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Developing a 'leading identity': the relationship between students' mathematical identities and their career and higher education aspirations

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Abstract. The construct of identity has been used widely in mathematics education in order to understand how students (and teachers) relate to and engage with the subject (Kaasila, 2007; Sfard & Prusak, 2005; Boaler, 2002). Drawing on cultural historical activity theory (CHAT), this paper adopts Leont'ev's notion of leading activity in order to explore the key 'significant' activities that are implicated in the development of students' reflexive understanding of self and how this may offer differing relations with mathematics. According to Leont'ev (1981), leading activities are those which are significant to the development of the individual's psyche through the emergence of new motives for engagement. We suggest that alongside new motives for engagement comes a new understanding of self—a leading identity—which reflects a hierarchy of our motives. Narrative analysis of interviews with two students (aged 16–17 years old) in post-compulsory education, Mary and Lee, are presented. Mary holds a stable 'vocational' leading identity throughout her narrative and, thus, her motive for studying mathematics is defined by its 'use value' in terms of pursuing this vocation. In contrast, Lee develops a leading identity which is focused on the activity of studying and becoming a university student. As such, his motive for study is framed in terms of the exchange value of the qualifications he hopes to obtain. We argue that this empirical grounding of leading activity and leading identity offers new insights into students' identity development.

Keywords: Aspirations · Leading activity · Identity · Cultural models · Cultural–historical activity theory

1 Introduction

In recent years, there has been a growth in research which has focused on mathematical identity as a means of understanding student engagement (and disengagement) with mathematics (Boaler, 2002; Sfard & Prusak, 2005; Solomon, 2007). Key to the learners' relationship with mathematics is their evolving sense of self and their understanding of how mathematics fits with this. For example, Mendick (2006) notes how students' conceptions of self are connected with their choice-making and performance at advanced level (A-level)¹ and Boaler and Greeno (2000) highlight how identity is crucial to the belief that one can be a creative participant in mathematics as a social practice. In this paper, we explore how two students studying advanced-subsidary level (AS level) (see footnote 1) mathematics (aged 16–19 years) narrate their identities in relation to mathematics within the interview setting, by exploring two key aspects:

1. How they perceive doing mathematics fits with 'other' motives—particularly, their understanding of themselves in relation to future aspirations

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2. How a connection between future aspirations and ‘mathematical identity’ shifts or changes over time as students progress through their AS level year

2 Theoretical framework

The paper draws on cultural historical activity theory (CHAT), which views identity as emerging from engagement in joint object-orientated and socio-culturally mediated ‘activity’ (Roth, Hwang, Goulart, & Lee, 2005; Holland, Lachicotte, Skinner, & Cain, 1998). This is because, as Vygotsky pointed out, the use of ‘psychological tools’ (such as language) in practice is always double-edged; what is used in social interaction comes reflexively to be used internally, on the self. Thus, one ‘becomes’ what one ‘does’ and, importantly, one comes to ‘think’ what one ‘says’ through reflexivity (Jenkins, 2004).

In previous work (Williams, Davis, & Black, 2007), we have made the distinction between ‘identity in practice’—i.e. identities which are constructed/drawn on in the doing of an activity—and the ‘narrative self’—i.e. the stories we construct about ourselves upon reflection, such as in the context of the research interview (Bruner, 1996; Gee, 1999; Roth et al. 2005). We have argued that these two engagements of identity are held together by cultural models which emerge or are provided by one’s participation in practice(s) and are drawn on in one’s reflections when constructing the narrative self (Gee, 1999; Holland & Quinn, 1987). These are culturally derived rules and schema (Holland & Quinn, 1987) or everyday cultural concepts and conceptual frameworks (Gee, 1996, 1999) which govern what we can perceive, but also what we can tell. We find the more recent notion of a kind of cultural landscape of ‘cultural models in figured worlds’ evocative (see Holland et al. 1998); one’s narrative of identity can be told as a path or trajectory through our available ‘figured world’. Thus, a student might tell of an identity as someone who “likes to work alone ... and always needs to know there is a ‘right’ answer” and in doing so may draw on propositions such as ‘maths is black and white’, ‘maths is lonely’ or ‘maths is for geeks’ (these all arose in our interviews). As such, cultural models provide a resource—and a constraint—which we draw on in constructing stories about ourselves but which essentially are learnt in practice as a product of subjective experience.

In this paper, we seek to build on this work by incorporating Leont’ev’s notion of leading activity and our derivative concept—leading identity (Leont’ev, 1981; Stetsenko & Arieviditch, 2004; Beach 1995, 1999) as a means of understanding identity development and students’ aspirations.

Leont’ev (1981) uses the concept of leading activity in his account of the child’s psychological development²—he argues that whilst children encounter an array of activities, some are of greater significance in terms of the individual’s development than others. For example, he suggests that the emergence of ‘rule-based’ play activities presents a significant shift in the child’s awareness of social relations and interactions, which paves the way for ‘non-play’ rule-bound activities (e.g. schooling, sport). Thus, rule-based play can be seen as a leading activity for the pre-school child because it develops the child’s capacities for schooling (rather than because it ‘dominates’ or is frequently experienced, say). Essentially, what defines an activity as leading for Leont’ev is not its dominance in the present but its role in shaping particular psychic processes to the extent that development is essentially dependent on such activities. We argue here that the post-compulsory phase of schooling may be developmental and so may be seen as a leading activity if it prepares students for the next developmental stage—e.g. university or work. This is consistent with Beach (1999), who suggests that playing–schooling–working–retiring is a sequence of

leading activities characteristic of many western societies. Our students are at a stage where they appear to be consciously reflecting on the schooling/mathematical activity they engage with, how they relate themselves to schooling activities and what this means in terms of their future. An analysis of leading activity may offer us insights into the students' reflexive understanding of self and the trajectory they are on.

But how do such leading activities bring about development? Leont'ev argues that activities become leading when new motives are generated so that the original motive of actions is surpassed by a new motive, and hence, a new activity. He gives the example of a school-goer who completes her homework so that her parents will allow her to go out to play but who comes to realise that doing homework brings about a new relation with schooling (i.e. it pleases her teachers) and, so, a new motive for doing homework is generated: indeed, homework comes to be part of the activity of 'schooling'. Thus, the action's result (getting good marks) becomes more significant for the individual than the original intended motive (to get the job done and go out and play) and a new 'objectivisation' of needs emerges. This suggests in general that, in identifying the activities that are crucial to students' development, we should look to those that bring about new motives for the student or a new 'objectivisation of needs'.

At this stage, it seems important to establish what exactly is meant by terms such as 'identity' and 'self'. Here, we draw on Leont'ev's (1981) account of personality, which we prefer to translate as 'self' (after Stetsenko & Arievitch, 2004) to avoid the semantic baggage that has been attached to westernised accounts of 'personality' over the years. Leont'ev argues that since we are each the unique product of a constellation of cultural activities, we encounter many motives and, thus, many subjectivities within our lives. As we have argued elsewhere, over time, these subjectivities are reflected upon and may become crystallised as identities which relate to the specific activities in question (Williams et al. 2007). For example, we construct our identities as mathematics learners upon reflection on the subjectivities we have experienced when engaging in various forms of mathematical activity in the past. Thus, our notion of identity (or identities) is historical in origin and emerges from the subjectivities (how one views oneself) we experience in the process of doing activities. However, as we engage in many activities (and, thus, experience many subjectivities) through the course of our lives, we have a collection of identities upon which to draw at any one moment. These become hierarchically organised within the self—the socially constructed and internally reflected (psychic) pathway through our unique constellation of activities. This occurs through both processes of engagement in activity (i.e. reflection in action) and reflection on activity/identity (as in the interview situation, for example). As such, the 'self' is not a static or fixed personal attribute which we can 'have' but a process, constructed and performed through engagement in activity and always in development (Stetsenko & Arievitch, 2004). Here, we argue that the precise hierarchical structure of our identities (i.e. those that are consciously reflected upon by the self as the most significant) at any one stage is essentially dependent on the leading activity. Thus, the leading activity provides a structured hierarchy to the internal life of the self where certain identities become more or less important to our developing self. In this paper, we refer to the identity made available by this leading activity as leading identity and suggest that this reflects a hierarchical organisation of motives in understanding the self. For instance, a student may tell of a particular work experience placement (e.g. in a hospital) as being critical in shaping their aspirations (to become a doctor)—this can be classed as a leading activity for the student if (a) the placement was begun with a particular motive (e.g. a week-long break from the toils of school) which then shifted to a new motive (to understand and

engage with the occupation in question for its own sake) and (b) this resulted in a new leading motive for the student driven by one's potential identity within that occupation. Within this framework, the student acquires a new leading identity (e.g. a medic) which is revealed by the new motive and subsequently directs organisation of the various other identities available to the student (e.g. as a student, teenager, son/daughter, worker). This shift may then drive his or her interpretation of subsequent events and activities when narrating the self (e.g. what qualifications he or she needs to attain, what subjects are relevant). In this paper, we seek to apply this framework to understanding students' relationships with mathematics, specifically focusing on the value students assign mathematics in resourcing their leading identity.

3 The project

Keeping open the doors to mathematically demanding F&HE³ programmes is a project which investigates students' participation in post-compulsory mathematics education (aged 16–17 years) in England. The study has investigated post-compulsory students undertaking two advanced subsidiary (AS)-level programmes, Mathematics, and Use of Mathematics, with a view to understanding how pedagogy impacts on students' dispositions towards studying mathematics, and electing to study mathematically demanding courses (e.g. Science, Technology, Engineering, etc.) in higher education (HE).

As part of this project, we conducted interviews with 40 students on three occasions—at the beginning of their first year of post-compulsory study (AS level), towards the end of their first year of post-compulsory study and at the beginning of their second year of post-compulsory study (A2 level). In each of the interviews, they were asked questions regarding their background history (including whether they would be the first in their family to enter HE, etc.), their experiences with mathematics and their dispositions towards future study; their current attitude to their experiences in mathematics classrooms is also of interest, as this helps reveal how their identity work makes use of or is mediated by pedagogy. In another paper (Wake & Davis, 2008), we analysed the narratives pertaining to all students in the sample and highlighted three different 'canonical' stories (Bruner, 1996)—'when troubles come, aspirations adjust', 'when troubles come, aspirations remain the same' and 'steady as they go (no troubles)'. The data reported here focus on two students, Mary and Lee, who each have different experiences in their current college⁴ programmes and show contrasting aspirations in their interviews. As such, they provide contrasting examples of two of the 'canonical' stories referred to above ('when troubles come, aspirations remain the same' and 'when troubles come, aspirations adjust'). In this paper, we highlight how these two stories present different versions of leading activity and, subsequently, leading identity and how this distinction then implicates different values (cultural models) about mathematics. Thus, they show the significance of a leading activity and leading identity in mediating one's position in alignment or misalignment with cultural models about mathematics and learning mathematics, which we have also identified across the data set (Hernandez-Martinez, Black, Williams, Davis, Pampaka, & Wake, 2008). We present longitudinal data from two interviews with each student. We have focused on two interviews here since, in the case of these two students, specifically, this provided sufficient data to enable us to explore shifts/changes in their stories which signify their experience of a leading activity (see section 4 for more details). Mary's story (below) was classified as 'when troubles come, aspirations remain the same' and is based on the

first two interviews conducted since the third did not suggest any major changes to her overall narrative.⁵ In Lee's case, his narrative was classified as 'when troubles come, aspirations adjust' and again we have focused on two interviews which are sufficient to show the shifts in motive evident in his account. We have focused on only two 'canons' specifically since, in both, 'troubles' played out in significant and opposite ways. The third canon (steady as they go) was largely an untroubled narrative and, therefore, was less complex in terms of shifting relationships with mathematics.

In line with CHAT, we recognise such interviewing as an activity in which researcher and student co-construct a narrative 'object' relating to the student's life—an activity which is itself bound by rules and a division of labour between the interviewer and interviewee and produced for a distributed audience or community (Roth et al. 2005). As part of this activity, we recognise that our students have been specifically asked to talk about mathematics and to present themselves as learners of mathematics (or not as the case may be) through the interview process. However, we also view the students as boundary crossers—transiting between their experience of engaging in mathematical practices and that associated with the research interview. Thus, we recognise that the interview data we have analysed are both co-constructed by researcher and student within the interview but also permeated by the student's ongoing, reflective and reflexive construction and re-construction of 'self'. Nevertheless, the interviews are designed not to reveal some arbitrary 'truth' about our students' biographies, but rather to offer an opportunity to narrate shifting motives, leading activities and identities and how mathematics may enter the story.

4 Analytical framework

Given our interest in identity, we have opted to utilise narrative analysis here as a means of exploring how students engage in this process of (re-) constructing the self within the reflective practice of the interview. This draws on the work of Bruner (1996), who emphasises the significance of narrative not only in construing how we understand ourselves in the world but also the 'reality' in which we operate. Gee (1999) also argues that narratives are important sense-making devices that utilise cultural models and situated meanings to build socially situated identities. In doing so, we have incorporated aspects of discourse analysis (following Gee, 1999) with CHAT in recounting the oral narratives students co-constructed with the interviewer.

We view our students' interviews as biographical narratives, made up of inter-connecting sub-stories (Gee, 1999) which can then be connected (or disconnected) through a reformulation process. The latter involves the identification of a 'plot' within each interview, and events or sub-stories told by the student are considered in terms of their proximity (Goodson & Sikes, 2001). Given the focus of this paper, the student's leading identity (or lack of one) forms the plot, and we have interpreted sub-stories or recounts of events in respect of this. As such, the analysis focuses on the 'whole story' as it emerges across the interview(s) which, we argue, is appropriate to our focus on leading activity (with its emphasis on shifting motives). We suggest the latter is not something which can be interpreted from a microanalysis of one or even a few sentences but, rather, requires a degree of inter-subjectivity to develop between interviewer and interviewee. Table 1 outlines how the key constructs discussed earlier have been used to read the data.

We recognise that interpretation of data such as these are inherently problematic and that validity is never a once-and-for-all matter (Gee, 1999). Others reading these data may see different meanings and stories at work. However, in line with Gee (1999), we have attempted

to establish the situated meanings which appear relevant to both student and interviewer as situated in the context of the interview, and our analysis of the interviews is founded on these.

5 Mary's story

The central plot or 'leading identity' which we have identified and which is repeatedly referred to throughout Mary's interviews is her intention to become an engineer. When asked about her future plans in her first interview, Mary tells us:

... I would like to do more physics as that has a lot of maths in it as well. I do enjoy physics. I was going to go to university to do engineering or something like that. Something with maths.

An aspiration which is then re-told in her second interview, when asked about changing her plans:

not really, I would still like to do engineering when I'm in university—do a degree in that and I might do something with physics and maths, coz I learned to like physics and maths I've always had a interest in, so...

Table 1 Constructs used to read the data

Construct	Operationalisation
Leading activity	Used to identify an activity which involves a significant shift in the student's motive to engage with that activity or others like it. This may relate to a particular sub-story the student recounts or may refer to shifts in motive which are apparent when comparing the sub-stories told at different points in time (i.e. between the first and second interviews)
Leading identity	Identity statements pertaining to the new relations between motives, emerging through the student's engagement in leading activity. Identity statements may refer to either their state of being (in the past, present or future) (e.g. I am, I will be, I was, etc.) or themselves in action (e.g. I do, I got, I will do). The intention is to establish if/when one particular significant identity acts as a driver to both the student's sub-stories and our subsequent interpretation of the data
Cultural models	The identification of cultural models is thematic, focusing on beliefs, propositions or value statements, e.g. those made about mathematics and learning mathematics. Central to the identification of such statements as cultural models is establishing them as socially shared (or culturally derived). This was achieved through an empirically grounded cross-sectional analysis of the whole interview data set which highlighted beliefs as common amongst the whole sample or specific clusters of students. Additionally, some of the cultural models we refer to, such as 'maths is hard', also draw on wider discourses about maths and have been identified in previous research (Mendick, 2006; Solomon, 2007)
Troubles/obstacles	Drawing on Bruner (1996), we sought to identify sub-stories where the student recounted 'troubles'—problems or challenging events in their experience of being in college which may bring about a shift in motive/identity for the student through reaching some kind of resolution or rationalisation (not always positive). We are particularly interested in those 'troubles' which may signify some kind of 'crisis' for the student—Leont'ev notes that a 'crisis' may occur when a youngster's 'potentialities' are not matched to their social reality (the activities they engage in)

When asked why she has chosen engineering, she tells us that she was particularly influenced by her prior experience of a double GCSE (see footnote 1) in the subject prior to coming to college:

I want to do something engineering based. I don't really know why I am choosing engineering. I did a course in G.C.S.E's which counts as two G.C.S.E's. I just liked designing animals, you have to work out what measurement you want it to be, whether it's too big it's not going to work and I did a lot of moving things. We had to make a bazooka gun that fires out a ping pong ball which was quite fun, and you had to make it so it can move. It had a stand and everything. Other people just did their's quite straight, mine it could move, it had handles and it was metal, and I had to bend metal with a hammer...

Furthermore, Mary tells us that mathematics has played a key role in developing her ambition since she views it as central to her capacity to act as an engineer. This is evident in the following extract where she elaborates further on her experience of GCSE engineering:

I liked doing all the maths in that as well as you had to find out what size would be ok, like I had to make a dog on a skateboard and it had moveable arms, I had to figure out what size to make the hole and what size to make the dowel, so it could go through the hole so the fit had to be, so if the hole was 10, I would have to get a dowel that was 10.5 or if the hole was 9.5 I would have to get a dowel that was 10. So then the dog, the arm would not fall out or wear out as quickly as it should. That was quite good. ... I like that sort of maths where it kind of relates to making something. So I had to use loads of maths then make it and see if it worked and if not then I have to go back and say where it went wrong. I like hands on stuff where you actually have to do it.

Thus, in Mary's narrative, we can class her engineering project as a leading activity since it appears significant to formulating both her current motive for study (maths, physics, etc.) and her future plans. It appears to act as a driving force which, according to Mary, has brought about a particular awareness of her 'needs' as a student ('I like hands-on stuff...') and her future potentiality. The latter is most evident in her second interview where she talks of how involved she got in the project and how she now wishes to "do something massive, and be like 'Yes I did that'":

I: So, that university you are going to for the three days, what interests you about that one in particular?

M: I think because I did it in school, I did engineering [...] It was a whole design from scratch, we had to design something and carry it the whole way through to actually making. That whole process and that accomplishment and that feeling I got, I loved it and I just thought I really want to keep that and be part of it. One of my dreams is to do something massive, and be like, 'Yes, I did that'. I just love that whole, you know I just get my head buried in making it and designing it and changing it, changing the ways it has to be cos it won't be suitable for this or that use. You know just loads of things you have to think about, I like that, just getting your head into it and just doing it.

Furthermore, we can also interpret a number of cultural models at work in Mary's interview data which resource this leading identity. For instance, in the extract above, Mary

draws on the cultural model that ‘mathematics is useful’ in actually doing engineering and, thus, is instrumental in her motive for mathematics: this places mathematics in a hierarchy of motives led by her view of herself as a future engineer (her leading identity). Thus, we see her motive to study is not just for academic purposes—gaining qualifications, pleasing the teacher, etc.—but mathematics has ‘use value’—a deeper purpose which is relevant to her leading identity. Furthermore, in the following quotation, we also see her refer to the cultural model ‘maths is fun’ with specific reference to shape, area and volume—key components in her story of making a dog on a skateboard in the engineering project previously described.

I: So if you work to the kind of mathematics that you like to do how would you describe it?

M: I like finding areas and doing shapes and stuff like that. I like finding the formulas and when you get this really odd shape, and you have to find the area and volume of it. I like doing loads of very complicated stuff and going through a whole long thing to find one answer. That I find quite fun. Little things as well, like I can do lots of long stuff, but when it comes to little, small questions I get stuck on those. Which is quite funny, but otherwise, I like really long equations, and really long sums to find one little answer. I’m very weird like that.

Additionally, Mary accepts, but makes use of, the cultural model which was highly common amongst our students—that mathematics is ‘hard’. However, rather than perceiving this as a hindrance, she posits mathematics as ‘challenging’ and she likes a challenge:

I: So how can you describe a typical mathematics lesson in secondary school?

M: ... It was basically like at college, but at college it is more challenging. But I have always liked challenges in maths and stuff.

I: Would you say that maths is hard or challenging?

M: Its challenging, it’s not hard. I find it challenging, like a fun challenge.

Within another narrative, Mary might well have adopted this notion as a means of representing a different disposition, of telling a story of a different person and imagined life (e.g. mathematics is ‘too hard’ and should be avoided), but here, we see a positive disposition towards doing mathematics—a disposition which may be fuelled by the apparent ‘use value’ mathematics now holds for her engineering identity.

However, as we know, such dispositions can be fragile, and there are a number of ‘troubles’ or ‘obstacles’ which emerge in Mary’s narrative as possible challenges. For example, in her first interview, Mary describes her problematic journey in secondary school with mathematics where she was ‘lazy’. Despite being able to ‘whiz through the work’, she was not good at other subjects and was consequently put in a lower set in mathematics. This she deems as ‘one of those things I do get annoyed about’ since she perceives that not being in a higher GCSE set meant that she did not get to do the extra work that she felt was required for AS level.

In her second interview, 9 months later, Mary tells us she has had to drop statistics because of the risk of failure:

I: what has happened since we visited you last time, in terms of the whole college and maths [...]?

M: Well I've actually dropped the stats side of use of maths, because I thought I was going to fail quite badly. So I thought the best thing to do was leave it and maybe do it a year later. I thought because I like the algebra side more and I'm doing better in that and I thought stats might be bringing me down in like other subjects as well. So, I thought if I dropped stats I could use that time to do another subject.

When asked why, Mary again recounts the sub-story regarding her problems of being in the lower set at GCSE:

I: Why do you think you were going to do badly?

M: ... there were many things that I should have learnt at GCSE that I couldn't use coz I didn't know how to do them in the stats and that brought me down and it would have taken me three times as long to catch up with everyone else and I didn't have that time because I much more needed to push up my grades so I thought I should just leave it for now.

Consequently, Mary's prior troubles re-occur in the narrative, and in light of this, she no longer draws on cultural models which view mathematics as a 'fun challenge' but rather engages with the 'exchange value' of mathematics by describing it as a series of assessment tasks where one engages in strategies (such as dropping modules and 'pushing up grades') to maximise success. This is a cultural model (and resolution to her troubles) of the exchange value of mathematics and which may align her much more with the dominant discourses of the education system.

Nevertheless, Mary's narrative still appears driven by her leading identity of becoming an engineer and her positive disposition towards mathematics in general has shifted towards her remaining Algebra module specifically 'I like the algebra side more and I'm doing better in that', and also towards doing the mathematics, which underpins her Physics course: 'Physics I do love and there are calculations similar to algebra, and I'm very good, I've been told and I've been getting extra marks for the maths.' Thus, across Mary's two interviews, we see a sense of consistency in the narrative (Kaasila, 2007) where a leading identity of becoming an engineer (derived from the GCSE engineering project) is sustained but the cultural models she draws on about what it means to do mathematics have shifted and changed in the face of an obstacle—struggling with statistics. The approach taken by Mary in relation to mathematics here does not contradict but sustains her leading identity and is rationalised as these new cultural models become embedded in the sub-stories Mary co-constructs with the interviewer.

However, being able to engage in this type of identity work and, consequently, to transform one's 'figured world' in light of certain obstacles may be more possible for some students than others. To illustrate this, we now present the narrative of another student, Lee, whose narrative portrayed a very different identity in relation to mathematics than that of Mary.

6 Lee's story

In reading Lee's first interview, we were struck by the lack of a stable leading motive in his sub-stories. Although he spoke of several possible motives, e.g. his desire to get 'a good job' and his view that college was a necessary pre-requisite to university, he did not seem to be enjoying college particularly and it seemed he had not quite found his purpose there,

saying he was 'bored', and even felt 'not good enough' in some of his subjects:

I: ... why don't you like it [college] anymore?

L: [...] I felt it's kind of boring

I: Why? Is it too hard, or...?

L: No, it's not too hard [...], I just feel I am not good enough and I am still there but I don't feel like I am good enough

M: How would you imagine it to be so you would be happy?

L: I don't know. I was gonna get a job but then again, to get a good job you got to go to Uni, well in most cases, not all the time.

This ambiguity in Lee's motive for college study was more explicit in his account of his current experience studying mathematics (AS level Use of Mathematics) stating on numerous occasions 'I don't see the point' and frequently citing its lack of relevance to his life and future :

I: So what is it exactly that you don't like from this...[AS level Use of Mathematics]?

L: What I don't like about it, ... I don't see the point there. I don't see the point, I don't get it. Up until the last couple of weeks where it's getting closer to the exams, there was no like, proper pressure. [...] And then you've got 4 exams in it, I don't see why you got to do 4 exams. I am just not interested in it at all.

I: How do you find that ... reality in the course?

L: Like, they say it's real but I don't want to know about how much coffees (are?), ...

I: So you don't find the context interesting or relevant?

L: No, it's not relevant to me. I don't need to know that. [...] I don't need to know how to do trigonometry, in everyday use. So I don't see that as real life context.

Thus, Lee tells of a fairly negative disposition towards mathematics—'you either like maths or you don't. I don't like it, so ... that's how I see it.'

In addition to this lack of a motive for studying mathematics in Lee's first interview, we also see several sub-stories which outline a series of 'troubles' he has experienced in learning mathematics. One sub-story is of his transition to AS level. He tells us that, despite lack of interest in mathematics at secondary school, he got a grade B at higher level in his final examinations and chose to take up AS-level Mathematics when he started college because it would 'look good for university'. However, Lee recounts the problems he had as he began to struggle with the subject and, as a consequence, was encouraged by his teacher to transfer courses to AS-level Use of Mathematics, which was regarded as an easier option.

I: M: How did you end up in this (AS level Use of Mathematics) course?

L: And I was doing... all right in maths, and then I just...I don't know.And then, like the math teachers, ...they were saying if you are struggling now you won't pass your January mock, you know there is an exam in January. ... because like I got a couple of bad results in the tests, like practice tests kind of thing. So it was like December, November time, he [the teacher] said 'I think it's best if you do Use of Maths which is like this course', so I was like 'Oh, it's way too late now'. He said

'you'll do all your exams in May, June, whenever it is', and he says '... you should do coursework, someone like you will do that easy and pass quite easy'.

Lee says that he thinks the reason he struggled with AS-level Mathematics was because he did not keep on top of the workload and it was no longer possible to 'just go through the course and pass it like ... quite easily like I did (before)'.

Another sub-story regarding his 'problems' with mathematics relates to his experience of the AS-level Use of Mathematics programme where he predicts that he will 'completely fail the course'. He tells us that he has tried dropping out a number of times and has remained in the class only because his teacher has insisted he stay. This, he feels, is a waste of time:

I: So you are dropping out of it?

L: I am going to try but I've tried dropping this class before...she said 'No'. It's no point going into, I have to do 4 exams, and I know I can't do it, I have not done the coursework, so ... it's just a waste of time for me. I could have concentrated more in my other subjects.

In telling these sub-stories, Lee draws on a cultural model which is not too dissimilar from Mary's view that 'maths is challenging'. He portrays his experience of maths as 'not easy' or harder than he expected. However, unlike Mary, this cultural model is implicated in his troubles in terms of failure to get the required exam results and, thus, it seems he now views mathematics as something to be avoided. For instance, in recounting mathematics at secondary school, he says 'it was like, you got all like harder stuff coming up obviously, like formula, and stuff like that' and that 'I just don't see the point'. Indeed, the fact that the AS-level Use of Mathematics course was presented to him as easy but turned out to be harder than he expected is a central 'event' in his sub-story of his troubles with the course:

L: He [his teacher] said 'you'll do all your exams in May, June, whenever it is', and he says 'you will do it at the Uses and you should do coursework, someone like you will do that easy and pass quite easy'. So obviously you get told you are going to do it at easy and you do it. So when I came to this class ... is misleading ...[...] they said that you'd just pass that easily. Then I came in here and it's just as hard as the other ... [AS-level Mathematics] [...] I got told that this course is ... you were going to get UCAS⁶ points and stuff, and that it was quite easy...

Lee's narrative highlights how not all students are able to draw on particular cultural models in the same way. Although he draws on the notion that doing mathematics is 'not easy', this is not used to align positively with the subject as 'a challenge', but is used to position himself away from mathematics because it is 'not relevant to me'.

Thus, we see that 'troubles' re-occur in Lee's narrative and we might argue that he has even reached a point of 'crisis' between his reality of studying mathematics (and being at college more generally) and his sense of potentiality—what can be achieved with 'proper pressure'. Unlike Mary, Lee does not reveal a leading identity which might help to transcend or rationalise these troubles but seems embroiled in several possible activities which may emerge as leading at some stage. As yet, none of these dominate or are 'leading'. He even comments on this lack of direction as characteristic of himself saying 'I change my mind a lot. ... in my head, there were loads of changes, if you know what I mean. ... I don't like thinking too far ahead in the future because I don't even know what I'm doing tomorrow'.

However, by the time of his follow-up interview, a year later, a new motive has emerged

in Lee's narrative and is revealed as a plan to study psychology at university.

I: And you're doing psychology at university [already mentioned earlier in the interview] or?

L: I'm just doing psychology.

I: It's just this option or...

L: No. It's psychology or nothing.

At this stage, he tells us that this is by no means a leading career plan since he states: 'If I want to take it on, I'll have to do a post-grad but I'm not thinking...I don't want to get ahead of myself'. Instead he says he wants to pursue this 'because it's interesting'. Nevertheless, we see a distinct shift in the identity work Lee does regarding his future self—a shift which involves concrete decision making with a clearer sense of direction than before.

I: So you sorted out what you're doing next year?

L: Yeah. I've just got to meet my...decide like, my first and insurance choice [of universities applied for] by the third of May⁷.

But to what extent does this shift in motive reflect a new leading identity and what might we identify as the leading activity from which this identity emerges? Unlike Mary's, we might argue that Lee's leading activity at this stage is 'academic study', with its motive embedded in the exchange value and status of the qualifications he hopes to obtain (n.b. his main reason for studying mathematics in the first place was because 'it would look good'). In the following quotation, Lee even reflects on this motive and almost laughs at its arbitrary nature:

I: Will you be more positive about maths if that was the way [reflects back on what might have been different]

L: Depends what grade I'd have got. I don't know.

I: Grades are very important, I hear, in your whole life. It's...

L: Not really but coming to college it is because that's pretty much the only reason of coming to college because sometimes you need to come to college to get the grades to go to uni so it's got to be done, hasn't it? [...] When you think about it, it's a bit of a joke, the fact you're always working towards an exam and you're not always even learning the whole thing. You just...churning out the work that you're going to pass your exam which is good because yeah, you've got to pass the exam but you've got to take something further.

We might argue that his leading identity is derived from the activity of study and acquiring grades—a motive which has the ultimate aim of becoming a psychology student and the next developmental stage of going to university and, thus, 'not getting ahead of myself'. Furthermore, it appears that the plan to do psychology at university now provides enough motivation for him to see a possible, if problematic, future involving mathematics.

When asked whether he thinks he will need to use mathematics in his psychology degree, he says 'nothing extreme. Just basics like, basic maths stuff' which he also describes as 'everyday maths' that he is confident with. When challenged further that

psychology may involve advanced statistics, he states:

‘I’d just do it because...I’m not saying I’d want to do it or I’m going to get any enjoyment but if it’s part of the degree then I’m going to have to do it, aren’t I?’

Thus, rather than dismissing mathematics as completely irrelevant to his future, he states that he would endure and ‘struggle with it’ in pursuit of completing his degree.

‘I probably wouldn’t feel that confident. It depends what it involved or how much...I don’t actually think there’s any, much maths, like special topic of maths in the actual course but if there was, then I would have to obviously do more work, get into it more because it would be something that I’d struggle with compared to the rest of the course.’

Nevertheless, his approach to mathematics remains passive—only engaging with the subject if he ‘had to’. Furthermore, despite never having studied advanced statistics before, he tells us that he already feels ‘a bit wary’ and believes ‘I’d probably struggle’. However, there is a distinct shift in Lee’s narrative in this second interview whereby, having made the decision to study psychology, certain possibilities regarding mathematics are opened up where before they were closed.

To summarise, in both Lee and Mary’s narratives, we see some sense of a leading activity which is manifest in the motive they each describe. Yet these motives are qualitatively different: whilst Lee is engaged in a ‘career of being a student’ (both at college and university), Mary is directed by a more distant future self—a ‘vocational’ motive derived from the GCSE engineering project which we described as leading in shaping her engineering dream. Thus, we can see that Mary’s leading activity has already begun at the time of her first interview (the GCSE engineering project) and is reflected upon within the narrative. On the other hand, Lee appears to be at a point of ‘crisis’ in his first interview—the ‘troubles’ he recounts suggest a sense of frustration that his ‘needs’ are not being met (college is boring) and the lack of a stable, leading motive (I do not see the point, I need a goal). In Leont’ev’s terms, we might suggest that a ‘turning point’ or ‘shift’ in Lee’s motive for being at college has not been made in line with his transition from secondary school. However, by the time of Lee’s later interview, the motive to become a psychology student suggests a new leading activity has emerged—that of studying psychology (which he says ‘is interesting’).

Furthermore, both students appear to draw on cultural models regarding learning mathematics and studying in general which mediate their motive and, thus, frame their leading identity. On reflecting on her role in studying mathematics, Mary draws on its use value not just for qualifications but for her vocational future, whereas Lee’s motive for ‘going to uni’ and ‘becoming a psychology student’ is mediated through the status of the qualifications he hopes to gain and the exchange value of his grades. Although Mary resorts to drawing on a similar cultural model in rationalising her ‘troubles’ with statistics (i.e. dropping certain modules to maximise grades), this co-occurs alongside her continued recognition of the use of mathematics underpinning engineering and physics.

Thus, we see that the leading identity we have described in these students’ narratives appears crucial to the way they say they relate to mathematics. Both of the shifts identified in Mary and Lee’s accounts over time highlight how the student’s perceived relationship with mathematics can change in light of the motive provided by a leading activity and its internalisation as a designated, leading identity. Although Lee continues to present

mathematics as ‘a struggle for him’, he is at least prepared to contemplate studying statistics and is willing to ‘do more work’ and ‘get into it more’ in pursuit of a degree in psychology. In a similar way, Mary refines the kind of mathematics she can do in light of obstacles (potential failure) and in pursuit of her engineering dream. Thus, we see the student’s leading identity acting as a kind of ‘gravitational pole’ for the self (Stetsenko and Arieivitch, 2004)—constantly evolving but simultaneously driving one’s engagement and alignment or misalignment with the cultural models which sustain this identity.

7 Conclusion

The analysis provided here presents a CHAT framework for theorising self and identity in terms of one’s motive to engage in activity and how one conceives of the object’s use value and exchange value in narrating the self. This builds on the work of Leont’ev (1981) and Stetsenko & Arieivitch (2004), who theorised the notion of leading activity in relation to self. Beach (1995) applied the concept to his study of Nepalese shopkeepers in transition between education and the workplace and has, in fact, argued that leading activity is a key methodological tool to understanding various forms of transition—including the individual’s transition from one institution (e.g. education) to another (e.g. the workplace). Nevertheless, while Beech’s study empirically grounded the concept in a mathematics education context (i.e. the learning and use of arithmetic reasoning strategies by the students/shopkeepers), to the best of our knowledge, our paper is the first to use leading activity in respect of the development of identity(ies) and self in relation to mathematics. In this paper, we have used both leading activity and leading identity to understand how the motives derived from students’ aspirations may play a crucial role in shaping their relationship with mathematics and, specifically, the mathematical identities they may draw on in narrating the self. Both Mary and Lee speak of previous and current ‘troubles’ in studying the subject—in fact, Lee did end up dropping mathematics, albeit temporarily. Nevertheless, the two students narrate their troubles very differently. We argue that the notion of leading activity and our derivative conception—leading identity—provide useful conceptual tools to explain their differences.

Our explanation has focused on understanding the development of self in terms of the hierarchical organisation of motives and the shifting nature of such hierarchies. How we view ourselves reflectively in relation to a given activity and the identities we draw on is an intricate part of our overall social and psychic development—our trajectory through the constellation of activities which make up our lives. The construct of leading activity proposes that some activities and, therefore, some motives are more significant for the individual than others, and because of this, they offer developmental change—a shift in self (and the associated hierarchy of motives). A shift in identity is then implicated when one comes to reflect on this new leading activity since a new hierarchical organisation of motives is set in place. For instance, by the time of his later interview, Lee tells of his new academic self and provides details of the grades he has obtained and what he will need for university. Thus, we see development from what was potentially a point of ‘crisis’ for Lee where a range of possible motives were recounted in his purpose of being at college, e.g. to ‘get a good job’, ‘to go to uni’, towards a clearer-leading motive which subsequently provides organisation to other motives (e.g. his motive for studying mathematics is now subordinated in pursuit of the wider goal).

However, from a CHAT perspective, this notion of ‘development’ is not merely about individual change or the construction of a future, ‘designated’ self (Sfard & Prusak 2005)

which might motivate one to become a certain kind of person. A CHAT interpretation also allows (after Marx) for historical progress, of humanity fulfilling itself and its collective needs—development in these terms essentially involves shifts or movement along a trajectory towards one's life as an adult and one's contribution to society (Stetsenko & Arievitch 2004; Beach, 1999). In light of this, we might argue that Mary's motive for study (and thereby, the identity she constructs and consequently draws on) is qualitatively different from Lee's in that it is clearly 'vocational', and she draws on cultural models which frame the content of her study (in this case, mathematics and engineering) in terms of its use in what will eventually become (if she is successful) activities of production. By contrast, Lee's motive to become a psychology student, whilst indicating a shift in his own development (i.e. his motive for schooling), is embedded entirely in the activity of 'studying' and is mediated through cultural models which define study in terms of its exchange value (e.g. getting the grades). There is no recognition that the object of study, i.e. knowledge (mathematics or otherwise), has value in terms of its use outside of the context of the education system. On the other hand, we might argue that Mary's purpose for studying mathematics offers a different, arguably more meaningful, engagement with the subject.

Therefore, we suggest this analysis offers a number of features which differentiate it from previous approaches to exploring identity in relation to mathematical learning:

1. As with previous research (Holland et al. 1998; Sfard & Prusak, 2005), this analysis incorporates an understanding of 'identity' as potentially multi-faceted in that we may draw on a range of identities when narrating the self (and in practice). However, by subscribing to the notion of a leading identity, we argue that some may be more significant than others in that they reveal a hierarchical organisation of motives and also indicate developmental change. This is distinct from Sfard & Prusak's (2005) notion of 'designated identity', which they use as a discursive category to account for any notion of 'future self' a person may refer to when narrating an identity—of which there may be many. A changing or emerging leading identity may signal a more fundamental shift in one's development.
2. Our use of CHAT to interpret students' narratives also offers something different to the application of concepts from the field of social psychology such as 'cognitive dissonance' (Festinger, 1957; Harmon-Jones & Mills, 1999), which are used to understand how people rationalise contradictory ideas, beliefs and behaviours. Such concepts appear to centre on an internalised notion of self whereby change occurs within the individual in response to their experiences within the social world. In our analysis, we argue in line with Leont'ev and Vygotsky that the self is always mediated through the student's leading activity—i.e. through actions which result in an outcome which is more significant than the original motive which induced it. This defines 'change' as an ongoing, socially situated process whereby the internal mind and social world are always in dialectic relation—one cannot progress without the other.

Additionally, this analysis raises a number of questions about how the activities which constitute learning mathematics at this level might align or misalign with or even become a student's leading activity. How might we organise mathematical activities so that cultural models associated with use value are made available to students? How might the use value of mathematics come to be seen as motivational to students so that more decide to take up the subject at post-compulsory level? Elsewhere (Williams, 2008), we have suggested that

enjoyment of mathematics involves the realisation of its 'use value' in terms of both cultural consumption and enhanced mental labour power—one's enhanced capacities for work either in the home or in the workplace. Here, we suggest that, for the 'use value' of mathematics to be motivational (and, thereby, integrated into one's hierarchy of motives), both our students needed to experience or at least come to recognise the power of mathematics in terms of its eventual consumption, i.e. its use in terms of labour power.

This leads us to ask if such an argument is only applicable to mathematics or could this be generalised to other curriculum subjects? Of course, on the surface, many school subjects are taught with the intention of creating continuity for the student in transition from school to the workplace and are implemented with expectations of their use value in terms of future consumption in the labour market. However, we suggest that mathematics may be different from other subjects for two reasons:

- (a) Firstly, its status as a 'semiotic tool' which underpins a wide range of practices means we are not simply talking about students learning procedures and applying them to activities in the outside world—rather, we are talking about the development of semiotic tools and a language which can be used to operate on objects as a means of achieving outcomes—hence, its powerful 'use value'.
- (b) Secondly, mathematics in the education system has an elite status or currency assigned to it which is mostly disconnected from its eventual 'use' in the labour market. Thus, familiar cultural models surrounding mathematics as 'hard' or 'challenging', which we have seen Mary and Lee draw on, serve to maintain this status and enable its use as a selection mechanism (e.g. to define who can progress in certain subjects or to highly valued university courses and institutions and who cannot) (Solomon, 2008; Mendick, 2006). This detachment of its exchange value from its eventual 'use' raises all kinds of tensions which may be applicable to only a small number of school subjects. For instance, we have many examples in our data where students and teachers talk of the relentless pursuit of grades through the use of surface strategies at the expense of deeper, conceptual understanding (Davis, Pampaka, Williams, Wake, Nicholson, & Hutcheson, 2008). Thus, there appears to be a conflict which is quite particular to mathematics which emphasises 'performance' in the here and now against 'use value' in the future (Williams, 2008). The analysis presented here highlights how Mary must negotiate this contradiction in pursuit of her leading identity of becoming an engineer. She must persist with her projection of the 'use value' of mathematics (delayed gratification for her future employment) as a motive for study and thus transcend the minimal exchange value her grades in the algebra unit alone will give her. Consequently, we suggest that programmes which emphasise the 'use value' of mathematics (such as the AS-level Use of Mathematics) may be crucial in enabling students to manage such tensions and contradictions.

Finally, this analysis also has implications in terms of understanding the difficulties students may experience in studying post-compulsory mathematics and the interventions which colleges and schools might implement in response. Here, we argue, it is important that teachers, colleges and policymakers recognise the varied motives students have for studying mathematics. By seeking to understand the particular motive or identity which may be leading for the student at a given point in time, there is much to be gained in terms of offering tailored support and appropriate ways of teaching and learning mathematics. Therefore, we suggest a move away from strategies which focus on maximising the exchange value of grades. Such a focus encourages students to 'drop' subjects which are

unlikely to bring about a high return for their efforts. Instead, we encourage interventions which might facilitate students' reflective and reflexive understanding of their long-term developmental trajectory, and their developing motives for study. In our analysis, it appears that it is the latter which can bring about a commitment to persisting with mathematics, particularly for at-risk students who may face more difficulties or challenges than others.

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Endnotes

¹ In England students are required to take compulsory mathematics up until the age of 16, when they sit their General Certificate of Secondary Education (GCSE). Post-16, they can opt to take four advanced-subsidary subjects (AS level) of their choice which are then typically refined to three advanced-level subjects (A-level) at the age of 17.

² Here, we refer to 'development' as a process of change which the individual experiences in 'becoming' someone new—in line with their participation in and transition between socially and culturally situated activities.

³ Further and higher education refers to universities and colleges which students attend having completed their advanced level subjects (or equivalent qualifications).

⁴ In England, post-16 education is taught in various locations, including schools, sixth-form colleges and further education colleges (which also teach some higher-education programmes). Mary and Lee both attended sixth-form colleges.

⁵ Interestingly, we have interviewed Mary on two more occasions as part of another project as she has moved into university and these, again, have shown little change to her story.

⁶ UCAS is the university and college admissions system—all advanced-level qualifications have UCAS tariff points assigned to them which determine their value as per the entrance requirements of university courses.

⁷ Once students have received offers to study on a particular course from their chosen universities, they then have the opportunity to select two courses—one as a firm choice and one as an insurance should they not make the grades for the former.

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