Adopting Goldin et al.'s student '*engagement structures'* for investigating teacher '*engagement structures'*: Some preliminary analyses

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As part of PhD research into mathematics teachers' emotional engagement, I am exploring means of addressing the complexity of classroom interactions, whilst incorporating teacher beliefs. Goldin, Epstein, Schorr, and Warner (2011) propose '*engagement structures'* which are suggested as a theoretical model for framing analysis of the complex nature of affect for students of mathematics. In this paper, I examine whether this '*engagement structures'* construct can be appropriately and usefully adapted for secondary mathematics teachers. I then discuss the fit of emerging affective characteristics to each of the strands outlined by Goldin et al. (2011). The teacher data includes a pre-observation career story; videoed observations of lessons; and post-observation discussion of video extracts where the teacher recalls emotions. If transference proves useful, then linking teacher and student '*engagement structures'* could support detailed examination of classroom interactions.

Keywords: engagement structures, teacher affect, emotions, mathematics

Introduction

Research into emotional engagement of secondary mathematics students has attracted attention (Hannula, 2012), especially recently as more is known about the brain processes whilst engaged in learning mathematics, and how affect interacts with cognition (Damasio, 2006), but less is known about emotions whilst actively engaging in the teaching of mathematics in schools.

As part of a PhD study into emotional engagement of mathematics teachers, I am seeking an approach that provides the means of addressing the complexity of classroom interactions, whilst yet incorporating teacher beliefs. Such an approach would help address research questions such as:

- How do teachers share their emotional relationship with mathematics?
- How does a mathematics teacher effectively use (positive) emotions?

Following an initial exploration of *Engagement Structures* (ESs) for one teacher (Lake & Nardi, 2014), this paper continues the investigation into considering a different teacher, whom I will call Debbie.

What are '*engagement structures'*?

Goldin et al.'s (2011) '*engagement structures'* are designed as multileveled hypothetical constructs for framing analysis of the complex nature of affect. Specifically designed for students learning mathematics in school, the structures include statements that incorporate complexity of beliefs and social *'in-the-moment'* interactions. The structures can overlap, occur briefly, and share characteristics, but there is always one predominant one which directs emotional reactions. Significantly, Goldin et al.

(2011) suggest that differences in motivation may still produce similar behaviour, which may act to limit available ESs for either student or teacher, but still potentially supports adoption from one context to another.

Adopting 'engagement structures' for teachers

There are several reasons why ESs could be adoptable for teachers. Firstly, the construct has been used or tested by other researchers since 2011. For example Lewis (2013) and see also Leal, Schorr, and Warner (2013), although both studies apply to students. Secondly, if ESs emerge from common observable characteristics as suggested by Goldin et al. (2011), then this commonality implies transferability. Finally, classroom interactions are complex, so a model specifically designed to incorporate complexity for students is likely to apply to other actors in the same environment, in our case teachers. Yet there are additional layers of complexity, as a teacher has an additional role of manipulating the classroom social dynamics.

The data

The participants are secondary school mathematics teachers. Each teacher was interviewed for their career story, and encouraged to diagrammatically represent their story. They were then observed (and videoed) teaching. A discussion of an extract of the video then took place, asking each teacher to articulate any evoked emotions.

How does this particular work from Goldin et al. (2011) support the analysis of this data?

The analysis process included highlighting within the transcripts any aspects with an emotional dimension. This was then used to produce a mind map of connections and any repeating strong emotive themes. This mapping is followed by an examination of each of the following ten strands (Goldin et al., 2011) in order to identify which, if any, ES apply. Focussing on each of the ten strands with each piece of data in turn supports the emergence of a characteristic summative construction, which then informs multilevelled mapping to the ES model. The strands are:

1. Characteristic goal/motivating desire
2. A characteristic pattern of behaviour
3. Characteristic affective pathway
4. Signification of emotional feelings
5. Characteristic 'self-talk' in response to and evoking emotional feelings
6. Characteristic strategies and heuristics
7. Interactions with beliefs and values
8. Interactions with the individual's self-identity, integrity, and intimacy
9. Meta-affect
10. External affective expressions: tears and laughter, body-language, blushing, expression, eye-contact etc.

These ten strands then combine to form paraphrased ESs for students. The ESs as they appear in Goldin et al. (2011) are:

- *'Get the job done'*
- *'Look how smart I am'*
- *'Check this out'*
- *'I'm really into this'*
- *'Don't disrespect me'*
- *'Stay out of trouble'*
- *'Let me teach you'*
- *'It's not fair'*
- *'Pseudo engagement'*

To illustrate one of these engagement structures, '*I'm really into this'* is in evidence when a student's self concept (8) appears to be that of a serious, involved thinker who values (7) mathematical problem solving for its own sake, and is driven by an underlying mastery goal (1). This contrasts strongly with engagement structures such as '*Stay out of trouble'* or '*It's not fair',* both representing lower levels of engagement. More engagement structures will be discussed later in relation to Debbie.

It seems reasonable that there would be a predominant ES at any one time, but one needs to retain an appreciation of the fleeting and overlapping nature of ESs within the complexity of classroom practice. Also that adoption is likely to be different for teachers and new ESs may emerge as the analysis develops.

The case of Debbie

Debbie is a secondary mathematics teacher, the youngest of the participants and in her third year of teaching. She presents as physically active whilst teaching. Her drawing constructed within the preliminary career story interview (Figure1) has a certain simplicity in style, as has her phrasing as she brought her interview drawing into the discussion; *"I want to draw another picture.* [Does some drawing] *I'm not very good at drawing*" [Laughs, more drawing].

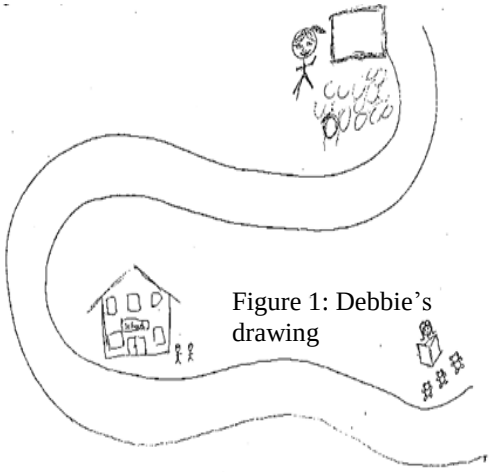

Figure 1: Debbie's drawing

Some brief illustrations of the first stage of analysis

This section uses the data to look in particular at how Debbie engages with challenge and adds complexity, how she sees the modelling of fun in engagement, and how she enacts teaching as a performance.

In the observation, I noticed that Debbie was often speaking whilst moving, and frequently running several conversations at the same time, to the point of making things more complex than perhaps was necessary. She also spoke fast. I noted that it is almost as if she was creating a new challenging situation within the existing one. She also encouraged her students to do the same, for example, "*When they do Tarsia puzzles I try to make it [...] a bit more complex by putting the same answer in, but I only do it with one answer, just because they've done so many of them before*". The valuing of complexity also seemed to be just for the fun and novelty of it, such as creating mathematics murder mysteries. And although she used the term stressful, my feeling is that she liked "*juggling around six different things*". Another example is "*when I have had a long day, I will sit on my wheelie chair and wheel myself around the room.*" So even tiredness for her is a problem to solve creatively, i.e. turned into fun for her, whilst still appearing enthusiastic.

I would also suggest she models enjoyment in learning mathematics. Her performance was interactive, she rarely stood at the front of the class for long, and I had trouble tracking her rapid circling of the class with the camera, although this activity may be part of her performance under observation. It is evident from video that her style is dramatic, highly active and full of gesture, for example her directions to the students are often physical e.g. '*swish it all up'* for collect your papers together, accompanied by a wide sweeping gesture. Perhaps overly so, as she acknowledged

when asked about these gestures; '*I was just being silly*.' She used many overt noises such as "*Wooo!*" and "*Oooh...swearing? No!*" And had a strong appreciation of absurdity, "*We have a bit of a giggle and we get on with it and we get the work done which is always good."* She made use of comic pauses and punch lines and attached emotive language to objects e.g. "nice worksheet". Overall, it felt to me that she was really enjoying the session, and I would hope the students felt the same. This was an impression supported by her frequent laughter in interview, but also in the classroom. In particular, she found watching herself teaching amusing.

Characteristics and examples from engaging with the ten strands

This section relates the data to the ten strands (Goldin et al., 2011). Examples for Debbie from the first strand of characteristic goal or motivating desire include a desire to meet challenges, to solve practical problems and to be seen by others as creative. Underlying these desires is likely to be a need to choose options that give the highest reward, and to get satisfaction from meeting challenges.

As a result, Debbie's behaviour includes placing heavy emphasis on creating resources; this accent on creativeness was evident both in the interview and in observation, suggesting Debbie invests a lot of emotion into creativity within her teaching. As discussed earlier, she seeks and adds levels of complexity to all aspects of her teaching, seeking challenge in many forms. Identifying with creativity then may act to assign meaning for her. In the observed session she was using Tarsia puzzles, and she mentioned that these have proved successful and hence are associated with positive outcomes. Once the class was engaged in a variety of activities, most contact time was with students doing the puzzles. The meaning construed from using puzzles probably then guides her practice, for example she likes the younger students because they will engage in the puzzles, supporting her self-perception of an engaging happy teacher, whilst to engage in puzzles fits well with part of her meta-level constructed mathematics teacher persona, that mathematics is a game.

This teacher is very expressive, both as an individual and in social interaction. The wealth of examples of this has significantly influenced my identification and interpretation of Debbie's motivating desires. Examining Debbie's beliefs and values can act to summarise her characteristics and longer term orientations. In terms of mathematics and education, she may feel that you get most reward from sharing and communicating mathematics with others. Within her role as a teacher, she values working hard, especially perseverance and focus, and that being different is strategically rewarding. I would suggest Debbie feels that children learn mathematics through their teacher modelling engagement, fun and activity and through the teacher enacting the satisfaction accruing to successfully meeting challenges.

Goldin et al. (2011)'s 'engagement structures' in the case of Debbie

This section will consider each ES, as discussed by Goldin et al. (2011), for the case of Debbie. '*Don't disrespect me*' is constructed around defensive responses to perceived threat which does not dominate in this data example. The ESs of '*Stay out of trouble'*, '*Pseudo-engagement*' and '*It's not fair*' do not figure strongly either, although they can be drawn upon. Rather than see mathematics as a series of tricks, Debbie is more likely to see tricks as challenges, both in mathematics and in the communication of them, and that she seeks them out rather than being characteristic of '*Staying out of trouble*'. I also feel that she is deeply engaged in teaching, so, even though she 'dances' in class, which could be effective in portraying '*Pseudo-engage-*

ment', this is not the case as she often talks about time and commitment. If '*It's not fair*' was a primary ES for this teacher, then I suggest that equality would be more apparent in her teaching and in her discussion of her relationship with students. The ESs discussed so far are those which, from a teacher position, are less supportive of learning.

There are necessarily elements from '*Get the job done'*, for example meeting the requirements of curriculum, and professional scheduling obligations for any teacher in the UK or elsewhere. For Debbie this ES may include enlisting the support of students in completing tasks, as she expresses satisfaction for compliance in her interview, but her articulated philosophy of mathematics does not view mathematics as procedural and rule following, a belief strongly associated with this ES.

The ES '*Look how smart I am'* incorporates belief in innate ability and high self-efficacy. She is indeed confident in her own ability, and aware that successful teaching is effective in increasing her self-regard. Her adoption of the teacher as a performer style may indicate that she derives satisfaction from achievement. However an ES that appears to be more often applicable is *'check this out'*, as this ES is more communicative, an ES evolving and forming a belief in the inherent interest of mathematics, and I would suggest she often aligns, especially by modelling, with perceived reward coming from completion of a problem or conscientiousness. This 'payoff' also appears for her motivations within her career story.

Yet there are two ESs that I think apply more often and more completely to Debbie, *'Let me teach you'*, which I expect to find as common to all my participants, but also *'I'm really into this'*. This ES is similar to *'Check this out'*, but the reward is more intrinsic. She gets a 'buzz' from representing mathematics creatively to her students and from problem solving for its own sake. For Debbie, the reward is enhanced when her students verbalise their engagement both with the effort she puts in for them and with the devised resource. The value given to problem solving and creativity is deep, to the degree that she seeks complexity and new levels of problems to solve. I would suggest she is occasionally in flow whilst teaching. For example she commented that she forgot that she was being observed. The bigger the challenge the more I feel she relishes it, but I consider this applies more to being a mathematics teacher rather than for the challenges of the subject. I think this ES is both indicative of, and forms a strong alignment of her different identities since in observation she frequently modelled to her students that '*I'm really into this'*.

Discussion

There are several directions that analysing teacher data in this way can take within this PhD research, for example exploring how the balance of the strands as a means of constructing ESs may differ for teachers. In this case, as Debbie is relatively new to teaching, she may put more weight on 'in-the-moment' than on her beliefs, which are still being established in terms of mathematics teaching. I would also suggest that meta-affect and self-talk are stronger for teachers and they may attach more meanings to their feelings than a youngster, possibly through reflection which develops with experience, and to be more comfortable with alternative strategies. The third strand on characteristic affective pathways is also an area for potential future exploration, Goldin (2000) gives examples for students, with paths through frustration, anxiety and even despair when problem solving in mathematics, but I would suggest teachers experience similar pathways when actively teaching mathematics, for example a pathway of understanding through bewilderment to satisfaction.

Overall, I feel that the interconnectivity of the model, whilst still being able to focus on one component, is valuable for the process of analysis. This is despite the practical difficulty of dealing with innumerable overlaps between the strands and ESs. Using the ES model might reveal what affectively drives a teacher and their teaching. In Debbie's case I expected to see the ES of '*Let me teach you'*, but not how well '*I'm really into this'* applies in her case. One latent purpose of attempting to establish ESs for teachers is to explore how dominating ESs either enables or restricts the available ESs for students. I would cautiously suggest that for Debbie, her dominating ES has the potential to block the more negative and egotistical ESs for students.

The characteristics of the ten strands underlying ESs are generic, which may support the adoption of the ES model from students to teachers, yet there remains a concern that the additional complexity of a teacher role, for example the added dimension of a differentiated power relationship, acts to prohibit a teacher from being emotionally engaged or disaffected in the same way as a student. This restricts the options and implies that new ES may emerge as the research develops.

To conclude, this analysis confirms earlier findings (Lake & Nardi, 2014) that there is likely to be a predominant ES for each teacher; one that dominates within the data sample. However, one purpose of the analysis is to draw out the emotional attachment a teacher feels to the subject and how that affects their teaching. So I tentatively suggest that ESs have possibilities for accessing and modelling mathematics within an affective domain. I also think ESs have potential for becoming a unified tool, one which enables a deeper understanding of the interplay between teacher and student emotions; a means of accessing the complex teacher emotions.

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