Qualified, but not choosing STEM at university: unconscious influences on choice of study

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Abstract:

This paper offers explanations as to why good candidates for mathematics or physics degrees might opt to study subjects other than STEM (science, technology, engineering, mathematics) subjects at university. Results come from analysis, informed by psychoanalytic theory and practice, of narrative-style interviews conducted with first-year undergraduates and from survey data. It is argued that psychoanalytic interpretations have a role in educational research. Also, it is shown that unconscious forces influenced young peoples' decision making. Implications for policy are discussed, in particular, the issues of (1) the role of commitment and (2) of being good enough to study a STEM discipline.

INTRODUCTION

> *It's just because he's your Dad isn't it. You kind of want to do what he did.*
>
> *Never thought about it properly.*
>
> (Zac, first year undergraduate reading mathematics and physics)

How do we find out why a young person has come to be studying mathematics or physics or has avoided those subjects? As the quotation above intimates, Zac, one of our interviewees, had not previously considered in any depth 'Dad' as his reason for his choice of study at university; instead, during his interview, Zac cited that being 'good at maths' was the main driver for his choice. A central purpose of this paper is to explore how a psychoanalytic lens can help reveal more of students' reasons for their being on their undergraduate course than are standardly available. A secondary purpose is to discuss how such research on particulars

(particular: students, interviews, interpretations) can be used to think generally about participation and how policies might be adapted.

The research is from the UPMAP project (Institute of Education, 2013). We are particularly interested in understanding why many of those who do well in mathematics and the sciences at school do not opt to pursue science, technology, engineering or mathematics (STEM subjects) at higher education. There is concern at the relatively low number of students continuing with mathematics and physics after the age of 16 (Gilbert, 2006; OECD, 2006; Royal Society, 2007). In particular, in 2008 the Higher Education Funding Council for England began a £20 million (HEFCE, 2013) rescue plan to attempt to counteract the decline in the number of undergraduates taking science and mathematics. It is in the context of these concerns that we have a different take on 'students' reasons'. Our approach parallels concerns raised by critiques of 'rational action theory' from sociological perspectives (where the central rational action theory assumption is that individuals behave in ways that are goal-directed towards that which they explicitly wish to attain, like money, a specific career or a sexual partner). One well-known vehicle for criticising rational action theory is Bourdieu's theory of habitus (1980) which asserts that people are subject to powerful, constricting sets of dispositions so that, in practice, they are unable to 'maximise' their goals in a 'rational actor' sense. Subsequent empirically-informed sociological theorisation has extended Bourdieu's work to issues of educational choice (Reay *et al*., 2005), illustrating, for instance, how parental choice of school is typically severely constrained by socio-economic and other regulating factors.

BACKGROUND

Student subject choice post-16 has been studied in a number of ways, whether specifically in science and mathematics or more generally (e.g. Cleaves, 2005; Blenkinsop *et al.*, 2006; Archer *et al.*, 2007; Bøe *et al.*, 2011). In these studies, predominant data collection methods

are questionnaires and interviews and the UPMAP project is aligned with this social science mixed-methods tradition in using questionnaires, interviews and school ethnography. However, we have gone further in pursuing that which is not readily articulable by employing a theoretical frame that includes notions of the unconscious – whilst aligning findings from such analyses with a more traditional method of analysis (i.e. the use of large scale surveys). Our hypothesis was that while a student may well be able to articulate a rationale for their choice of course of study that fits with standard university application procedures, there are likely to be further reasons for their choice of which they may not be fully (or even partially) aware.

The notion that humanity – including our rationality – has an affective core (i.e. a 'centre' where emotions, including desires and urges, are of prime importance) has, as Freud acknowledged, been clear to poets since antiquity, was discussed by Spinoza in the 17th century and has been further explored neuro-physiologically from the 20th century onwards (Damasio, 2003). In education, though, the importance both of affect (Alsop, 2005; Holm & Kajander, 2012) and of unconscious forces (Coren, 1997) remains underexplored. Our aim was to facilitate our interviewees unearthing and talking about some of the affective influences on their careers and our results include exemplars of undergraduates' reasons for doing their course which may well have not been available to them in their conscious mind.

METHODOLOGY

The UPMAP research project uses a range of methods. In this paper we primarily draw on findings from our interviews with first year undergraduates and interpret some of these findings by drawing on responses to our survey with school students.

A methodological question we asked ourselves was 'How do we, as researchers, tap into the a-rational/irrational parts of an interviewee's mind to address the research question 'why did s/he opt for this university course?'?' From the variety of interview techniques

developed by practitioners and researchers, the model that we adapted was from Hollway and Jefferson (2000). This 'narrative style' approach, in which the interviewee is simply invited to tell their story and then supported in so doing by the use of non-directive, positive feedback and questioning, was judged suitable because no prior assumptions need be made as to what might be important issues (unlike semi-structured interviews), it was logistically manageable and we aimed to conduct the interview so it would be a positive experience for the interviewees. While we acknowledge that issues of power relations between the researcher and the researched need to be acknowledged (Huckaby, 2011), feedback from the interviewees at the end of their interviews often included comments that indicated that the process of talking about 'their choices' had brought to mind things they had not been aware of, helping to validate the methodological process. For example, "I found it very interesting as it offered self-reflexivity which I had not considered before" (Becky – all names are pseudonyms that indicate gender); "It was a nice relaxed atmosphere – and the questions asked were actually insightful for me in analysing my own education" (Peter).

In interpreting our data, we concur with Hollway and Jefferson's central mantra that interviewees generally:

- May hear a prompt or question in a way not predicted by the interviewer;
- Protect themselves by 'investing' in ways of talking;
- May not understand why they feel things they do;
- Unconsciously disguise some feelings.

(adapted from Hollway and Jefferson, 2000, p.26)

Hence, analysing these interviews also required using notions derived from psychoanalysis. For the purposes of this paper, we very briefly review the psychoanalytic concepts that pertain to this paper, which are 'defence mechanisms', 'splitting' and being 'good enough'.

Defence mechanisms

Defence mechanisms were initially mooted by Sigmund Freud as unconscious responses – 'repression' for example – to deal with life's anxieties (Freud, 1896). While Freud located defence mechanisms through his study of adult cases, Melanie Klein reformulated the idea through her work with infants (Hinshlewood, 1991). Klein's observations of babies led her to posit that not only do all of us defend against anxieties using defence mechanisms, whether we are aware or not, but that 'mechanisms' of psychological defence develop (with) personality. Hence, defence mechanisms are essential for survival and not a priori 'negative'. To understand how a person is defending him/herself is to gain some insight into their unconscious motivation.

Splitting

The notion of a 'state of mind' (Waddell, 1998, pp.5-13) is integral to an analysis that aims to locate interviewees' defence mechanisms. While there are many 'states of mind', we review the Kleinian dichotomy between (1) the 'paranoid schizoid', the more primitive state that 'splits' dangerous from safe into *good* and *bad*, and (2) the 'depressive', the more mature state that is able to consider experience before evaluating it.

A significant contribution from Klein was her theorisation that relationships, rather than (Freudian) instincts, were the bases for mental life, hence the term 'object-relations' – where 'object' usually refers to a person – that is used for Klein's branch of psychoanalysis. Central to Klein's understanding of the developing mind is that right at the beginning of life the baby splits good and bad into separate 'objects'. Klein's paradigm example of splitting is that of an infant's relationship to the breast that feeds it: when satisfied by feeding the breast is (experienced by the infant as) *good*, but when frustrated by hunger the breast is (experienced by the infant as) *bad*. This splitting of a single object into good and bad is indicative of the 'paranoid-schizoid' state of mind; this state of mind is experienced by all of

us on occasions throughout life, particularly when our survival (physical or mental) is threatened. Contrasting with the paranoid-schizoid state of mind in Klein's terminology is that of the 'depressive' state of mind. In a depressive state of mind, an object is able to be thought about without instantly being experienced/assessed as good or bad (i.e. split apart into good object and bad object); ambivalence is tolerated. Being able to hold the idea that good and bad can co-exist is the key feature of the 'depressive' state of mind that is able to consider reflectively.

'Good enough'

This question of how independent thinking gets started during development was also a primary concern of Winnicott, who argued that how the environment – which, for a young child, is normally principally the mother's presence – adapts to the baby, facilitates the baby's developing mental functions. Winnicott used the term 'good enough mother' to express the idea that typical, intuitive motherhood was 'good enough' to support the developing child and also, crucially, that to progresses to being autonomous, the child must tolerate lack of perfection in the mother (Winnicott, 1964). In other words, 'perfection is not perfect' when it comes to an environment in which a child should grow.

This notion of 'good enough' can be applied to other relationships, including those within education. For instance, Bibby has discussed what it might be to be a 'good enough teacher' in a primary school context (Bibby, 2011). In the second part of the paper, we address what would it be to be 'good enough' at mathematics in the context of choosing to study a STEM subject.

Sampling

Our sample of undergraduates was purposive: we recruited from four UK universities, representing a range of institutions[1], roughly equal numbers of STEM and non-STEM first year undergraduates all of whom who had qualifications that would have given them a university place to read a STEM subject, and, as we proceeded, we sought students to interview who had different profiles from those already interviewed[2]. Our sample was not designed to be a statistically representative one but one that contained representatives from a variety of backgrounds.

The interviews were audio-recorded and subsequently transcribed. These resulting texts can be interpreted using a range of lenses (Black *et al.*, 2009). As well as the psychoanalytic lens, we used a form of grounded theorising we called 'face value' which was used to collect information about schools, families, enrichments etc. Part of the analysis reported below, on Dan's interview, shows why such a grounded approach alone does not uncover sufficient issues concerning interviewees' choices from interview texts.

In this paper we also draw on our survey work with year 8 (12-13 year-old), year 10 (14-15 year-old) and year 12 (16-17 year-old) students. We obtained completed surveys from 30 000 students in 141 schools across the UK. The surveys can be downloaded from our project website url supplied; details about the validation of our surveys are given in Reiss *et al.* (2011).

RESULTS

An example of an interviewee where two different, yet complementary, interpretations could be used to explain choice is Dan. Dan was studying English and drama at a Russell Group

[1] The universities were two Russell Group institutions in different regions of the UK, one pre-1992 non-Russell Group university and one post-1992 university, where the term 'Russell Group' refers to 20 of the UK's leading universities.

[2] For example, after having interviewed white, female, ex-selective school mathematics undergraduates, we invited people with different profiles. While we acknowledge that each person in a 'profile set' may have a very distinct story, the decision was to seek diversity of profiles when possible.

university. He is the oldest of three children; his father is a professor of chemistry and his mother works in NHS (National Health Service) human resources. Dan went to a comprehensive school and his A levels[3] were in mathematics, English and chemistry, all A grades, with AS further mathematics grade B.

Early on in Dan's interview he tells of switching A level courses – from sociology to mathematics – within the first few weeks of Y12[4]. His stated reason being that "with maths I knew I knew stuff". At face value this is a rational decision by a young man who has the option of continuing with sociology or switching to mathematics. But even his utterance that communicates the reason for his switch is open to other interpretations, for example, 'why does he have the need to know stuff at the beginning of a course?'. Later on, this needing to know threatens Dan's relationship with mathematics:

> I found the, the very last, the very last exam that we did for the further maths AS was FP1[5] and it was really, really tough

and he did not continue to A2 further mathematics; although he had said that when younger:

> I was always quite good at [maths] I guess. And then I don't know I just like found it quite interesting like kind of got it quite easily so, I just found it interesting I guess.

Yet:

> I didn't really enjoy maths like as I got older, like it was quite, it just got to a level where it got too complex and just stuff I could never see myself ever using in my day-to-day life.

This can be read at face value as 'Dan had had enough of mathematics because maths was complicated and irrelevant to him'. However, Dan's defensive language alerts the reader to a more complex story which may have been suppressed unconsciously: he not only defends

[3] Advanced ('A') levels are two year courses completed in the final year of school or college, usually when the student is 18 years old. They consist (in 2008 when these students took these exams) of Advanced Supplementary ('AS') levels – which is the qualification obtained after the first year of A level – and 'A2' which is the remaining part of the A level taken during the second year of A level study.

[4] Y12 is the first year in England and Wales of what is still often called the 'sixth from' – when students begin A level courses, normally aged 16.

[5] Further mathematics is an additional A level taken by about 10% of A level mathematics candidates; 'FP1' is the first further pure mathematics paper.

himself against not knowing (by switching from sociology to mathematics) but when his performance in mathematics is perceived as weak – B grade for an AS – his relationship with mathematics is under threat and further defences are evoked. When Dan says "I could never see myself ever using [mathematics] in my day-to-day life" we see an example of a mathematics-specific defence characterised by Nimier (1993) as 'mathematics as remote', noting that Dan does not manage even to say the word 'maths' in the obvious place in this utterance.

One way of interpreting why Dan initially chose mathematics and then moved away is to see this change in terms of his changing mathematics self-concept. In the surveys, students' mathematics self-concept refers to students' perceptions of their own abilities as learners of mathematics. Year 10 students who had aspirations to continue with post-16 mathematics had higher mathematics self-concept than students who had no aspirations to continue with mathematics post-16 ($p<.001$). Our analyses of year 8 students revealed the same statistical relationship ($p<.001$). Furthermore, there are strong relationships for each of our surveyed age groups between mathematics self concept and interest in mathematics, with a suggestion that this relationship is stronger in older students: year 8, $r=.475$, $p<.001$; year 10, $r=.509$, $p<.001$; year 12, $r=.589$, $p<.001$.

Dan's phrase "I could never see myself ever using [mathematics] in my day-to-day life" reflects a finding consonant with the quantitative analyses of students in years 8, 10 and 12. Students were asked to state the extent to which they agreed that mathematics helps solve everyday problems. 30.2% of year 8 students but only 15.5% of year 10 students strongly agreed with the assertion, a difference that is statistically significant ($p<.001$). In other words, as students get older they are less likely to see mathematics as being relevant to daily life.

The psychoanalytical interpretations we put forward, while they complement our quantitative findings and so receive a certain validation from them, are not intended to be read as if there

were no alternative interpretative takes; after all, an interpretation of an interviewee's words depends on the relationship the interpreter is fashioning with the text. Pitt and Britzman (2003) drew attention to methodological tensions related to the production of knowledge in such interview-based research:

> Poststructuralist method heightens the problem of the verisimilitude embedded in such foundational concepts in qualitative studies such as voice, identity, agency, and experience while still expecting to offer some contingent observations about how individuals – including the researcher – make knowledge in and of the world. This methodology offers a new tension to educational studies by bringing to bear on participant narratives the very problem of narrating experience and by asking what conditions or structures the narrative impulse. This linguistic turn in qualitative research is now known as "the crisis of representation" in that the adequacy of language to capture experience is considered an effect of discourse rather than a reflection of that experience". (Pitt & Britzman, 2003, p.756)

In our narrative analyses we claim that unconscious motivations figure in choice making. We evidence this claim from analysis of the interview texts – employing the psychoanalytic concepts of 'defence mechanism', 'splitting' and being 'good enough'. As Pitt and Britzman observe, the issue of whether the participant's narrative is a "reflection of experience" is one that can always be challenged. With this difficulty with communicating outcomes in mind that Pitt and Britzman predicted, we proceed, in the following section, to present a fuller analysis of an interview. From this analysis, we claim that Robin 'chose' to read a non-STEM subject at university because of defences that are seemingly outside his conscious awareness.

Analysis of text – why Robin did not study a STEM subject

Robin is reading history with economics at a Russell Group university having, the previous year, started an engineering course at another top UK university, left after a term and applied to university again. He has one sister six years his junior, his father is an accountant turned manager in the NHS and his mother is a teaching assistant. Robin went to comprehensive

middle and high schools and then to a post-16 college. His A levels are mathematics, further mathematics, physics and history, all grade A, and he has an AS in economics, grade B.

The broad outline of Robin's interview is: he talked – very freely – first about school, then about his engineering-related experiences and his mathematics education; he then talked about what he might pursue as a career and only mentioned his family when prompted. The analysis below presents quotations in chronological order with respect to the interview, because, as the interview proceeded, the interviewee-interviewer relationship developed such that it seemed that Robin was using the interviewer as an object to contain some fears and some fantasies. This ties in with Pitt and Britzman's concern with 'representation' (quoted above) in that Robin's narrative impulse seemed to have responded to the circumstance of the interview. The quotations below have been chosen to give a sense both of the progression of the interview encounter and also to illustrate the complex web of defences this highly qualified young man communicates that he experiences. The accompanying commentary on the quotations leads to an explanation (not 'the' explanation) of reasons for his lack of participation in STEM at university.

Robin's narrative with commentary

Going to university both symbolises and constitutes a distinctive stage of a young person's entry into an adult world. So when such a young adult volunteers to talk about their 'choices' for their course of study at university, even though they are willing participants in the interview, engagement in this discussion entails dealing with concern about their survival and self-preservation as emerging adults. A post-Kleinian (see Waddell, 1998, pp.xii-1) take on this interview encounter theorises that the research subject will, when in such a self-preserving state of mind, split off the 'good' from the 'bad'. Yet, as mentioned above, the interviews seemed to have for some a developmental function (as predicted by Bion, see

Waddell p 3). Indeed, towards the end of his interview, there is evidence of Robin adopting the repairing 'depressive' position.

In his first response in interview, Robin presented his relationship with both the subjects of mathematics and history through identification with significant 'objects', that is, his teachers:

> I had some really good teachers in that high school, in particular a really good maths teacher and a really good history teacher and basically that's what put me on to my A-level choices.

In our quantitative analyses we asked students if they were encouraged to continue with mathematics post-16 by a range of adults, including teachers. Findings reported elsewhere indicate the importance of teachers' encouragement on choice (Authors, in press). We found the following statistically significant associations: a correlation between teachers' encouragement to continue with mathematics post-16 and intended choice (year 8: r=.445; year 10: r=.546); and, perhaps most pertinently, a correlation between year 10 teachers' encouragement to continue with mathematics post-16 and year 12 actual choice: r=.619).

Returning to Robin's interview, he then told the interviewer of having started an engineering course, which he left after a term, and finished this first response by declaring:

> I enjoy arguing too much! With maths you get told you do this and that's how you do it.

An interpretation of this utterance is that Robin split mathematics off as 'bad' in the sense that he feared the lack of survival of his personal identity in a mathematics environment. Although we are suggesting that Robin had discarded mathematics because of his fear of not surviving, we observe that this is neither straightforward nor complete. For example:

> But one thing I will say, I really enjoyed maths. Which is why I didn't want to do a straight history degree, my ideal would have been history with maths but obviously you can't do that.

By positioning mathematics as part of a history degree as unobtainable, he can retain his 'good' mathematics (memories of enjoyment) and split off the potentially 'bad' mathematics that might threaten him if he studied it at university.

Robin related details of prizes, enrichments and disappointments in his experience of engineering and compared this with a key experience in studying history:

> In the gap between middle school and year 9 I made this kind of robot thing and ended up winning £100 as runner up. And that was out of about 600 entrants so that was quite good. And that was my first kind of idea as an engineer. …[6] the Engineering Education Scheme [also] probably had a big effect.
>
> I've always enjoyed machines. Machines and flying really so that was Aeronautical Engineering. … And also I wanted to become a RAF pilot. So I went to a RAF recruitment thing and then they said have you got any breathing difficulties and I said I had asthma and they said they were sorry we're going to have to end your ideas about a pilot here … that was very gutting … And then …at the end of A2 year, … I started really questioning what I was doing. I'd done a long history assignment, four thousand words, over a period of three months it was a lot of individual research and deciding whose argument was best basically and interpreting statistics and I enjoyed that.

In this passage Robin defends himself against the rejections from engineering after his early success. He also positions the in-depth history assignment as 'good' because feeling he can express his own 'arguments' is important to him. Robin's identification with his history teacher was important to his developing identity:

> And I had a brilliant history teacher again at both AS and A2 years and she really got me involved with history so … I think she was also the person who ran the Engineering Education Scheme.
>
> She was really an enthusiastic person and she was as enthusiastic about engineering as she was about history. Her profession was history, she had a history degree but she really

[6] '…' means some of the quotation has been omitted here. A new paragraph indicates a distinct quotation.

> enjoyed, in a sense she's quite a lot like me, she enjoys history but she enjoys working out how things work and stuff like that. So, yeah, I enjoyed the last year of history at A-level.

The important of one's teacher for one's post-16 subject choice is indicated by our quantitative analyses. The construct 'I like my mathematics teacher' was significantly associated with intended post-16 participation in mathematics (year 8: $r=.286$, $p<.001$; year 10: $r=.160$, $p<.001$) and with actual post-16 participation in mathematics (year 12: $r=.210$, $p<.001$).

Robin talks at length about his mathematical journey (about 500 words of continuous prose). This extract illustrates how his relationship with mathematics is both external and internal: the good (and not quite good enough) marks he receives and the pleasures of classroom fun and personal insight:

> I've always been good at maths from basically whenever I could start thinking. I was, I don't want to sound big-headed, I was in the top set all the way through middle school … it's kind of I'm just being very able to do maths. I can look at something and look at kind of logical route through it but I suppose year 6 was when people realised that I was quite good at maths … we had a very good teacher for that, he was really funny, he didn't make maths funny, he just made lessons funny. So, you were having a good time whilst doing maths … and it was kind of then with the more advanced maths that I kind of, it sounds very geeky but I got thrills out of completing a question, having a really kind of hard question in front of you and having that flash when you get to the answer. So I did GCSE a year early, I was less than half a mark away from an A* in that, I got an A in the end. And having re-marked it I never got that extra half a mark…it was just unfortunate really and being a year early. I went straight into A level maths in year 11 and I got 90s so that was a kind of big kind of boost for maths. And then I chose maths just because I enjoyed doing maths … I worked very hard for my maths A level I did a lot of work and came out with two As which I was pleased with.

At post-16 college, Robin studied mathematics entirely within a 'further maths' class; there were 11 students in the class, three of whom who went to read mathematics at prestigious

universities had been maths classmates with Robin since year 6 (age 11-12 years). He defends himself against their superior mathematical powers by 'preferring coursework' and 'choosing not to do maths' yet he is not in a position to jettison completely his relationship with mathematics:

> … and I prefer coursework to exams because I put a lot more, I can be a lot more picky and I spent a lot of time going through things like with exams I quite often run out of time … in the further maths group that I was in, most people would finish before the time, yeah the group I was in was very good … that was hard, that was hard to keep up with, I wasn't keeping up with that. But, not for lack of trying but I just didn't have that kind of ability.
>
> My three friends have all gone to do maths … it was weird, I recognise that it had been my choice not to do maths and I don't, I went home over Christmas and I found all my further maths stuff from college but I didn't want to throw it out because I don't want to get rid of maths.

This sense of feeling not quite good enough comes through when Robin confesses to another rejection which is defended against in quite a transparent way:

> I did apply for engineering at Cambridge. I got pooled and rejected for that. … I enjoyed the interview. To be honest I wasn't too bothered about not getting into Cambridge.

Towards the end of the interview Robin starts to reflect on 'Who am I?' but his beliefs about historical creativity appear more childish than a non-psychoanalytically-informed perspective might expect from an undergraduate reading the subject:

> I confuse myself because I enjoy rules, I enjoy having an answer to something but I enjoy being able to maybe have a different answer using my own rules, like with maths you can come to an answer using rules set down by basically nature but you can have your own set of rules in a history degree.

As part of these 'who am I?' reflections, Robin is able to consider his father in a considered ('depressive') light:

> Dad got an accountancy degree.

> I wouldn't want to become my Dad … actually no to be fair, like it's only been in the last year or two that I've really started understanding what he does as his job … I now don't look at it as an entirely bad thing what he does. …

How come Robin is not studying mathematics?

Robin has a mathematical self-identity going back to early the "start [of his] thinking", yet he was not quite an A* student at GCSE and his former classmates' abilities are considered superior; so failure is imaginable for him. He experienced rejection from engineering – no place for him at Cambridge nor in the RAF – despite having been positioned, through prizes and enrichments, to participate in that field and he defended himself against further rejection by avoiding continuing with engineering. His history teacher inspired hope in a different arena; he fantasises identification with her – "she's quite a lot like me" – and he follows her path, rather than not be good enough in the STEM world.

This (psychoanalytical) approach to exploring and attempting to discern why young people do or do not opt for STEM courses at university can produce a very different product (in the sense of answer to the research question) from questionnaire or structured interview-based approaches. This approach shows that unconscious forces play a greater role in choosing a course of study than a 'flow chart' model of choice presumes. And yet, as we have indicated, the two approaches can also complement one another.

THINKING ABOUT POLICIES TO ADDRESS 'SPLITTING' IN CHOICE-MAKING AND BEING NOT 'GOOD ENOUGH' IN MATHEMATICS

The UPMAP project was commissioned in order to advise on changes in policy that should increase participation in STEM subjects and the focus of this paper is students' participation in STEM study at university. Our analysis, informed by psychoanalytical perspectives, leads us to claim that: (a) the current standard framework of applying to university is pseudo-rational in that the process encourages 'splitting' of the rational from the affective; (b) there is lack of participation in STEM by well-qualified candidates because of their perception of

not being 'good enough' in/at mathematics or other STEM subjects, though our experience suggests that the issue of not being 'good enough' at STEM subjects is most important in relation to mathematics and least in relation to biology. In this part of the paper, we briefly develop these claims and consider what policies might facilitate young people's being more open to choosing STEM.

Splitting, rational choice and applying to university

There is a complicated and culturally-relative issue about the role of the young person's family and community in the decision of what course to s/he is to pursue, if applying to university, which is outside the scope of this particular paper (see Reay *et al.*, 2005); hence we would caution against any impression (that might be read) that these young adults act independently of others. However, most students in their last few years at school throughout the UK will be exposed to a "discourse of choice" (Salecl, 2009, p.1) that demands that individuals attend to what Salecl refers to as their 'life-making'. Within the context of this life-making, choices are made that are implicitly considered as 'rational'. For example, Dan's decision to study A level mathematics could be seen as 'rational' as he was confident that he "knew stuff" at the beginning of his course and then he 'rationally' dropped further mathematics when he got a less than top grade. The UK Universities Central Applications Service (UCAS) for higher education applications is an online procedure that is experienced as a systematic 'flow' through a framework of different stages (http://www.ucas.ac.uk/apply). Well-qualified young people, who position themselves by their grades, apply to university by clicking on available courses. This procedure (making apparently rational choices) is itself integral to the discourse of 'choice of university course'.

What we have referred to as the 'current standard framework' is a discursive positioning that includes the UCAS technological interface, reasoning such as Dan's and the organisation of individual schools and colleges that facilitate their students' applications as

well as the wider civic culture that endorses shopping for choice. Yet, of course, adolescent concerns do not align neatly with such a rational, 'flow chart' model of decision making. This is because negotiating and defending one's emergence into the adult world involves defensive splitting akin to the infant's at the start of life. Towards the end of Robin's interview, we witness the notion of the rational decision maker rising from his narrative as well as the anxiety this view provokes:

> Robin – Some of the decisions I have made have been the wrong decisions clearly.
>
> Interviewer – Which decisions?
>
> R – Well going to [read engineering].
>
> I – Was it?
>
> R – Well OK, not the wrong decision but …more of a kind of deviating path, kind of exploring one route, finding it's a dead end so starting again. So I've with the academic ability there is a lot of influences like pulling me one way or the other … the science that I connected with most which was physics. …I enjoyed too many [subjects] I wanted to keep my options open.

Coren (1997) discusses the commodification of education (ibid., pp.126-40) and the potential losses to an individual's personality as s/he splits procedures (*e.g.,* strategically choose A level courses in order to maximise grades, produce a grandiose personal statement, volunteer for a charity to put on the application form, *etc*.) from the feelings about what s/he is becoming as a result of these processes. To gain a place at a good university, the young person must sell him/herself as a commodity in order to invest years of study (and often be financially indebted) for the sake of a commodity that is the qualification.

Commitment as a means to avoiding splitting

There are various programmes[7] that target potential students from non-traditional backgrounds. For example, more maths grads (2013) targetted young women, while, the Lothians Equal Access Programme for Schools targets "young people with little or no family

[7] some of which in England are under the Widening Participation banner (House of Commons, 2009)

experience of higher education or those who may have experienced adverse social and/or economic circumstances" (LEAPS, 2013). Such targeted initiatives recognise that relationships with relevant people and on-the-ground experience in relevant environments contribute to the likelihood of success of university study.

However, academically successful students at school often have a plethora of opportunities with which to engage and, not surprisingly from the psychodynamic point of view, those with multiple opportunities, including those provided by a supportive (e.g. high social capital) family culture, find it difficult to consider, or mentally hold, all their options; thus they (must) split off as bad those options they cannot pursue. For example, the two young men, both from majority ethnic middle class backgrounds, whose interviews have illustrated this paper, have each turned from his father's path (Dan from chemistry, Robin from accountancy) in the anxious search for the holy grail of, in Salecl's term, 'life-making'. It seems that the mentoring and relationship building recognised as necessary for those from non-traditional backgrounds may also be needed for the culturally and intellectually buoyant. What is happening in practice is that many a potential STEM student cannot commit to the imaginary of the profession because of (1) the insidious 'discourse of choice' that, as Robin said, "pull[s] them one way or the other" and (2) the lack of a real person as guide to both commitment and learning. In a novel set in the mid-1950s Anne Michaels's character Avery (Michaels, 2009) imbibes engineering from his father, William:

> [A]fter the war William took Avery with him everywhere in his … blue swallow side car along with their gear and they rode up to Scotland and down to Wales for the hydro-electric projects. (p.89)

Avery, having been "hired on his own merits *and* under his father's supervision" (our emphasis, p.36), experiences his deceased father's presence within his job as an engineer:

> Avery awaited the arrival of the Bucyrus Erie 45 – an immense dragline that had been floated to the future site of the St. Lawrence dam from a Kentucky coal mine. All around

> him was a display that would satisfy even the most ardent machine-worshipper: nine dredges, eighty-five scrapers, one hundred and forty shovels and draglines, fifteen hundred tractors and trucks. This was the moment his father had loved best, surveying the gathering of the mechanical infantry. (p.36)

This most profound mentoring and passing of the mantle cannot be legislated for, yet the issue of commitment (from both the young person and from the institutions in society) could be extended. The armed forces have long had various programmes where a young person is sponsored through their university study in exchange for some work commitment (http://www.desg.mod.uk). Further development of commitment in higher education, from prospective student as well as institutions, might restrain the frantic splitting that over-commodification incites.

Being 'good enough' at mathematics

In our context of investigating participation in STEM courses at university, we ask what is it to be 'good enough at mathematics'? A feature of mathematics as experienced in education that is still pervasive is that one has to be the 'best' or achieve 'top' marks to continue, as Robin's and Dan's narratives both illustrate. Our analogy with Winnicott's 'good enough mother' and Bibby's 'good enough teacher' is that of the relationship with mathematics. (This relationship may be personified by some significant other(s) – teachers, parents, peers or even cultural icons like Stephen Hawking or Brian Cox.) The 'inevitable failures' of this relationship are necessary to produce 'frustrations that stimulate thinking' (about mathematics). As explored by Nimier (1993), the comforts of the paranoid-schizoid position can be experienced as manic defences for mathematics. This suggests that performing correctly when faced with the stereotypical exercises that have been exemplified on the teacher's board brings an infantile satisfaction which can be split off from the terror when answers are wrong.

In contrast, 'solid food' can be thought of as mathematics which is not immediately digestible, where alternative approaches are acceptable and emerging errors, contradictions or dead ends give rise to further contemplation. Despite the educational discourse that privileges 'rich mathematics' (*e.g.*, nrich.maths.org.uk), many students have not experienced positively an environment of uncertainty that this involves. Hence, when not-all-good ('can't do it') is experienced, the relationship with mathematics is under threat and, in its brittleness, susceptible to fracture.

CONCLUSION

The presentation of Robin's and Dan's narratives expose complexities around decision making, including choice of university course, that are central to some young people's lives. We have shown that defending against anxieties – defences being psychic mechanisms that all of us employ and are natural to personhood – can disrupt a potential career, as in Robin's case. Robin's A level grades are excellent and would be a very solid platform for pursuing mathematics or physics at a good university. Our analysis of his interview suggests that he was defending himself against not being 'good enough' at mathematics – a notion (self-concept) that mirrors our quantitative analyses. Robin's narrative also exposes the nature of some of the anxiety prevalent in higher education and the splitting mechanisms employed to protect from self-doubt – did I make the right choice?

Sigmund Freud famously described his own profession as one of the:

> 'impossible' professions in which one can be sure before hand of achieving unsatisfying results. The other two, which have been known much longer are education and government. (Freud, 1937, p.268)

And by considering education and policy (government) in the light of psychoanalysis we are embarking here on a three-fold impossibility! Nevertheless, we address how results such as those we have examined might be used to help develop policies that acknowledge the

existence and respect the power of unconscious forces when young people apply for a university course.

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