"Lost in transition": Alienation and drop out during the transition to mathematically-demanding subjects at university

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Abstract

This paper explores the reasons why some previously engaged students drop out during their transition to mathematically-demanding university degrees. The concept of alienation is used to explain drop out: alienation occurs when social practices restrict the individuals' agency in such ways that they are unable to transform the social conditions in which they participate, even though they might place a great effort in doing so, hence becoming alienated objectively and subjectively. So, for instance, engineering students that see themselves as 'practical', find that the theoretical/academic practice of university mathematics becomes irrelevant to their aspirations and ways of learning, i.e. alien to their identity as learners. The impossibility of changing this situation becomes recognised and results in their drop out.

Introduction

University dropout rates are a concern to many industrialised countries such as the UK (Paton 2012), the USA (Carlozo 2012) and Australia (Cervini 2014). The main reasons for this concern are the consequences that a shortage of well-prepared graduates can have in the economy of these countries. This is an even more acute problem in the case of students that choose to follow a mathematically-demanding career – mainly those on a pathway to degrees in Science, Technology, Engineering and Mathematics (STEM). This type of graduates is crucial to innovation, entrepreneurship and growth because "STEM capabilities underpin our economy. Organisations in all our high added value sectors on which this country relies depend on those with STEM skills" (Hermann 2009, 2). Therefore, the dropout rates, the non-participation rates (i.e. students not choosing a STEM career in spite of being suitably qualified) and the mathematical unpreparedness of undergraduate students – known as the "Mathematics Problem" (Hawkes and Savage 2000) –, all add to the graduate shortage problematic. Apart from the negative economic consequences this problem can bring, research shows that students that drop out of education are at more risk of being unemployed and have lower earnings (Rumberger & Lamb 2003). Furthermore, employers now favour a more educated labour force, which includes a mathematical education, making a high school degree the minimum credential for finding a job in almost all member countries of the OECD (OECD 2014).

The *Transmaths* project (www.transmaths.org), which researched the transition to university mathematics, found that a high number of students during this transition perceive mathematics as 'too hard' or 'too different' from that at school. This sometimes results in dropping out, either from the degree (shifting to a 'less demanding' one or moving to a different university) or worse, entirely from education.

This paper aims to explore further the reasons why some students studying engineering degrees decide to drop out in their first year at university, and in particular those of them who seemed to be academically well prepared, have previously been engaged in education and have been successful in mathematics before their transition to university.

Drop out theories

There is a large number of research studies, most of them quantitative analyses that seek to describe and explain different factors that relate to student drop out at different stages of formal education. The large number of these factors reported as having a (statistical) correlation with drop out figures makes the study of this concept a very complex one. However, in general, these factors tend to fall into three categories: (1) school (e.g. academic preparedness (Smith & Naylor 2001), dissatisfaction with student experience (Yorke 2000), et cetera), (2) social (e.g. matureness or emotional competence (Kingston 2008), financial support such as loans and grants (Arendt 2008), et cetera) and, (3) family related (early parenthood, child labour and poverty (Cardoso & Verner 2006), et cetera).

Several theories have been proposed to deal with this complexity in order to try to explain the drop out phenomenon. Two of the most influential of those theories are Finn's (1989, 1993, 2006) 'participation-identification' model and Tinto's (1975, 1993, 2002) 'integration' model. Most of the drop out theories, including Finn's and Tinto's models, draw upon the more general concept of 'engagement' to conceptualise the drop out process. Rumberger (1987) suggests: "In fact, dropping out itself might better be viewed as a process of disengagement from school, perhaps for either social or academic reasons" (p.111). The present paper considers Finn's and Tinto's theories as seminal and representative of most of the general ideas surrounding the drop out literature. These two theories have been elaborated and enhanced throughout a long period of time and therefore incorporate most of the ideas expressed in the current drop out literature, and are cited in recent articles studying the drop out phenomenon (e.g. Fall & Roberts 2012, Archambault et al 2009).

Finn's model shows drop out as resulting from low levels of school participation and identification. His model proposes "that if a youngster does not remain an active participant in class and in school, he/she may be at risk for school failure regardless of the risk that may be implied by status characteristics such as race/ethnicity, home language, or family income" (Finn 1993, v). He argues that "the likelihood that a youngster will successfully complete 12 years of schooling is maximized if he or she maintains multiple, expanding forms of participation in school-relevant activities. The failure of a youngster to participate in school and class activities, or to develop a sense of identification with school, may have significant deleterious consequences" (Finn 1989, 117). Therefore, in view of this model, a student that does not develop a sense of "belonging" (identification) by not getting involved in school activities

(participation) will likely disengage and drop out at some point in their education. In this model, the emphasis is on the part of the student that decides to engage or disengage from school life for whatever reason.

Tinto developed his model based on Durkheim's theory of suicide (individuals commit suicide when they are not sufficiently integrated into the fabric of society), where he argues that:

> The process of dropout from college can be viewed as a longitudinal process of interactions between the individual and the academic and social systems of the college during which a person's experiences in those systems (as measured by his normative and structural integration) continually modify his goal and institutional commitments in ways which lead to persistence and/or to varying forms of dropout. (Tinto 1993, 94)

Hence, this model argues that "it is the interplay between the individual's commitment to the goal of college completion and his commitment to the institution that determines whether or not the individual decides to drop out from college" (ibid, 96). In view of this model, a student who feels that they do not 'fit in' (integration) will develop low levels of commitment and will likely disengage and drop out from education.

The present paper agrees in part with Tinto's view that the process of drop out is a relational one between the individual and the social practices of the educational system, hence emphasising the importance of this relationship and not only of the individual's position, as in Finn's model. In fact, in more recent work, Tinto (2002) incorporates the concept of 'institutional responsibility' to indicate that disengagement is not only due to a student's failure to integrate but also the result of the institution's failure to adapt to diverse students. The present paper will go further in emphasising the *dialectic* nature of this relationship, that is, how learners are able to shape the context in which they participate (by exercising their agency) and in doing so, change themselves. This is an important aspect of drop out furthered in this paper that underlines the struggles that some students, particularly those who until the point of transition have been relatively successful in education, go through in trying to continue their previous achievements. These students may really try hard to participate, to integrate and to show commitment to their education, for example by involving themselves in curricular (e.g. seeking help or attending extra lessons) and extra-curricular activities (e.g. sports, social life or joining a student union's society) but they fail because of the inflexible, 'alienating' - as will be argued here - practices of university mathematics.

Furthermore, both Finn's and Tinto's models consider drop out as the possible consequence of a long process of disengagement that might start early at school and end up in the withdrawal of the student from education. Attendance problems or disruptive behaviour could be early signs that a student is disengaging from

education. Nevertheless, this is not always the case. Recent research into school engagement (e.g. Janosz et al 2008) has found that even some students with high levels of school engagement end up dropping out of school, and data from this paper confirms that some students that were previously engaged with and successful in mathematics end up dropping out in their first year of university, after a relatively very short process. The contribution of this paper to the research literature on drop out is therefore twofold: (1) it will show that some previously engaged students (i.e. there was no previous history of disengagement in any sense) can drop out during their first year at university, highlighting the limitations of previous drop out theories that see disengagement as a long process, usually starting early in school, that is associated with social/behavioural or academic problems; and (2) it will show how certain mathematics practices at university have an 'alienating' effect in some students even though they seemed engaged in other aspects of their university life (i.e. there was an identification and possible integration with the institution of university in a more general sense). The dialectic development of alienation is stressed here: the student is faced with an objective, non-negotiable practice (an objective alienation) that negates their (mathematical) identity, from a positive one (mathematics as a practical, enjoyable subject) to one where participation in mathematics is hard and meaningless. There is here a subjective alienation as the learner struggles to engage in the practice in their own terms and feels that this is impossible. To solve this contradiction, the student (consciously) decides to drop out as the best possible option.

In order to explain this process, this paper uses the concept of alienation to explain drop out. The notion of alienation used here relates to that of Marx's 'estranged labour' (Marx 1844), in which workers are disconnected from the product of their labour and certain aspects of their human nature. Due to the (objective) practices of the capitalist mode of production, workers invariably lose the ability to determine their life and destiny, and although they are autonomous, self-determined human beings, their labours are dictated by those who own the capital (bourgeoisie). In the context of this paper, alienation involves an objective practice as the cause of a subjective response (subjective alienation with consequent drop out), a non-negotiable 'force' of the 'other' on the learner who wishes to exercise their agency but is severely restricted by the practices of the educational institution.

However, this paper wants to emphasise the subjective alienation of individuals (expressed in the data as accounts of struggle and pain) without losing sight of the dialectic process of alienation that involves an objective practice and a negation of identity (or its 'opposite'). In order to do this, socio-cultural perspectives on identity are used; in the light of these perspectives, it is proposed that analysis of drop out experiences should focus on the relationship that agentic individuals are able to establish with the social practices in which they participate, and in the alienating effect that some of these practices have on those students whose (mathematical)

identity does not 'resonate' with the new setting. The following section will describe this perspective in more detail.

Socio-cultural perspectives on identity and the concept of alienation

The concept of identity seems very adequate to understand how individual learners interact with their social contexts (e.g. at university). Socio-cultural perspectives emphasise the dynamic process of identity-in-practice. Wenger (1998) explains 'identity' thus:

> We define who we are by our engagement in communities of practice. Daily engagement in activities constitutes "who one is" – a way of being in the world (p.149).

Furthermore, Edwards & Apostolov (2007) suggest that individuals are able to act (as acting agents) and reshape the social conditions of their development and in turn, transform their own identities.

Holland et al (1998) add to the understanding of identity-in-practice the concepts of *figured world*, *positionality*, *space of authoring* and *making worlds*. *Figured worlds* are "frames of meaning in which interpretations of human actions are negotiated" (p. 271). What we and others think, speak and do send messages with which we identify, oppose or distance from, therefore making meaning of social situations. By doing this, subjects *position* themselves not only in relation to others (e.g. I am an engineer because I do what engineers do) but also in relation to social positions that entitle them to access social and material resources (e.g. I am a respected member of society because I got a university education) that are valued differently in diverse figured worlds (e.g. being an engineer might be of little value in the figured world of medicine). Individual agency is then exercised in the *space of authoring*, where individuals organise social discourses/practices that allow them to operate in certain ways, with different degrees of freedom, in the social universe. Finally, individuals are able to *create new figured worlds* by engaging in social practices and imagining new ways of being – "through play our fancied selves become material" (p. 236). It is within these new figured worlds that individuals reshape the social conditions of their development.

Neither Wenger nor Holland et al write explicitly about the concept of alienation but their perspectives are useful to define (theoretically) this construct in the following way: alienation occurs when social practices (objective conditions) restrict an individual's space of authoring in such ways that they are unable to imagine ways of participating differently in new figured worlds (subjective positionings), i.e. they are unable to transform the social conditions in which they participate even though they might make a great effort to do so. Drop out becomes a consequence of this process when individuals are faced with a negation of their identity and consciously recognise the impossibility of creating new figured worlds.

The concept of drop out as described here has important differences to that of other previously described models in the sense that students might want to participate in the world of university and maybe even seek to "make it their own" (to create new figured worlds in which they see themselves participating) but they find that the practices of university mathematics are so different and inflexible that they are unable to change them, hence alienating them. Again, the emphasis here is on the *dialectic* nature of alienation in which students are unable to create new figured worlds in which their identities resonate with the practices of the new institution. This inability makes the students conscious of their own position in that world (e.g. as not mathematician in a university academic sense) hence deciding to drop out.

Methodology

This paper uses narrative analysis to explore the interviews of previously successful students that dropped out from university. Two students were interviewed, hereby called Alex and James (pseudonyms), about their experiences of first year engineering degrees at university and why they decided to drop out. Interviews were done shortly after they dropped out, so the experience was still very fresh in their minds. It is worth noticing the difficulty in finding students that wanted to talk in-depth about this negative experience, as it evokes distressing, sometimes shameful emotions that most would like to forget. However, the two students in this paper were willing to share their stories, perhaps because they saw themselves as successful students that underwent bad experiences during their first year at university and wanted to share those experiences. This is an important aspect of the data that will be discussed later on in the paper.

Such interviews are taken as "ways in which people make and use stories to interpret the world" (Lawler, 2002, 243), or as Bruner (1990) says, as a way of conveying meaning. Narratives allow people to re-cast chaotic experiences into causal stories in order to make sense of them, and to provide a coherent sense of their own identity. However, this paper does not treat narratives as stories that transmit a set of facts about the world, and therefore we are not interested in whether these stories are 'true' or not; instead, narratives are seen as social products (always co-constructed) that people use to represent themselves and their 'worlds' to themselves and to others (Lawler, 2002).

In this context, it is important to find the "plot of the story", that which binds together the meaning of what the person is trying to tell, in this case, Alex's and James' stories of why they decided to drop out, and how they experienced and interpreted the practices of university mathematics. Therefore, the analysis of these interviews focused on their stories about their previous experiences, expectations and identities before the transition (e.g. why they chose their degree and university, their learning of mathematics at school, their self-perception in relation to engineering, et cetera), their experiences during their first year at university and in particular their struggles or efforts in negotiating their identities within the new

practices (e.g. mathematics lectures, theoretical mathematics, help available, et cetera). The result of this analysis has been crystallised in the "Drop out narratives" that are described in the next section. It is worth noticing that these narratives are not only a subjective interpretation of the students' experiences but also a description of objective conditions being alienating, hence revealing the value of thinking of the construct of 'alienation' as previously described in this paper, allowing alternative explanations to those offered by the existing drop out literature.

Drop out narratives

Alex's story

Alex attended the best comprehensive school in his area, a school graded as 'Outstanding' by the government, but had to work hard to obtain good grades. He never thought he was "naturally clever in maths", but wanted to get a good grade in the subject. He described how in year 10 (aged 14) he deliberately began to sit in the front of the class because "you want to focus on the lesson, you don't want to miss anything, you want to listen to the teacher properly, and the teacher knows that you are interested": as such it is argued that his history as an engaged and academically-identified learner was especially strong. He even attended extra mathematics lessons at lunch time, and from a set 6 he worked his way up to set 4, where his teacher put him forward to the Secondary education (called GCSE) higher mathematics paper where students can get a C – A* grade. He obtained a B, which to him was disappointing.

His experience at Sixth Form College was, as he described it, a "shift": he wanted to be the best student and get the highest grades. His commitment to education was manifest. By then, he became very interested in engineering and decided to do a vocational engineering course (called BTEC) in his local Further Education (FE) College. This was a crucial decision for him as he decided for a vocational qualification rather than doing the traditional academic A-levels "as everybody else". This signalled from the start a very practical engineering identity, where mathematics played an applied, useful role in engineering. And from the start, he actively pursued the challenge of being the first one in his college to get distinctions in all of his subjects. This meant that teachers could not give him much help with his coursework, "I was pretty much on my own", he said and described these times as "stressful and hard". However, he looked for help wherever it was possible to have it, from former teachers up to hiring a private tutor. It is clear from this that Alex was an autonomous and resourceful learner, showing his agency by pursuing help and thus creating and shaping the conditions for his success. At the end, he achieved his goal of getting all distinctions and even won a prestigious award from his College in recognition of his hard work. Even though this experience was challenging for Alex ("stressful and hard") the support that he got from former teachers and the private tutor and crucially from the vocational nature of the course (applied mathematics and practical oriented assessment practices) – the objective conditions - meant that

he was able to succeed, and this success in turn affirmed his engineering identity. He was able to negotiate his identity with the practices that he encountered in his course or, in other words, he was able to transform the conditions in which he participated (in ways that were impossible at university, as shown next). As a result, he applied to do Mechanical Engineering at university.

Unfortunately for him, the university he applied for did not accept BTEC as an entry qualification for its Mechanical Engineering degree, and Alex was offered to do a foundation year before being allowed into the programme. He described his short experience of foundation year as follows:

> I was quite surprised, I found myself doing A-levels pretty much, A-levels maths, A-levels Physics. It's almost like my BTEC was useless. And it's quite (a) hard thing to understand, when you come to university. You don't do hardly any engineering!

In particular, he found a big difference in mathematics:

> The maths (at FE College) was applied, that's what I was kind of more interested, in you applying something. [...] You learn, say, complex numbers and how to apply them [...] and that's what I do, visualise it... and it's actually quite enjoyable. [...] And it was a confidence buster that, you know, you were doing something of use.

> All of a sudden (at University) you are doing something you have not done before in complex numbers and you think: What? And you're whizzing through it... and there is no interaction... and that's it for the day, you close your book and you think: Oh my God, I've learned nothing. I can't understand anything and it's the end... It's that kind of difference in learning. [...] I've not learned like that ever, and to keep carrying on... I tried to stay as long as I could, for two months or something.

After two months of trying "to stay as long as I could", not being able to negotiate the conditions of learning in the foundation course (i.e. no interaction between students and lecturers, the mathematics and physics are removed from engineering applications, the "whizzing" pace of the lecture), Alex applied to be transferred to the Manufacturing Engineering programme at the same university, which allowed BTEC students, thinking that he would be doing more "engineering" and this would make things better. It is worth noticing that at that point Alex was participating fully in other aspects of university life, practising a sport and having made a good number of friends. However, in relation to his studies, things did not work as he had envisaged:

> If you are doing something like engineering at uni you do have to be pretty good at maths... and if you are one of those people who is always asking: Why? "We don't have time to ask why", and you know you can't ask why but that's almost how you understand it as well and you can't just accept that this

happens because you want to know a reason why it does and then it helps you learn. [...] The lecture was very much like... emotionless. It's one of those things that after being to College I can't just doss through it. And when you're doing a subject like engineering, it's not just one of those doss subjects, certain stuff that's in it is hard, but it kind of makes it harder the way is kind of... [...] In the tutorial he just started where he left off, it was just like another lecture pretty much, we had three lectures and not two.

From the above it is clear that for Alex, the majority of the mathematical practices that he encountered in his university course were non-negotiable, i.e. he was unable to transform the conditions of his participation: these were fast-paced ("We don't have time to ask why"), emotionless with no interaction (which signals a lack of care for the learners' views), empty of a conceptual meaning (students should "just accept" things as they are) but that otherwise could become meaningful to students like Alex if applied to practical situations. We infer from this that there were objective conditions that contrasted with Alex's identity as someone "who is always asking: Why?" and "can't just doss through it". His identity, affirmed in the past by the practices of his FE college, was negated by the new university practices which demand from students not to ask "why" and to sit for hours in fast-paced, emotionless lectures where understanding is not an important aim. However, as an autonomous learner, he reacted to this situation (showing his agency) and strived to engage in the programme by looking for help from wherever he could get it:

I pretty much lived in the maths support centre. I was there all the time. It did help, learning stuff and understanding stuff, but you just learn something and understand it and the next day is something else, and the next day something else... and you always feel like you are behind. It was good to think "This is informal", that kind of way is the kind of way I learn, but is not the kind of way the university is structured, that's not how it's done.

Alex's struggles and pain to engage in the practices of university mathematics are evident, as is the impossibility of him changing them: it is not how "university is structured". After almost "making myself ill" and becoming conscious that he was not going to change how university works, Alex decided to drop out of university. In reflection, he identifies what he believes the problem was:

It was the environment I was in, the university environment, how the academic side of it is done. I couldn't like... I could never be happy... or I could never get settled in, to go into the lectures to be pretty much told... something, not learn something. [...] People might kind of adapt or it might suit them but some people learn the best in a certain way and it makes them feel the best about themselves when they learn it, and if you're only getting that not very often then it's very hard to try to keep the motivation to learn the stuff and understand it.

It is therefore suggested here that the impossibility of making his environment resonate with his identity as a practical engineer who wants to know "why", to understand the mathematics he is learning and to feel that "you were doing something of use", meant that Alex could not see himself participating anymore in the institution of university (a figured world), despite the mathematics support learning offering some 'space' for 'understanding'. His agency, his space of authoring, was so restricted that he was indeed alienated by these practices and felt that the best option was to drop out. It is worth noticing that this 'practical engineering' identity is unusual and different from what, anecdotally, is sometimes reported about undergraduate engineering students who want to know 'how' and not 'why'. However, there is evidence that many students, mainly those from a vocational education background, share Alex's unusual identity (Hernandez-Martinez et al 2008).

James' story

Likewise Alex, James found mathematics at Sixth Form College hard. In his first year mathematics course, he obtained a grade E, the lowest passing grade. After this, he decided not to complete the second year of the course and instead preferred to focus on his other courses in Design and Technology (with grade A), Physics, and Spanish. After College, he spent a gap year in industry "in production, so I was doing quality control". Coming from a family with an engineering tradition (his father and grandfather were engineers, so he "wanted to be like them"), James entered an engineering foundation course at a prestigious research-intensive university that accepted him because of his gap year experience, good results in his Design and Technology college course and despite his weakness in mathematics. His engineering identity was strong and he endeavoured to succeed and continue his family tradition.

However, during his foundation year, mathematics continued to pose a struggle for him:

> *James:* It was a bigger step up from not doing the... (mathematics college course).
>
> *Int:* So you faced problems in foundation as well?
>
> *James:* Yeah, yeah.
>
> *Int:* You had problems in ...?
>
> *James:* I ... had support, I could go to the extra classes and things like that to help.

Similar to Alex, James relied in extra classes and other help to achieve a good result in mathematics. He successfully completed his foundation year and began his first year of a BEng in Mechanical Engineering, showing engagement and commitment to his education. During this year, James found the mathematics "too difficult", as he described:

I did have the support but I just, found it too difficult I didn't, it wasn't interesting me to do that level of maths, that's not what I want to do as a career, that height of maths, I'd rather do the practical side.

It is interesting to note here the link that James does between finding the mathematics too difficult and his personal position towards the subject: he sees himself as a "practical" engineer, something that was in contrast with the kind of mathematics that was taught at university (an 'opposite' identity). Therefore, it is inferred from this that the problem was the non-negotiability of the mathematical practices (as too 'high' or 'non-practical') that contradicted with his 'interests' in engineering, which resulted in his dropping out and switching to a BSc in Mechanical Engineering at a less prestigious and more technical university. This inference is strengthened by his narrative of what happened in the new university. At this new university, he suddenly found himself doing very well, "since being here the level of maths is completely different, more practical side rather than the...theoretical". Significantly, the Calculus he found difficult was not required: "no differentiation, no integration and nothing".

At the end of his first year in the new university, James obtained first class marks (98% on his Electronics module, which he "failed really badly" in the old university, "with the maths and that"). All this made his experience in the new university much more "enjoyable", as he said:

It was, erm, too much maths based and not practical enough (at the old university). (...) Well I can do maths up to a certain level and I'm happy to do that and obviously, whilst I can do it then it's enjoyable when you're successful. But when it's, when it's extreme it's, it's just too hard and it's not enjoyable. (...) It's a lot more fun here, yeah, the aspects of it, it's a lot, a lot better. Er, the stuff we're doing, you know, it's easier to understand. Therefore, you can enjoy it more by, you know... because you understand it. You're not struggling to understand what's happening and then apply it.

Talking about the main differences that he found with the new university, he described smaller lectures (25 to 30 students rather than a hundred or more before) that were more interactive (e.g. problem solving group work, "people ask questions", "There's always lecture interactions") and better taught (e.g. printed notes as opposed to having to take notes from the whiteboard, more practical projects), but more important, "it's taught more slowly, you get more time to understand all the subject areas". Note that James' achievements had objective roots: the conditions that he found at the new university were actual practices with characteristics that differed from those at the old university. These practices in turn allowed James a certain 'freedom' to be a more active learner:

Int: So do you, if you need help what is your...

James: Er, speak to the head of my course.

The characteristics of the practices in the new university course described by James clearly point to better learning conditions where "understanding" can take place and the practical side of mathematics is predominant. Within these new conditions, there is no struggle to "understand" the mathematics, which makes it easier to "apply it". Furthermore, he explained how his previous experience at the old university gave him an advantage in the new one:

> *James:* I understood how university works, (...) and what lecturers required. (...) So I think that's (the two years in the old university) worth having an advantage over everyone else here. (The other students) I think they're all still enjoying the social really.
>
> *Int:* What advice will you give them (to the other students)?
>
> *James:* Attendance. So many people don't bother.
>
> *Int:* So they don't attend?
>
> *James:* No... So, so important.

It is worth noticing how this narrative shows a degree of agency from James (sometimes enacted by attending lectures or speaking to the head of his course when he needs help, other times by not 'socialising' as much as the 'new comers') as he knows "how university works" and "what lecturers required". Even his gap year experience became useful in the new university, by allowing a very tangible link between what he was learning and his previous work (again, this shows a degree of agency conferred to James by the practices in the new university):

> Erm, just when the lecturers telling, telling you about a certain situation, or how something manufactured, I can just think and just remember how I saw it for my own eyes, you know.

It can be inferred from the above that the practices at the new university and James' previous history and experience allowed him to negotiate better the conditions of his participation in university. It is argued that there is indeed a degree of negotiation with the new practices going on in James' willingness to attend all lectures or not to indulge in socialising too much, albeit perhaps this is not as pronounced as in Alex's case.

This was such a positive shift for James that he began to think more positively about mathematics, and how this could affect his future:

> *James:* Erm, I think it will be important to do more maths than we are here, you know, I'd be happy to do some more maths.
>
> *Int:* Hmm. And you feel comfortable doing some work?
>
> *James:* Erm, yeah, some, a bit more, but not to (the old university) level. It will be good to have more, because, you know, it's so important. (...) It's good, just brain-training. It's good.

(...)

Int: Do you think... are you in a position to say whether you want to do a Masters or not...after you finish?

James: Erm...yeah, it's possible. Probably, yeah.

Int: Was it in your plans before or...?

James: Erm, when I was at (the old university), I didn't see any possibility. No chance at all.

It is worth noticing that the agency experienced by James in the new university meant that now he had choices to exercise such agency by actively transforming the context of his studies, for example, by using his previous experience to his advantage (knowing not to socialise too much), attending all lectures, asking for help or linking his gap year experience to what he was learning. The practices of the new institution, in particular those related to 'understanding' and 'applying' mathematics, made this possible whilst there was no such possibility in the old university. It is argued here that this new found agency allowed him to start authoring new figured worlds, where he could negotiate the kind of engineer he imagined to be and where there is a possibility for mathematics to have a greater role. James can now become a different person than the one he was or could have ever been in the old institution with its alienating practices.

Discussion

The narratives of Alex and James show a particular, although not uncommon, way in which university practices, in this case in relation to mathematics, can alienate students objectively despite the subjective disposition for their engagement – leading to a subjective alienation and and finally an increased probability of dropping out. This type of students that in other circumstances could become 'first class' professionals, are pushed away by some university practices that have become too inflexible and distant from these students' aspirations (or imagined future identities), therefore closing any other perfectly reasonable alternatives of ways of being a professional engineer (new figured worlds).

This paper advanced the concept of alienation as a way to explain why some students that have been actively engaged in their education up to the point of transition suddenly find that they are unable to negotiate their identities with the practices of the new institution. It is argued here that the concept of alienation, as dialectic in nature, is key to understand why these students drop out: these are very positive learners with a vocation and with such maturity that they test the institutional negotiability to the limits. This type of alienation is very different from the common alienation of students described in the majority of the drop out literature, such as in Finn's and Tinto's models. Students such as the ones in this paper make considerable efforts to integrate, to actively engage in their education but cannot negotiate their learning even in universities that have well-set up

mathematics support centres or that provide extra help for first year students. This is quite an indictment of the institutionalisation of alienation in these university mathematics practices.

It was also argued that the concept of identity was adequate to understand how individuals interact with their social context. The particular concept used in this paper was that of identity-in-practice. One of the reviewers of this paper critiqued what they perceived as a tendency to treat a "practical engineering identity" as something that is fixed or strong because students relate it as stable. This paper takes the viewpoint that individuals can have multiple, socially constructed identities (e.g. I am a 'mathematician' at work and a 'good father' at home) and that they modify or construct new identities by engaging in the practices in which they participate. But it is also argued elsewhere (Black et al 2010) that individuals can have a 'leading identity' (e.g. a practical engineer) which is a reflection of the hierarchy of motives of engagement in significant activities (e.g. in an engineering degree). The key idea for this paper's argument is the dialectic nature of the process of alienation: There is clear evidence that these students faced objective conditions at university that they could not negotiate successfully (in Marx's terms, they have been alienated from their labour); this led them to be alienated from themselves as 'mathematics labourers' (a subjective alienation), i.e. their leading identities, previously positive in relation to mathematics, are negated as 'not-mathematician' (in the practices of university mathematics). Hence, the solution to this contradiction is a conscious decision to drop out (i.e. alienate oneself from the situation).

A further critique to this paper was that of a possible alternative interpretation of the data to that of alienation. One of the reviewers argued that students might have constructed their narratives as justifications of drop out that absolves them from the social blame of failing, using discourses of opposition such as abstract vs. practical or academic vs. work-based learning to explain their painful experiences. The reasons why the author of this paper argues against such an interpretation is that these students did not consider themselves as 'failures'; their narratives described positive, mature and engaged students that had been successful until the point of transition and, at least in the case of James, went onto become a 'first class' student in his new university. Anecdotally, after dropping out Alex completed successfully a Higher Apprenticeship qualification and became employed as engineer in the same business where he did his apprenticeship. As described in the methodology section, these students were willing to share their experience and therefore it is unlikely that their narratives were a justification to avoid shame. There is, therefore, sufficient evidence of objective alienation. The kind of interpretation suggested by the reviewer could arise from models such as Finn's or Tinto's; for example, one could say that students failed to integrate and therefore felt the need for justification, or that the institution failed to provide for these students, even though there was the provision of extra classes or a good mathematics support centre that these students actually accessed. These interpretations do not give an accurate and full picture of what happened. That

is why the concept of alienation as used here becomes important in showing the dialectic process of negotiation that occurred, in particular between a practical engineering identity and the academic practices of university mathematics. It is claimed elsewhere (Harris et al 2015) that for many engineering students it is important to perceive the use-value of mathematics in their engineering courses and, therefore, the cases of Alex and James are not unique in this sense. Solomon and Croft (2015 this issue) argue about the close relationship that exists between understanding (in the case of their data, about mathematical proof), alienation and what these authors posit as its opposite, ownership. Alex's and James' mathematical discourse was about understanding and owning the knowledge in such a way that it had a use-value, a practical one, and this struggle to understand and apply the mathematics was confronted with fast-paced, non-interactive, non-applied, transmissionist, highly theoretical practices that alienated them.

Furthermore, data from the *Transmaths* projects show that many students undertaking vocational qualifications at Sixth Form College use a similar discourse to Alex and James to describe the close relationship that, in their view, should exist between mathematics and its applications to subjects like engineering (Hernandez-Martinez et al 2008). Many of these students find mathematics at university 'very hard' and some end up dropping out, but whilst some drop out models might explain this failure as inappropriate student preparation or a history of disengagement with education, the explanation here is that sudden changes (e.g. during transitions) can result in the drop out of committed, previously successful students.

The 'one size fits all' policy that governs the majority of teaching at university can be very alienating for some students. In contrast, in one of the *Transmaths* project's case studies, we observed a mathematics teaching practice designed to facilitate the transition of students that were identified as "mathematically weak" (with vocational and poor Sixth Form College mathematics qualifications), and which students seemed to agree was very helpful (Williams and Hernandez-Martinez 2010). However, these isolated practices might not be enough to prevent some students from becoming alienated, just like a good mathematics support centre did not prevent Alex from dropping out. The main practices of university teaching should also become flexible. Thus, elsewhere in the *Transmaths* project's publications the suggestion is that hybrid teaching practices (i.e. a mixture of college and university pedagogies) are better at helping students in their transition to university by being more dialogical and flexible (Hernandez-Martinez et al 2011). Practices that are flexible allow diverse students a space of authoring where they can exercise their agency and create new figure worlds. In the same way, dialogue can link mathematical practices with students' identities by emphasising understanding and sense-making (Alexander 2008).

Therefore, we suggest that mathematics teaching should incorporate practices such as discussion of ideas or spaces to explore the "why" and not only the "how";

also, integrate content that is authentic, relevant, useful and that appeals to different students' aspirations, and provide enough support for students to overcome challenges and to help them reflect back on their experiences (e.g. problem solving and mathematical modelling, enquiry based learning, etc.). This support might be in the form of social spaces where students can assist each other (e.g. informal peer groups, after school clubs, etc.) or have access to well-designed learning materials and specialised support (e.g. learning support centres, online resources).

The actual educational policies, however, seem to be more oriented towards accountability and, in turn, schools and universities are overtly focused on league tables and acquiring funding at the expense of flexible pedagogies. It is not that these are not important issues, but the emphasis should be in the quality of teaching/learning above accountability. Alienating students, in particular those who otherwise could contribute to and enrich society in different ways, is not a good educational policy.

Acknowledgements

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