.

183. E. Maybe they don't take as serious. [...]

184. J. It's 50 or so many pounds for a lecture, I have the same statistics, that's a lot. I mean you pay for that stuff, so you look at it this way so it is a lot to miss, I've only missed one and that's because I woke up late, I think I was ill, and the lecture was at 10 and it was 5 minutes to, and I would have made it but I would have been 5 minutes late but out of respect to the people in the lecture I said I am not going to go and take the notes somewhere else. It annoys me when people come 15 minutes later, I look at them just to make them know. I just don't know why do you come after 15 minutes later, you missed the beginning you are bot going to get the rest.

185. E. There are people that always do that.

186. J. I know, I know, I see them, I make a nod with my head.

187. E. The other thing is that if you are not in this position you can't realise it how much work the lecturer puts in to be there.

188. J. I can imagine, they have to prepare for it, which is why people turn up. There was a lecture last week [talking about a seminar in the dept that he attended and he got nth because it was high level]

D.2 Construction of Jason's narrative

I will give now an example of how I constructed the students' narratives from the data that I collected. I will use Jason's case as a model.

For the construction of Jason's narrative I explored initially some elements from his background story and his relationship with mathematics. He talked about the influences that he received from his family, the mathematical inspiration created by his school teachers, the ways he worked with mathematics during school and the expectations that he had from university mathematics before starting the degree. Then, I tried to explore in what ways he experienced university mathematics by interacting with the various messages that the lecturers transmitted and how this interaction was shaped by and shaped his identity as a mathematics learner. By analysing these interactions I identified how the transmitted messages prompted him to take action (or not) in order to adjust to the new context, and his eventual positioning.

In the following I will go through Jason's interview transcript and indicate in a number of passages the recognition and realisation rules that I used for the construction of his narrative. The recognition rules arose mainly from the previous phases of the study (questionnaires, focus groups) where the student through his responses gave significant information about his background and the ways he reacted to a number of transmitted messages. Thus, he facilitated my understanding of the context that he talked about. During

the interview he expanded on the narration of the events and in this way I was able to produce the story of the influences of the transmitted messages on his transitional experience.

[2-10] The content of this passage is about Jason's background relationship with mathematics and how this was influenced by numerous members of his family and two of his mathematics teachers (recognition rules). Jason builds up his personal story with mathematics since he was a child until his last years at school (realisation rules).

[24-32] In these extracts Jason describes in what ways his school teachers inspired his love for mathematics (recognition rules). He expands on this by making a connection with his current situation at university and describes how he is fascinated by Lecturer B's lectures which remind him of his previous teachers that he appreciated highly. Lecturer B's mathematical enthusiasm transmits an explicit message regarding the learning of mathematics at university and by interacting with it Jason's learning is explicitly influenced, something that he makes apparent in [66-80] (realisation rules).

[34-42] In this passage Jason refers to the information that he received before coming to university about the nature of mathematics that he would encounter and about how much the A Level Further Mathematics would help him to integrate better (recognition rules). By contrasting his initial expectations to what he actually found at university he reveals aspects of his identity as a mathematics learner. He admits that mathematics at university is a challenge for him, which he is willing to deal with in order to see how things actually work instead of passively accepting facts as he did at school (realisation rules).

[52-56] In this extract Jason elaborates more on an answer that he gave in the focus group, regarding the lack of time for managing his work. He describes

the structure of his weekly schedule and he includes details about his work and life activities. He admits that the structuring of his time in this particular way is entirely decided by himself (recognition rules). Although he received the message transmitted by Lecturer A regarding the effective management of the study time, Jason admits that he was very well prepared from his school teachers and thus able to organise his time himself at university and not need to use his lecturer's advice (realisation rules).

[104-116] In this passage Jason expresses his thinking about discussing mathematics with other peers (recognition rules). He describes the reasons behind his choice of not engaging in conversations with other students when Lecturer A invites them to talk about certain tasks. By elaborating on his view he expresses elements of his identity as a mathematics learner and reveals how he sees mathematics - as an individual activity that he prefers doing alone and on his own terms (realisation rules).

D.3 Utterances from students that suggested mathematical identities

In the following I present utterances from Jason's interview which suggest his mathematical identity.

[2,4,8] In these three instances Jason describes how his family influenced the ways that he approached mathematics since he was a child. He talks about his grandfather who was a physicist and always spent some time doing mathematics with him, or his uncle and grandmother who challenged him with mathematical quizzes. He recalls these instances from his past as rather determinative for shaping his interest in the subject. Furthermore, he

describes in what ways his parents' professional backgrounds influenced significantly his mathematical competence. For instance, his ability to represent mathematics through graphs which was inspired by his mother who works as an artist. All the above experiences were important in Jason's journey for shaping his identity as a mathematics learner.

[42] In this passage Jason expresses his mathematical curiosity and how much he wanted to challenge his existing knowledge with the new content once he arrived at university. He is interested in exploring how things work and not just accepting facts as he did at school.

[68, 78] In these two extracts Jason talks about the mathematical examples that Lecturer B uses in his lectures. He thinks that the examples are clever and that they transmit the lecturer's passion for mathematics, something that is important for Jason and the enhancement of his mathematical knowledge.

[116, 118] Jason reveals how seriously he takes his studies as opposed to his peers. He is willing to cooperate with other students but only when they take the work as seriously as he does. He expresses once more how eager he is to approach mathematics as a challenge and how keen he is to be set a mathematical challenge and to try to cope with it.