SHIFTS IN LANGUAGE, CULTURE AND PARADIGM: THE SUPERVISION AND TEACHING OF GRADUATE STUDENTS IN MATHEMATICS EDUCATION

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The case of a student who embarks on study for a Masters or a doctorate in mathematics education in a language other than their first, from a non-Western background and in a discipline other than that of their undergraduate studies is quite common. This student often needs a broadened understanding on how to read, converse, write and conduct research in largely unfamiliar ways. The intervention into the practices of post-graduate teaching and supervision that I describe here aim at fostering this broadened understanding and thus facilitating students' participation in the practices of the mathematics education research community. Here I exemplify the intervention through a brief discussion of an activity series designed to facilitate incoming students' engagement with the mathematics education research literature.

INTRODUCTION

In today's global and highly mobile educational community students arrive at their graduate studies often from different linguistic, cultural, pedagogical and scientific backgrounds. The case of an international student who embarks on study for a Masters or a doctorate in a language other than their first, from a non-Western background and in a discipline other than that of their undergraduate studies is quite common. This student needs a broadened understanding on how to read, converse, write and conduct research in academic environments that are unfamiliar in many ways.

The educational research literature has described this unfamiliarity as a key aspect of the post-graduate student learning experience; and the overcoming of this unfamiliarity as a key issue that the teaching and supervision of post-graduate students needs to address. The intervention into the teaching and learning practices of post-graduate teaching and supervision that I describe in this paper aims exactly at that: to facilitate students' gaining of aforementioned broadened understanding and thus facilitate their transition to post-graduate studies. In doing so I take cue from research in this area – some of which I summarise later in the paper – that calls for a reconceptualization of the Higher Education curriculum, pedagogy and assessment on this matter and focus this small-scale trial, itself part of a plan for a larger study, on aspects of pedagogy.

Mathematics education, the discipline of my immediate expertise and the discipline within which the activity sets of the trial will be carried out, is a suitable Example Case discipline: mathematics education postgraduate students, especially those engaged in university-level mathematics education research, are likely to come from a background in mathematics. The shift from a Science to a Social Sciences milieu for these students is typically a very pronounced part of their transitional experience.

THE TRANSITION TO GRADUATE STUDIES: AIMS AND PRINCIPLES

Research into the challenges of the transition from undergraduate to postgraduate studies has been growing rapidly in recent years, often in connection with the move 'from elite to mass higher education' (Sharpham, 1993) or the 'widening participation' agenda that has been driving developments within Higher Education (HE) in several countries (e.g. http://www.hefce.ac.uk/whatwedo/wp/ in the UK).

Often this research includes direct, self-reporting studies of students' perceived needs and perceptions of effective supervisory practices (e.g. Egan, Stockley, Brouwer, Tripp & Stechyson, 2009; Pyhalto, Stubb & Lonka, 2009). Alongside a plethora of supervisory practice guides, much of this research tends to focus on generic issues. These include: interpersonal aspects of the relationship between supervisor and supervisee, accessibility and availability of the supervisor, academic compatibility, time management and expectations, etc. (e.g. Krauss & Ismail, 2010).

Findings concerning generic issues such as that 'especially international students and those in soft[1] disciplines, require a personal and holistic style of supervision' (Egan et al, 2009, p.337) are of utmost significance. However of at least equal gravity is the focus on practices that aim to foster skills and attitudes in postgraduate students which are *epistemologically* specific, namely specific to the discipline – in our case: mathematics education – they are coming into (Boaler, Ball & Even 2003). Attention on these is also part of a longer-term perspective on post-graduate studies as a stepping stone to a career in research (e.g. Shacham & Od-Cohen, 2009).

The project I describe in this paper aims to make a contribution in these respects (epistemologically specific, long-term) and builds on a relatively small body of work in this area – aptly summarised in (Boaler et al., 2003) and evident in several chapters in (Sierpinska & Kilpatrick, 1998; most explicitly in the chapter by Gione, p. 117 - 127). In what follows I outline the theoretical foundations on which the project is built.

Engaged pedagogy. As Pyhalto et al. (2009) identified there is 'an urgent need for more effective means of fostering PhD students' experience of active agency within scholarly communities' (p221). Much in the spirit of Gunzenhauser and Gerstl-Pepin (2006), the teaching and supervision practices trialled in this project reflect the prioritising of 'an engaged pedagogy, which represents a shift in emphasis from instrumental training in research methods to an approach in which students develop appreciation for complex possibilities' (p.319).

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[1] The authors include in this term the social sciences, of which mathematics education is widely perceived to be one. I acknowledge that this assumption is not universal; in fact it is a culturally dependent assumption. For example, in continental Europe, chairs in didactics of mathematics are usually located in science faculties, often alongside those in applied or pure mathematics. However, regardless of whether mathematics education research is carried out by researchers whose affiliation is in a mathematics, an education or another department, the epistemological differences between the two fields are profound. For extended accounts of these see, for example, (Sierpinska & Kilpatrick, 1998, Part VI, p. 445-548) and (Nardi, 2008, Chapter 8, p. 257-292).

Cultural sensitivity. Particularly for those whose background was shaped away from where much of the educational research dominating the publication venues was conducted in (e.g. graduate students of non-Western backgrounds), they, 'valued as knowing subjects, may enrich their investigations of educational problems and questions with epistemologies and theoretical perspectives that value their individual identities' (p.319) and inform their emergent research plans. Away from a 'dominant discourse' that 'appears to centre on what universities do to fit international students into their existing cultures' (Turner and Robson 2008, p. 70), the project I describe in this paper aims to contribute to what the 2007 UK Higher Education Academy Report (Caruana and Spurling, p. 64) outlines as a much needed shift from merely 'awareness of difference' to 'valuing difference' and integrating this valuing into pedagogical practice in substantive ways – in other words the shift from 'symbolic' to 'transformative' internationalization (ibid. p. 126).

Independence, creativity and critical thinking. These are often described (e.g. Adler & Adler, 2005) as marks of the emerging membership to the scholarly community: decisions on what to focus on, the move from appropriating to creating knowledge, the growth of an epistemological perspective (for Adler and Adler's sociology students the 'sociological eye', p. 11); the flexibility of moving between immersion into the specificity of one's own research to contributing to abstract theory; and so many other features of what Baker and Pifer (2011) call 'transition to independence' (p. 5).

So far I have set out the foundations of the project as being built around the principles of: engaged pedagogy and participation; cultural sensitivity; and, independence, creativity and critical thinking. The spirit of the intervention is captured well by DeVita and Case (2003, p. 393) who outline the role of the HE teacher as 'helping students construct understandings that are progressively more mature and critical'. They thus propose 'the pursuit of didactic strategies aimed at facilitating processes of self-enquiry, critical reflection, mutual dialogue and questioning' that lead 'to a more participative and student-centred approach' in which students interact 'with the content and with each other' and are thus 'exposed to multiple perspectives and foster cultural understanding'.

Within mathematics education, working towards membership of the scholarly community often implies a rethinking of epistemological beliefs – as evident in the experiences of mathematics educators and university mathematicians engaging with collaborative research (see, for example, (Nardi, 2008: p. 257-292), including a review of literature on this matter). This is even more acutely true for those who arrive in mathematics education postgraduate study from a purely mathematical background. In a nutshell, the area where a shift of epistemological belief often emerges as necessary is towards what has been called in the literature (e.g. Boaler et al., ibid., particularly p. 497-516) a less absolutist, more contextually bound, more relativist and multiplist perspective on what constitutes knowledge (in mathematics education) and how it is constructed and shared.

METHODS AND SAMPLE OF PROJECT ACTIVITY

The intervention in the teaching and supervisory practices I describe in this paper is designed, and will be implemented and evaluated, in collaboration with post-graduate students in my institution. I will do so in consultation with the relevant literature and through drawing on personal and professional experience that I have accumulated over 20 years of my own post-graduate studies and post-graduate supervision and teaching.

Key to this intervention is also my ongoing work with colleagues from my institution, whose own background (mathematics, international), similarly to mine, is a valuable resource to this initiative. Involving colleagues is crucial also in that the ways in which supervisors work with students is naturally filtered through their own interpretations of these activities – and, of how these activities can be tailored to address their students' specific needs. At the moment – for example, in the instances exemplified in this paper – the involvement of other supervisors is informal but a more systematic participation is envisaged for the larger study.

Furthermore, since the inception of the Research in Mathematics Education Group at UEA in 2003, the post-graduate student cohorts (on the Masters and doctoral programmes) have been steadily informing the formation of the practices and activities trialled in this project and exemplified in this paper. For example, of the 13 completed/current doctoral students of the Group, five come from a mathematics background (hold undergraduate degrees in mathematics) and 9 are non-UK students (EU: 2; non-EU: 7).

The intervention has been designed in the spirit of developmental research (e.g. Sierpinska & Kilpatrick, ibib., chapter by Gravemeijer: p. 277-295). Sets of activities will be trialled in the course of the current academic year's post-graduate teaching and supervision. These aim to address key issues of the transition to post-graduate studies that I have observed as seminal over several years of experience. Realistically this small-scale intervention can only address some of these key issues. I will fine-tune the list of issues to be addressed with further reading of the relevant literature and through a small number of interviews with colleagues of analogous experience. I aim to carry out interviews with six HE teachers with substantial experience in post-graduate teaching and supervision (at UEA and elsewhere).

The activity sets will address issues germane to the following three areas:

- *Engaging with Research Literature*
- *Forming the Conceptual/Theoretical Framework of a Research Project*
- *Choosing and Applying Data Analysis Methods*.

Data collected during the implementation and evaluation of the activities will aim to:

- Describe and analyse the students' participation in the activities.
- Explore how subsequent versions of the activities can be amended to address students' needs more precisely and effectively.

The activity sets will be trialled and evaluated with new cohorts of Masters and doctoral level students. These activities will be fine-tuned versions of activities I already deploy – see example in Fig.1. I note that the treatment of issues germane to the clearly different needs of different groups of students (Masters and doctoral; British and international; mathematics and other backgrounds; with varying teaching or other professional experience) cannot be conflated into one single investigation. However, the profile of most participating students is such that a concurrent consideration of issues is often necessary, even potent. Any consideration of student data will be alert to this variation of student profile and this variation of issues.

I will trial these sets of activities during sessions of group and individual tutorials. The execution of the activities will be reported in field-notes produced by a collaborating doctoral student (not participating in the observed session) or me (drafted during the session and finalised immediately after).

Evaluation of the trialled activities will take place through student questionnaires and interviews. The number of students who will participate in the trials in 2012-13 is expected to be around 8 (at either Masters or doctoral level). This participation will be subsumed in the normal provision to the students. However their consent will be sought for their permission to be observed by a doctoral student during the sessions (and, where appropriate, audio-recorded). Their participation in the evaluation phase will be on a volunteering basis. Anonymity will be kept throughout, e.g. through anonymised questionnaire responses and interviews not conducted by myself but by suitably trained doctoral students. Ethical approval of the project will be sought from my institution's Ethics Committee.

An Example Activity: *Engaging with Mathematics Education Research Literature*

A post-graduate international student in mathematics education – or a student with a background in the *sciences* who arrives in the UK in order to complete post-graduate studies in the *social sciences* – is tasked with formidable challenges. Apart from carrying out their studies in a different language and learning the terminology of the field they are entering, this student faces novelty on several grounds. They would be required, for instance, to read the social sciences research literature that: is often *lengthier* than the research literature in the sciences; often uses a breadth of related, subtly *different but not equivalent terms* to describe similar phenomena; and, is typically rather more *open to multiple interpretations* than the bulk of scientific texts they are accustomed to.

This student is expected to identify, read, reflect upon, converse and write about this literature, often in a matter of months. In Figure 1 I sample some activities that I currently invite my Masters and doctoral students to participate in during the early months of their arrival. I then outline the empirical origins and rationale for each activity – in resonance with the observations on the type and scope of reading and writing that Boaler et al (ibid, particularly those on p.497-499 and p.512-513) highlight as pertinent in the transition to post-graduate studies in mathematics education.

The activities aim to facilitate incoming post-graduate mathematics education students' ***Engaging with Research Literature*** particularly in relation to:

- Searching: identifying relevant research literature
- Reading: critical reading of research literature
- Writing: reviewing research literature
- Conversing: presenting and discussing research literature

Of importance in the **outline of activities** below is to encourage students to draw upon the knowledge and experience they acquired in their own educational and cultural background and relate those to the reading of the novel research literature.

1. In an early session, **discussion of** various ***types*** **of publications** (such as books, journal papers, reports, policy documents) and of their ***status*** **in research writing**. A significant part of this discussion is on the ways in which literature from the students' own educational and cultural context (often not published in English) relates to the (often English-dominated) literature that they are expected to engage with.

2. In the sessions that follow, the students are asked to prepare as follows:

a) **Read** pre-specified texts, typically book chapters or journal papers.

b) Produce/identify a piece of **writing** that illustrates how they relate their reading for the session with what they have read or experienced before. This can be a publication from their own cultural and educational context, a short account of a mathematics teaching or learning experience that relates to the theme of the session.

This is their ***Short Contribution I***.

c) **Identify a journal paper** that matches the theme of the session from a particular journal, typically a leading journal in the field (such as *Educational Studies in Mathematics*).

d) Write a short account of their chosen paper that provides

- a summary of the paper,
- their views on the paper, and,
- how (if at all) the paper relates to their own research interests and plans.

This is their ***Short Contribution II***.

3. In ensuing weeks the **range of sources** that the students are asked to draw on **broadens** (from one to several pre-specified journals, then non-pre-specified)

4. Short *Contributions I* and *II* are presented briefly during the session.

5. Brief **presentations** are accompanied by **discussion** with the group.

Fig.1 **Example Activity Series on *Engaging with Research Literature***

Justifying Activities 1-5: *Empirical origins and rationale*

1. Discussion of *types* of publications and their *status* in research writing.

The early sessions of the MA in Mathematics Education are partly dedicated to what we call *The world of mathematics education research*. In these, types of mathematics education publications are discussed in terms of intended readership and distinguished as *academic* (e.g. a paper in *Educational Studies in Mathematics;* a peer-reviewed, research-based monograph/edited book/book chapter; a *PME Research Report* etc.), *professional* (e.g. a paper in *Mathematics* Teaching, the official journal of UK's ATM, Association of Teachers of Mathematics) and *policy related* (e.g. a government-commissioned report such as the UK's *Smith Report* on post-14 mathematics of 2004). Students are encouraged to consider this distinction in terms of the type of publication they are familiar with. Mathematics graduates appear to be more familiar with undergraduate mathematics textbooks and, mildly, with publications in mathematics journals. Many overseas students typically put forward influential governmental reports as examples of what they perceive a publication in mathematics education to be. All along, the students are asked to offer counterpart information about analogous or equivalent activity from within their own backgrounds.

The discussion is interspersed with sharing information about key conferences and symposia in mathematics education, national and international, and a brief historical account all the way back to 1908 and the establishment of ICMI. Through this discussion the students are invited to perceive the launch of their mathematics education post-graduate studies as inauguration into the scholarly community of mathematics education. I note that these sessions are also attended by incoming doctoral students who are expected to already hold a Masters qualification in (Mathematics) Education. The experience of these students, typically small but non-negligible, operates as a helpful bridge in these early discussions.

2. Reading pre-specified text and identify two related texts (insider, outsider)

As we launch into the thematic sessions of the MA programme, preparation for each session tends to be highly regimented (2a) but in tandem with the expectations that:

- the reading is embedded into own prior readings and experiences (2b, 'insider');
- the reading will be enriched with further readings (2c, 'outsider'); and,
- a rationale will be put forward for the choice of this further reading (2d).

(2b) and (2d) require of students to produce a small piece of writing for each session. Intertwined with the students' inauguration into the world of mathematics education research, these exercises aim to foster the perception that writing is paramount; and, acquiring the skill to write with the rigour and sophistication expected at this level is feasible through constant and regular practice. This applies equally to the mathematics graduates on the course (who may not have written in this 'genre' for a long time) and the non-UK students (who are of course writing in a language other than their own).

An example

The module *Introduction to Research in Mathematics Education*, attended by MA in Mathematics Education students as well as Year 1 doctoral students includes five sessions on key theoretical constructs used in mathematics education research. Two sessions are on developmental / cognitive approaches; and, three are on sociocultural, discursive and anthropological approaches). In the first of the sessions dedicated to developmental / cognitive approaches in (2a) the students were expected to read two seminal papers: Richard Skemp's 1976 *Mathematics Teaching* article on *Instrumental and Relational Understanding* and David Tall and Shlomo Vinner's 1981 *ESM* paper on *Concept image - Concept definition.* In (2b) one student, a recent mathematics graduate from Turkey, wrote a short account in which she recollected her first encounter with the concept of limit. As part of (2c) she brought along a *PME Research Report* on the use of the *Concept-image, concept definition* construct to explore Turkish students' understanding of limits. And, in (2d) she commented on the use of the construct in her paper of choice and related this to her own emerging research plans for her dissertation.

Within (2a) the students are asked to read two texts (Skemp's and Tall & Vinner's) that appeared at a time when mathematics education was at a turning point of its growth into an academic discipline – research was largely influenced by educational and cognitive psychology and PME was being founded. Within (2c) the students are asked to identify research texts, from that era or thereafter, that report research which deploys these theoretical constructs. They are thus encouraged to find out the *scope* and *impact* of these works in the field.

3. Broadening the range of sources

As the thematic sessions of the MA programme continue to unfold, the instructions for preparing for (2b) and (2d) gradually broaden and relax. In order to facilitate, and accelerate, the students' familiarisation with key publication venues in the field, initially they are asked to prepare for (2d)

- through searching for journal papers in *Educational Studies in Mathematics*;
- then, in a few more journals (*Journal for Research in Mathematics Education*, *Journal of Mathematical Behaviour*, *For the Learning of Mathematics*);
- then, a list of about ten international, peer-reviewed journals held in the UEA library. By the end of the module the list has opened up to include practically most peer-reviewed published work in mathematics education research.

The rationale for the **presentations within (4)** (for non-UK students it is perfectly acceptable that, at least to start with, this can consist of reading out to the group their *Short Contributions*) and the **discussion within (5)** is analogous. These activities aim to foster an understanding of how paramount these ways of engagement are and how regular participation in these practices can facilitate the acquisition of presentation and discussion skills.

PROJECT PROSPECTS AND FURTHER WORK

As much of the research in this area suggests (e.g. Pole, 1997; Boaler et al., ibid; Gione, ibid), there are issues in the training of graduate student supervisors and teachers that call for systematic investigation – what Boaler et al. identify as the search for an appropriate 'research curriculum' (p.518). These issues also call for dissemination of any insight into effective practice that this investigation generates. To this purpose, as colleagues and I have practised before – and apart from the publicising of the project findings in the usual academic outlets – the dissemination plan for the project includes an appropriately designed booklet and presentations of it in established higher education teaching and learning events and mathematics education conferences. Specifically, the booklet, which will be available in print and electronically, will consist of: a description of the designed activity sets; a rationale for the designed activities (grounded on relevant literature, the HE teacher interview data, prior trials of the activities); an account of the activity set trials, drawing on the observations, and researcher reflection as well as sampling student work and contributions; an account of the evaluation data, drawing on the session observations, and student questionnaires and interviews; and, recommendations for future trials, an outline of the larger study and, more generally, future interventions in this area.

As the bulk of my supervisory and teaching experience is in the discipline of research in mathematics education, this is the Example Case discipline of the intervention. I note however that the experiences and needs of students in this area are not untypical or substantially different to those of students in other areas, particularly those in transition from a science to a social sciences paradigm. I therefore see the potential of the project as transcending the disciplinary boundaries of mathematics education. I see this small-scale intervention as a precursor to a larger, longitudinal study that will include other institutions, involve a larger number of colleagues and extend the scope and range of the activity sets. The larger study will also allow the trial of the activities in several modification-and-improvement cycles.

I also note that the shifts that this project explores – shifts in language, culture and paradigm, central in the transition to post-graduate studies in mathematics education – might also occur during the transition from school to university mathematics (in analogous, not identical ways). The conceptual and methodological frameworks of the project may thus contribute to work on this transition too.

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