"I LIKE QUADRATIC EQUATIONS...BUT I DON'T LIKE GRAPHS": STUDENTS' DISPOSITIONS TOWARDS MATHEMATICS ACROSS YEAR GROUPS

Sophina Qasim, Afroditi Kalambouka, Maria Pampaka, David Swanson

University of Manchester, Manchester, United Kingdom

This paper focuses on how mathematics pedagogy relates to learner engagement and outcomes (including dispositions and attitudes) as part of a larger ESRC funded project (www.teleprism.com). It examines and applies Bourdieu's concept of 'hysteresis' and its role in transition, as well as, changes within the mathematics classroom (for example through introduction of new of unfamiliar topics through unaccustomed teaching styles). We identify that such topics may give rise to the hysteresis that can give way to missed learning opportunities.

Introduction

This specific paper is based on qualitative data from interviews with students during our case studies and aims to relate students' dispositions and attitudes to mathematics to their motivational profiles as well as examine possible 'shifts' of these dispositions taking into account the pedagogic practices, social environment, etc. at different stages of their schooling. We draw on about 50 interviews conducted with secondary school students in various classes, covering all year groups from Year 7 to 11. Interviews focused on students' educational background, their experiences of learning mathematics and their

future aspirations. However, in this paper we only present two cases as exemplary of some of the issues raised above. Our emphasis in this preliminary analysis is to investigate how students' stories vary from year group to year group, amongst their peers, and depending on the teaching they receive.

Such 'subtle' or 'obvious' differences between students or groups of them can be seen as not only evident in the practices visible within classrooms (such as engagement or disengagement in mathematical tasks) but also in the choices they make when reflecting on their practices in the form of use of language. Choices like these have been described by Pierre Bourdieu (see 1990) as an outcome of inculcation of objective structures (i.e. objectively occupied changing positions over time) that then structure one's own schema of perception, which in return acts upon the external structures in the form of a dialectic relation.

Hence using the above as an analytical framework, the findings presented in this paper will show how students' motivation to study mathematics and engage in mathematical tasks is driven by such a system of complex relations made up of the students' own perception of their social position within the classroom and amongst their peers (i.e. Bourdieu's concept of habitus, [social] capital, hysteresis etc.) and the objective positioning of these students e.g. by the school system in the form of group (ability) setting, access to resources etc. Furthermore, this paper maps out how certain pedagogic practices could have a potential implications on students' liking or disliking certain topics within mathematics (amongst other things), hence, impacting students' trajectory as mathematics learners. This will be a significant contribution to the open debates

about the connection of pedagogy and students' attitudes to mathematics.

The Project – Teleprism (348/400 words)

The findings of this paper are part of a ESRC funded study, namely Teleprism, which sets out (i) to understand how learners' dispositions to study Mathematics develop through Secondary School (i.e. KS3 and KS4), (ii) to understand how mathematics pedagogies vary across different situations and contexts, (iii) to understand how different pedagogies, programmes and school contexts influence learning outcomes, including dispositions, and (iv) to solve a series of measurement and analytical challenges involving a synthesis of longitudinal and cross-sectional analyses, and dealing with missing data.

The study of students' dispositions is vital because this may reveal key influences on their choices and decision-making and hence future engagement with STEM (see Mendick 2006; Reay et al. 2001; Wolf 2000; etc.). A complex of socio-cultural factors (class, gender, nationality, ethnicity, parental and peer cultures, etc.) are also significant in shaping students' dispositions and choice-making in education in general (see Ball et al. 2002; etc.), and in STEM subjects (see Nauta & Epperson 2003; Nauta, Epperson & Kahn 1998; etc.) and mathematics in particular (Cooper 2001; Cotton 2001; Dowling 2001; Mendick 2005; etc.). Students' affective dispositions (e.g. self-efficacy) may be critical to their choices and need to be included in modelling learning outcomes alongside traditional indicators such as grades (see Andrew 1998). The project will map students' progression through secondary education to see how they adopt after the primary-secondary transition (see Ferguson & Fraser 1999) and the well-

acknowledged shock and also how they develop and shape their decisions through this time of their life. This progression will involve both traditional learning outcomes (e.g. teacher assessment of National Curriculum level -NC) as well as dispositions, and students' decisions in regards to future choices.

Specifically, in this paper, we report on findings of how students' dispositions are shaped and altered during their experiences in a school year at various time points in relation to their studies generally, future career choices, etc. By doing so we hope to add to existing debates about what contributes to such changes and how this relates to the study of mathematics.

Theoretical Framework (845/1000 words)

In this paper, we take the view that Bourdieu's concept of hysteresis (i.e. the lag between the habitus - dispositions – re-adjusting itself to new opportunities in the field, see Bourdieu, 1997) can be a useful tool to account for changes in educational aspirations of the learner, generally, and in subjects such as mathematics, throughout their transition during high school.

Bourdieu states:

> …as a result of heightened consciousness associated with an effort of transformation (such as correction of accents, manners, etc.), there is an inertia (or hysteresis) of habitus which has a spontaneous tendency (based in biology) to perpetuate structures corresponding to their conditions of production. As a result, it can happen that, in what might be called the Don Quixote effect, dispositions are out of line with the field and with the 'collective expectations' which are constitutive of its normality. This is the case, in particular, when a field

> undergoes a major crisis and its regularities (even its rules) are profoundly changed (ibid: 160).

And furthermore:

> But, more generally, the diversity of conditions, the corresponding diversity of habitus and the multiplicity of intra- and intergenerational movements of ascent or decline mean that habitus may, in many cases, be confronted with conditions of actualization different from those in which they were produced. This is true in particular whenever agents perpetuate dispositions made obsolete by transformations of the objective conditions (social ageing), or occupy positions demanding dispositions different from those they derive from their conditions of origin, whether durably, in the case of *parvenus,* or temporarily, like the most deprived agents when faced with situations governed by the dominant norms, like certain economic or cultural markets (ibid: 161).

Generally, a crises in the field - which can be brought about by, for example, 'the appearance of a new and effective agent' or 'the adoption of a new technology' or 'the acquisition of greater market share' (Bourdieu 2005: 202) - can give rise to new positions which can be acquired within that field. In such a situation the hysteresis effect or inertia of a habitus of an agent can lead to two potential outcomes:

- One in which the conditions of existence of the habitus in the first place are re-perpetuated, leading to the non-acquisition of the new positions and missed opportunities. This is most likely to happen to agents who *cling to their old dispositions*: "this is not for the likes of me".

- The other in which the inertia of the habitus is quick to respond to new opportunities intra-generationally.

As Bourdieu states further:

> In a general manner, it is the people who are richest in economic capital, cultural capital and social capital who are the first to head for new positions (Bourdieu 1997: 262).

This change comes about through the awakening of the consciousness or in other words through the realization of the new positions to be held in the field:

> Not only can habitus be practically transformed (always within definite boundaries) by the effect of social trajectory leading to conditions of living different from the initial ones, it can also be controlled through awakening consciousness and socio- analysis (Bourdieu 2005: 116).

Hernandez-Martinez and Williams (2011) explore 'Bourdieu's relational view of social and cultural *capital* as that capacity to exercise agency in a *field* which is (i) incorporated in the *habitus*, (ii) objectified in artifacts, or (iii) institutionalised (e.g. as credentials)' (ibid: 4) in order to explore their concept of resilience as a form agency for learners in the state of transition from one field (college) to another (University). Here resilience also arises through friction between the learner's habitus and the field. They further state 'to Bourdieu's notion of social and cultural capital, we add this note of reflexivity: that students can *develop* capital through reflection, particularly in critical moments. It is that capital that allows for agency in new fields (for example, during transition), and the possibility to exercise that agency, negotiating successfully (aligning) their habituses with the conditions of the new field (resilience)' (ibid: 6).

Reay's (2004) analysis of the concept of habitus particularly demonstrates how a learner's habitus (or dispositions) can adopt and adapt in relation to practice linked with capital and field:

> According to Bourdieu it is through the workings of habitus that practice (agency) is linked with capital and field (structure). In relation to the charge of determinism, Bourdieu argues that habitus becomes active in relation to a field, and the same habitus can lead to very different practices and stances depending on the state of the field (ibid: 432).

And later on:

> Bourdieu sees habitus as potentially generating a wide repertoire of possible actions, simultaneously enabling the individual to draw on transformative and constraining courses of action (ibid: 433).

Adding to the argument above, we would like to state that this *friction* between the habitus (e.g. learners' dispositions) and the field (e.g. classrooms, family field) arising during transition between school years, educations systems and/or through the introduction of a new task (e.g. problem solving in mathematics) can lead to the *hysteresis* effect during which agency takes shape; and that reflexivity and resilience is the function of the hysteresis effect.

Methods

The analysis and findings presented in this paper represent two cases out of the 50 interviews (carried out so far) in the form of narratives that are exemplary of a learner's *adapting habitus* to new opportunities in the field: (i) Julie – a Year 10 student and (ii) Mark – a Year 9 student.

These narratives are constructed from interviews which took place at two data points (i.e. during the first and last terms of the school year respectively) and were analysed using thematic coding (following Gee, 1999 and Bruner 1996) then put together in the form of inter-connecting sub-stories similar to previous work (see Hernandez-Martinez & Williams 2011; Williams 2011; Black et al. 2010; etc.)

Narratives (2000 words)

Julie's story

Julie (a Year 10 student, top set in her mathematics class) comes from a middle class background. She has 3 siblings who've all been to Universities (either studying Classics, English or training as a primary teacher). Her dad is a counsellor and a University lecturer and her mum is a social worker. Going to University is something that she holds as very important, as she recounts:

> I know I definitely want to go to University. I don't have a view of what I want to do in the future. I will probably carry on with my English and history because I like them.

She has also chosen German, French and history as optional subjects for her GCSE exams based on her siblings' experiences, as she explains:

> … we are all very similar, and they all did languages at both GCSE and A level and all did English at A level as well. So we are all kind of similar in that context, so it is good having them in there… because they can tell me what it is like and things like that.

The above shows that Julie's dispositions towards learning (including her choices of subjects) reflect her family's influence (which we class as cultural capital bestowed upon her through her family). She herself is quite aware of her position, for example, in the mathematics class (field) as she describes herself as: 'quite good at Maths' and 'highest in the class' without trying 'to sound really big headed'. In terms of maths learning, she says:

> Things just register in my brain easily in maths, so I don't find it hard to learn new things, they click quite easily.

She has a particular liking of 'algebra' because 'it is just easy', 'straightforward' and it involves 'either right or wrong answers and there are formulas to work it out'. She further explains her way of thinking and solving algebraic problems as follows:

> I find it easier to do the – if it is a calculated paper, a calculated question in a quadratic equation because everything is there for you, you can work it out and you don't really need to think about which numbers to put in whereas if you just factorise it into 2 brackets, then you have to think about what numbers you have used to do this and it could take more time then, that just using the equation and working it out straight away. (…) the quadratic formula, I don't know how, but I just remember it, so straight away I can think I know the formula, I can use that, so that is quite easy and factorising. We have spent quite a bit of time doing that, so you can look at it and know which different methods to use.

So far Julie has been able to successfully negotiate and invest her cultural capital transmitted to her through her family (field) to the mathematics classroom (field) bestowing upon her a certain kind of educational capital that allows her further

success in her studies. She also seems to take a liking of topics, which are taught in a ‘straight-forward’ and *transmissionist way*.

At the same time, Julie has a dislike for graphs: ‘I don’t like doing graphs; they are just time consuming. It is just the way the look on the page, sometimes they look easy, but other times you look at them and you have no idea what they are about’. It appears to us that Julie’s habitus is accustomed to the transmissionist style of teaching. So she got used to learning in this particular way and ‘finds it easy’. The crisis here in the classroom field is introduced by the ‘problem-solving task’, for example, trying to understand graphs, plotting and solving equations (with the help of graphs), etc., which requires a form of a concept formation, as well as, the ability to transform and apply the concept.

Moving onto Julie’s future career choices in the beginning of the year, she has not been able to decide upon something beyond what her siblings have accomplished. This, however, changes later on during the second interview. Whereas she has not been entirely sure of what she would want to study at University earlier (during our first interview), she now seems to want to study medicine. For that reason, she now wants to choose Mathematics along with other Science subjects for her AS levels as her ‘teacher said’ so: ‘obviously medicine is very competitive and you need the best grades and you need academic subjects so I think Maths would be the and it’s yeah I think it would be quite useful in getting me to University’.

Here we see Julie making choices for herself in terms of her future in the form of new opportunities and exercising agency. This is partly due to her cultural and educational capital that she is able to make such choices. As Bourdieu puts it,

> In a general manner, it is the people who are richest in economic capital, cultural capital and social capital who are the first to head for new positions (Bourdieu 1996: 262).

In terms of what shapes her likes and dislikes in maths, she further puts an emphasis on what 'sticks in her brain' during her lessons linking it with certain pedagogic practices:

> If we were doing simultaneous equations for example, Miss will either do it as a table or in partners and she will give us shapes and then match them up and make a big shape and do all the matching. (…) or the formula of something and then match it with the actual formula and that helps because it makes things stick in your brain, we do that and have been doing that since Year 8 and we have been doing that quite a lot. Or if we have finished a topic like trigonometry she will get a big poster with all the different things on it, just to sum up everything we have done and just to check that we know everything. If we don't or people struggle then she will like go over it with us and we do that quite a lot.

Julie also attributes her success in mathematics to having the same teacher since Year 8, as she describes:

> It is hard to go to a different teacher and change the teaching style. If you have learnt one thing one way and then someone else teaches it a different way, it is a lot harder to adjust to the different ways. So having the same teacher you are used to the teaching style, the way they teach things and they know what you

> have already learnt, and what you have not learnt; what your strengths and weaknesses are.

So there are some relations of liking and disliking of certain topics within mathematics, as well as, continued success in mathematics generally, which can be attributed to certain pedagogic practices.

Mark's story

Mark's story (a Year 9 student – 2nd top set in his mathematics class) is different in the sense that he wasn't born and raised in the UK. He joined the UK during Year 6 and is originally from the Philippines. His family left the Philippines after his dad found work in the UK. As he puts it: "so my family came to find a better life here".

Mark has become conscious of quite a few differences in the education system (fields) he is experiencing here in the UK as compared to back in Philippines (due to his transition between fields), as he accounts:

> (…) back home it is like pretty different, the education is quite different. It is not like GCSEs, it is more like everyone is trying to go for nursing because it is very easy to go to other countries and help out your family. (…) But here you have got a wider variation of jobs/futures. So I find myself quite lucky to be here.

Mark also recounts that the 'teachers are more relaxed' here. In Philippines he was given homework 'in fourth grade, which is like grade 5 here' and mostly stayed behind till 9 pm to finish it off. Not only the schoolwork, but also the lifestyles appeared quite different to him. Nevertheless, he 'found it easy to adjust

really' and finds himself 'lucky to be here' mainly because he has got a 'wider variation of jobs/futures here'.

His family's interest in nursing is also quite apparent; his mum used to be a 'teacher at the nursing University' and his grandmother was the 'Head-Dean' at his 'mum's work place at the University'. They still push him towards nursing, as he explains: 'They would want me to be in nursing because they keep telling me (…) people get sick all the time (…) it's not like other jobs'. However, the focus is on nursing rather than other medical professions: 'just that field, not really a doctor'. That, however - as Mark insists, would not mean that he would follow into the nursing profession. Instead he is thinking about 'aeronautics' or something else as he says: 'there is a whole world out there just waiting'.

So far it is evident in his account that Mark and his family experienced the hysteresis effect i.e. the lag between the habitus adjusting to a new field due to transition from one country to another. Whereas he sees the new opportunities and wants to avail them (in terms of future choices), it is also obvious from his account that his family does not see, for example, any choices made outside of the profession of nursing suitable to them.

Reflecting upon his experiences as a learner, Mark describes himself as someone with 'ADHD' (Attention Deficit Hyperactivity Disorder) as he describes:

> I tried to cope with it, I don't take any pills for that I just try to keep focused – in the end it is quite well really it is just that I need more focus in my work because I get distracted by stuff.

Mark's awareness of his disorder combined with the new opportunities he recognises, however, made him resilient. This then enabled him to define his

own trajectory as a learner, as he further describes his experiences (specifically in mathematics) as:

> Maths is not my favourite subject in the world but I am progressing. I have seen an improvement in my grades lately from going from I used to do really, really bad to being 5A, but now I am really going into the level 7, 6b, 6A and 7C, so I am doing quite good in maths.

He puts down reasons for his motivations as himself along with identifying the cultural capital that has been transmitted to him through his family (like Julie):

> It comes from me really, and to my parents saying if you want to get a good job, get a good future raise a family, you have got to do well in school. So I decided right I am going to go to a good college, go to a good university, find a good job and maybe start a family and have a good life basically.

At the same time, (like Julie) he attributes his improvement in mathematics also to having had the same teacher since Year 7:

> (…) Personally I think changing teachers is another thing to adjust to with quite different teaching methods, but it is actually all right having the same teacher from the start and knowing the teacher basically helps you with the subject. It is not like another thing to adjust to.

Once again we see in Mark's story the impact of the hysteresis effect on his educational capital linked with his negotiation of his future career choices. The difference here is that, whereas in Julie's case – she experiences the hysteresis effect due to the introduction of a mathematical task she is not accustomed to (hence, creating a crises *within* a field), Mark is consciously availing (or planning on availing) new opportunities due to the transmission between two fields.

Conclusion

The friction between the habitus of a learner and the field can give rise to moments that enable the learner to either exercise agency and avail the new opportunities in the field or stick to their old dispositions (i.e. *hysteresis effect)*. Such enactments of agency can potentially lead to the re-structuring of the field and re-distribution of power within the field; wherein a different kind of educational capital becomes valued.

With Julie and Mark, we observe two different forms of hysteresis. Julie is well accustomed to, for example, a particular way of teaching that enhances her performance in certain mathematics topics. However, the crisis is introduced by certain topics that are more open and inquire a form of investigation. Julie does not see such opportunities as a way of developing her *educational capital*.

This may point to the dominant pedagogy, which automises and separates elements of mathematics that creates more opportunities for the hysteresis effect to happen; that, perhaps, wouldn't occur if mathematics would be taught more in a connected and integrated way. Arguably, the reason why problem-solving tasks, for example, solving equations with graphs tend to introduce the hysteresis effect in Julie's story is that such tasks are very much still external and 'alien' to the mathematics classroom field.

At the same time, Mark makes a more of a conscious effort to improve his *levels* in mathematics (and potentially create opportunities for his future career choices) as an outcome of his raised awareness of the differences between the two education systems he has experienced. The friction between his *old* habitus (and

the cultural capital of his family) has allowed him to develop a distinct form of educational capital and acquire new dispositions, in other words, exercise a form of agency. This is partly due to his ability to be reflexive as a learner and resilient to, for example, his disorder amongst other things.

The implication here for practice is that, although, hysteresis may potentially be something that is needed in order to raise reflexivity, resilience and other forms of agency in learners to successfully negotiate and develop their educational capital; we also ask the question: how can different elements of mathematics be integrated in a way that they do not remain 'alien' to students and create ripples in the form hysteresis which may then lead to missed learning opportunities?

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