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Chapter 12. Eliminating the fear of getting 'caught out': An examination of the development of out-of-field mathematics teachers' professional self-understanding

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Abstract Research has demonstrated that teacher identity matters in mathematics education. This is of heightened concern when we consider those teaching mathematics out-of-field, a phenomenon prevalent at the post-primary level in the Irish context. A national program (PDMT) to upskill out-of-field teachers was established and current research is appraising graduates' experiences. In this chapter we bring together out-of-field teachers' knowledge and identities, using Kelchtermans' (2009) concept of *professional self-understanding*, which is an essential part of a teacher's personal interpretive framework and acts as a lens through which teachers view their job, give meaning to it and act in it. We report on aspects of an online, primarily quantitative, survey administered to graduates of the PDMT examining their professional self-understandings on completion of the program. The findings contribute to our understanding of important considerations relating to the development of professional learning programs for upskilling out-of-field mathematics teachers.

Keywords commitment, job satisfaction, mathematics, professional self-understanding, self-efficacy

12.1 Introduction

There is a rich research literature examining the professional learning needs of teachers of mathematics at all levels of education. However, examination of the distinctive needs and experiences of those who teach mathematics out of field – without formal qualifications in the subject content or pedagogy – is still an emerging field of research. Out-of-field teaching of mathematics is prevalent in post-primary education in the Irish context and occurs when teachers are assigned to teach mathematics without meeting the Teaching Council of Ireland's subject registration criteria for mathematics (Teaching Council, 2013). Criteria currently consist of a degree level qualification, a third of which must consist of studies in mathematics, with specific credit requirements in analysis, algebra, geometry, probability and statistics and some additional optional topics. A national professional development (PD) programme to upskill out-of-field teachers was established and current research is appraising graduates' experiences.

The Professional Diploma in Mathematics for Teaching (PDMT) is a two-year, part-time, nationally delivered program, which is fully funded by the Department of Education and Skills. A key aim of the programme is to develop out-of-field mathematics teachers' knowledge of content (60 ECTs of program credits) and pedagogical approaches (15 ECTs of the program credits) (Ní Ríordáin et al., 2017), as well as teacher reflection, beliefs and practices, as aligned with mathematics subject specifications at post-primary education in Ireland (Goos et al., 2020b*;* Lane & Ní Ríordáin, 2020). However, research examining the effectiveness of such PD programs for out-of-field teachers is scant (Faulkner et al., 2019). Accordingly, the aim of this chapter is to add to the current literature on PD relating to out-of-field

mathematics teachers and to build on existing research examining the PDMT and its impact.

Typically, professional development programmes for out-of-field teachers of mathematics focus on developing subject matter knowledge and pedagogical content knowledge – two kinds of knowledge that Ball et al. (2008) combined into the single concept of Mathematical Knowledge for Teaching (MKT). However, teaching out-of-field involves more than mastering the content to be taught; it also entails developing a new professional identity, giving a sense of alignment with the community of mathematics teachers. Although the concepts of teacher knowledge and teacher identity are informed by different theoretical perspectives, knowledge and identity need to be intertwined when considering the development of out-of-field teachers (Goos et al., 2020a).

Our research into the PDMT brings together out-of-field teachers' knowledge and identities, using Kelchtermans' (2009) concept of *professional self-understanding*. Self-understanding is both a product, that is one's view of one's self at a particular moment in time, and an ongoing process of sense-making through which one interprets one's experiences. Professional self-understanding is an essential part of a teacher's personal interpretive framework – a set of cognitions and mental representations that act as a lens through which teachers view their job, give meaning to it and act in it. In this chapter we report on aspects of an online, primarily quantitative, survey administered to graduates of the PDMT to address the following research question: *What professional self-understandings are held by formerly out-of-field teachers of mathematics who have completed an upskilling programme that confers in-field status?*

The dimensions of identity of interest to us in this study are job satisfaction (Caprara et al., 2003), commitment to mathematics teaching (Meyer et al., 1993) and self-efficacy regarding teaching mathematics (Tschannen-Moran & Woolfolk, 2001). In addition, in the first phase of examining the impact of the PDMT, it was found that out-of-field teachers displayed low levels of proficiency with curriculum-aligned mathematical content and high rates of conceptual errors, which can accordingly impact on practices in the classroom and student learning (Ní Ríordáin et al., 2017). Given the major focus of the PDMT on developing teachers' mathematical knowledge for teaching, we are interested in evaluating participants' perceptions of the extent to which the programme prepared them to effectively teach the mathematical content of the post-primary mathematics curriculum, which in turn can impact on their self-efficacy (Carney et al., 2016).

12.2 Literature review

Teacher identity is a viable analytic tool for educational research given that it serves to represent teachers' psychological experiences and social behaviours (Sfard & Prusak, 2005). It is particularly suited to the study of teacher development as identity is situated at the nexus of learning and the socio-cultural context. However, the notion of identity is complex and keenly contested due to the great variety

of perspectives on the concept. In educational research, studies on identity have drawn on conceptions from the fields of psychology, sociology, cultural studies and anthropology (Sfard & Prusak, 2005). Each of these fields of study provides their own understanding of what identity is and how it should be researched.

Graven and Lerman (2014) argue that mathematics education researchers should be explicit about their use of the term 'identity', the sources that have shaped their perspectives on identity, and the pertinence of their work with identity with regard to the teaching and learning of mathematics. This would avoid the problem, identified by Darragh (2016), of researchers collecting inappropriate data and drawing conclusions that are inconsistent with the view of identity they have espoused.

In this study, our perspective on identity follows the theorisation of Holland et al. (1998) on identities and the processes of identification. Building on the work of Mikhail Bakhtin and Lev S. Vygotsky, identities are self-understandings produced by and from the experiences of living in, through and around cultural forms practiced in social life (Ibid). Mathematics teaching is an example of one such cultural form practised in social life. Therefore, in this study we are interested in researching the self-understandings of former out-of-field teachers of mathematics who have successfully completed the PDMT programme.

To more firmly anchor our analysis in the context of out-of-field teaching, we draw on the theoretical model of teacher identity development proposed by Hobbs (2013). She argues that out-of-field teachers must negotiate a boundary between their in-field and out-of-field practices and experiences. Successfully negotiating this boundary provides opportunities for identity development, leading to increased knowledge and appreciation of the subject outside their primary area of expertise. Hobbs' Boundary Between Fields theoretical model aims to account for factors that influence these teachers' identity construction. The model has three groups of factors: context, support mechanisms and personal resources. Contextual factors include a school's geographical location, size and design, governance structures, practices and policies. Support mechanisms could be provided by a school or sought out by out-of-field teachers to help them adapt to teaching an unfamiliar subject. Personal resources that teachers can bring to the out-of-field experience include adaptive expertise, knowledge, and dispositions such as confidence and commitment. In terms of the Boundary Between Fields model, we suggest that the PDMT represented a support mechanism sought by out-of-field teachers to strengthen their personal resources.

There are clear parallels between Hobbs' notion of personal resources, which is specific to out-of-field teachers, and Kelchtermans' (2009) more general concept of professional self-understanding as a personal interpretive framework for making sense of one's job. Kelchtermans identified five components of self-understaning: self-image, self-esteem, job motivation, task perception and future perspective. Canrinus et al. (2012) utilised these components as teacher identity indicators in their study of 1,214 Dutch teachers working in secondary education. According to Canrinus et al., the components of self-image and self-esteem are akin to teachers' self-efficacy. For Kelchtermans, the job motivation component refers to the teacher's motives for choosing to become a teacher along with their reasons for staying in teaching or giving it up to pursue a different career. Canrinus et al. couple

this component with occupational commitment in their study on the basis that an increase in the teacher's motivation is related to an increase in commitment to the job while a decrease in the teacher's motivation is associated with a decrease in their level of commitment to teaching. In addition, these researchers espouse that the teacher's job satisfaction contributes to occupational commitment. Therefore, for Canrinus et al., job satisfaction, commitment and self-efficacy collectively provide a tacit representation of the complex concept of teacher identity. Hence, the measures of job satisfaction, commitment to mathematics teaching and self-efficacy were employed in this study to obtain insights into teachers' identities. The existing quantitative identity research supports the use of these dimensions as effective measures (Hanna et al*.,* 2019).

Although many educational research studies have highlighted the importance of teacher identity, few have used quantitative methods to investigate the concept, with no quantitative study undertaken with out-of-field teachers of mathematics. Hanna et al. (2019) suggest that this gap may not be attributable to any conflict between quantitative approaches and epistemological viewpoints on teacher identity, but rather could be explained by the absence of an instrument for measuring teacher identity. In the present study, we do not claim to have used an instrument to measure teacher identity; instead we have operationalised the notion of self-understandings in order to obtain insights into the identities of out-of-field teachers of mathematics.

We have argued that identity is intertwined with knowledge in out-of-field teacher development, and the Boundary Between Fields model of Hobbs (2013) acknowledges the key role of knowledge as a personal resource that shapes out-of-field teachers' identity formation. It is therefore necessary to consider the role of knowledge for teaching mathematics and its significance for the development of out-of-field teachers' professional self-understanding.

Ball et al. (2008) ascertain that MKT is necessary in order for teachers to present mathematics as a coherent, interconnected and logical body of knowledge but also has been found to have a strong influence on how effectively students learn in the mathematics classroom. Accordingly, this has implications for out-of-field teachers of mathematics (Ní Ríordáin et al., 2019). Hobbs (2013) highlighted the negative effective of a lack of SMK on out-of-field teachers' identity due to their inability to engage with more advanced mathematical content in the classroom. This significant challenge has been found to result in more experienced out-of-field teachers relying heavily on PCK to scaffold their limited SMK (Sanders et al*.*, 1993). Ní Ríordáin et al. (2019) outline the need for out-of-field teachers to engage in relevant professional development in order to obtain the necessary PCK and SMK for effective mathematics teaching, a key design characteristic of the PDMT.

When considering the necessity for high levels of MKT we must also think about the quality of instructional design in relation to effective teaching (O'Meara & Faulkner, 2021). Characteristics of effective instructional design, and therefore effective preparation for teaching, include: student engagement in the learning process; providing a platform for students to attempt non-routine tasks; including real world problem solving into lesson plans; encouraging students to explore connections between different topic areas within mathematics; and using approparite manipuldatives to enhance teaching where appropriate (O'Meara & Faulkner, 2021, p.

3). While each of these characteristics has been shown to contribute to effective mathematics teaching, of interest to us is research indicating that each is underpinned by a teacher's self-efficacy, thus highlighting the important role that self-efficacy plays in effective mathematics teaching (Enochs et al., 2000; Bates et al., 2011).

Enochs et al. (2000) defined mathematics teaching self-efficacy as teachers' belief in their ability to teach mathematics effectively. Many studies indicate that there is a direct correlation between teacher self-efficacy and many aspects of teacher effectiveness. Bates et al. (2011) specifically discuss a relationship between teachers' self-efficacy and levels of teacher knowledge, while Czerniak and Schriver (1994) conclude that teachers with low levels of self-efficacy are inclined to use less effective, teacher-led teaching strategies such as reading directly from a textbook. Enochs et al. claim that inquiry and student-centered approaches are favored by highly efficacious teachers. Similarly, Darling-Hammond et al. (2002) ascertained that teachers' self-efficacy "increases when they receive learning opportunities that provide them with additional skills" (p. 297) and concluded that a relationship existed between teacher preparation and teacher effectiveness. Research in the area of out-of-field mathematics teachers' self efficacy is limited. One recently published study in this area set out to examine the self-efficacy of out-of-field teachers of mathematics and their self reported teaching style before and after engaging in mathematics-specific pedagogy workshops (O'Meara & Faulkner, 2021). These workshops were one component of the PDMT being examined in this chapter. Analysis of survey responses from this group of out-of-field teachers showed statistically significant improvements in teachers' self-efficacy after completion of the pedagogy workshops. Additionally participants reported a shift in their teaching style from more teacher-led approaches to more student-centred approaches focusing on student understanding. Therefore, PD programmes which are seeking to improve the teaching and learning of mathematics must be cognisant of the role that teacher self-efficacy can play in this regard and provide opportunities for teachers to enhance their own self-efficacy.

In summary, the design of out-of-field mathematics teacher PD is of immense importance when considering the value of the professional self-understanding concepts of job satisfaction, commitment and self-efficacy, and a strong MKT base, in terms of preparing effective teachers. Countries such as Australia, Germany, Ireland, the United Kingdom, the USA and Indonesia have begun the process of trying to address the needs of out-of-field teachers by providing in-service training specifically for them in their out-of-field discipline area (Price et al., 2019). These PD programmes have been found to vary in size and delivery approaches, however they have many commonalities in terms of what they deem necessary for effective preparation of out-of-field teachers. Faulkner et al. (2019) compiled a framework for effective PD programmes for out-of-field teachers based on the learnings from these programmes. This framework highlights four major components which include content weighted towards PCK; a student-led enquiry approach and a blended learning delivery platform; school based support; and clear programme expectations being set out and voluntary enrolment. Accordingly, out-of-field mathematics teachers cannot be expected to develop personal resources (Hobbs, 2013) or characteristics

relating to professional self-understanding (Kelchtermans, 2009) independently or in isolation; teacher preparation has a significant role to play. We aim to examine this further in relation to the PDMT by examining the professional self-undertsandings held by graduates of the program.

12.3 Methodology

The findings reported in this chapter relate to an anonymous online survey administered to graduates of the PDMT from 2014, 2015, 2016 and 2017. In total, 822 graduates were emailed in November 2018. However, 26 of these emails were void, perhaps due to changing school working context, so the survey was delivered to 796 graduates of the programme. There were 218 valid response received, giving an overall response rate of 27%. The sample consisted of 61% females and 39% males, with 33% of respondents graduating in 2014, 25% in 2015, 26% in 2016 and 13% in 2017 (3% did not respond to this question). A little more than half (57%) were aged 31-40 years, with 20% aged 41-50. The majority (71%) had 6 to 15 years teaching experience, and 70% had 10 years or less experience of teaching mathematics. The focus of the online survey was to examine the perceptions and experiences of graduates on completion of the programme. It contained several key sections, namely, personal and professional background, preparedness for teaching mathematics, beliefs and identity as teachers of mathematics, pedagogical approaches and effectiveness of the PDMT. Generally, the survey was quantitative in nature, with opportunity built in for further explanation/comment at key points which provided qualitative data.

The focus of our analysis is on the development of teacher professional self-understanding. Survey items examined teachers' levels of job satisfaction (Caprara et al., 2003), commitment to mathematics teaching (Meyer et al., 1993), self-efficacy with regard to teaching mathematics (Tschannen-Moran & Woolfolk, 2001), and self-reported preparedness to teach mathematics. Job satisfaction consisted of 5 items and used a six-point scale: strongly disagree (SD), disagree (D), somewhat disagree (SWD), somewhat agree (SWA), agree (A) and strongly agree (SA). The commitment scale consisted of 12 items (6 affective and 6 normative) and used a six-point scale: strongly disagree (SD), disagree (D), somewhat disagree (SWD), somewhat agree (SWA), agree (A) and strongly agree (SA). The self-efficacy scale contained 12 items (4 instructional strategies, 4 classroom management and 4 student engagement) and responses were given on a five-point scale: not at all, a little, a moderate amount, a lot, and a great deal. Teachers self-reported preparedness in relation to teaching curriculum aligned content and used a three-point scale (very well prepared (1), somewhat prepared (2), not well prepared (3)). The curriculum-aligned content was identified from the mathematics subject specification for Junior Certificate (JC) (DES, 2017) and Leaving Certificate (LC) (DES, 2015) in Ireland. In addition, qualitative responses to open-ended questions relating to overall programme experiences were examined.

Analysis was undertaken by examining frequencies of responses to the job satisfaction, commitment and self-efficacy items. The mean and SD are reported in relation to graduates' responses to preparedness for each strand of the mathematics curriculum at JC and LC. Thematic analysis was conducted on the open-ended responses in order to identify and describe patterns within the data (Braun & Clarke, 2006).

12.4 Key findings

12.4.1 Professional self-understanding as teacher identity

Table 12.1 shows responses to the Job Satisfaction and Commitment items included in the survey administered to graduates of the PDMT. Shading is utilised to illustrate the most common responses chosen by participants. The response rate for these items is 73-78%, that is, not every teacher responded to each item. It is evident that most respondents feel strong satisfaction in terms of teaching mathematics and in relation to who they are working with. This is a very positive outcome given that these teachers would have been teaching mathematics out-of-field. We suggest that engaging in a professional development opportunity (i.e., the PDMT) may have supported the teachers in achieving, or at a minimum maintaining, a sense of job satisfaction relating to teaching mathematics. This is important in terms of contributing to a well-functioning school and committing to the profession (Caprara et al., 2003). However, it is worth noting that over one in three respondents somewhat agree or disagree (at various levels) with the statement 'I am fully satisfied with my job', suggesting that although they are satisfied with teaching mathematics and working with colleagues, they do not feel complete job satisfaction. This may in part be attributed to what some referred to in their comments at the end of the survey as the lack of opportunity to teach higher level and senior cycle mathematics and the desire for their qualification to be recognised at a school level. After investing such a significant amount of personal time and commitment into completing the PDMT, Kate conveys some respondents' views in that it "…stretched me. I am proud of my achievement and grateful for the opportunity. I just wish I was teaching LC maths." Some also referred to the continued out-of-field practices in their schools, even on completion of the PDMT: "Disappointed that many schools still engaging in appointing unqualified maths teachers to teach maths with qualified maths teachers appointed to teach other random subjects" (Dave).

In terms of examining commitment, our study focused on affective commitment to the mathematics teaching profession and as an obligation to remain in the teaching profession (normative commitment) in order to help us to understand PDMT graduates' relationship with the mathematics teaching profession (Meyer et al., 1993). Overall, from Table 12.1, it is clear that respondents have a strong desire to remain in the mathematics teaching profession. They possess a strong affective commitment which generally develops when involvement in the profession is a

satisfying experience. We suggest that participating in the PDMT has contributed to these teachers' experiences and in building their sense of affective commitment. For example, John noted in his comments that "Am delighted I was given the opportunity to qualify to teach maths to all second level students. It has opened up new opportunities for me and I can honestly say that I love my work." Given that teachers were provided with the opportunity to develop valuable knowledge and skills, it is arguable that the PDMT has supported them in their practice.

Taking into consideration that teachers completing the PDMT were afforded the opportunity to upskill in a core post-primary subject area and to gain an additional subject for registration with the Teaching Council, we expected normative commitment to develop as a consequence of the resources invested in these teachers. Similarly, the teachers invested a large amount of their own personal resources and time to complete this demanding programme. Given the commitment to upskill, we expected they would develop a sense of obligation to remain in the teaching profession. Participants' responses to the normative commitment items in Table 12.1 demonstrate somewhat of a commitment to the profession but not an overall sense of obligation to remain in the mathematics teaching profession. This is an interesting insight and may be connected to their out-of-field background. Teachers completing the PDMT are registered teachers in other subject areas and mathematics is not a 'first love' in terms of subjects for many of the participants. Some pursue the course for job security purposes and due to pressure from leadership within their schools. As surmised by Annie "It got me what I needed. The piece of paper saying I am a qualified maths teacher. For that I am eternally grateful." This finding suggests a need to examine how we might develop a sense of normative commitment to the mathematics teaching profession within our PDMT programme given the importance of the construct in terms of for example remaining up-to-date with pedagogical developments and approaches in the classroom (Meyer et al., 1993).

Table 12.1: Percentage distribution of PDMT graduates' responses to Job Satisfaction and Commitment Statements

Statement	**SD**	**D**	**SWD**	**SWA**	**A**	**SA**
Job Satisfaction						
I am satisfied with what I achieve when teaching mathematics	1.2	0.6	3.6	14.8	55	24.9
I feel good teaching mathematics	0.6	1.2	1.8	11.8	45.6	39.1
I am happy with the way my colleagues who teach mathematics treat me	0.6	2.4	2.4	8.3	40.2	46.2
I am happy with the way my superiors treat me	2.4	3.0	4.7	14.8	37.3	37.9

I am fully satisfied with my job	4.1	2.4	5.9	22.5	36.7	28.4
Commitment – Affective						
Teaching mathematics is important to my self-image	4.7	8.9	4.7	29.0	31.4	21.3
I regret having entered the mathematics teaching profession	62.7	27.8	1.8	4.1	2.4	1.2
I am proud to be in the mathematics teaching profession	1.2	1.8	0.6	12.4	36.7	47.3
I dislike being a mathematics teacher	68.6	22.5	3.6	5.3	0.0	0.0
I do not identify with the mathematics teaching profession	54.4	30.2	7.1	4.7	1.8	1.8
I am enthusiastic about mathematics teaching	0.0	0.0	1.8	11.2	46.2	40.8
Commitment – Normative						
I believe people who have been trained as mathematics teachers have a responsibility to stay teaching mathematics for a reasonable period of time	11.2	14.8	11.2	22.5	26.0	14.2
I do not feel any obligation to remain teaching mathematics	17.8	20.1	11.2	20.1	20.1	10.7
I feel a responsibility to the mathematics teaching profession to continue in it	15.4	17.2	15.4	18.9	21.9	11.2
Even if it were to my advantage, I do not feel that it would be right to leave mathematics teaching now	17.8	30.2	13.0	14.8	16.6	7.7
I would feel guilty if I left mathematics teaching	26.6	24.9	13.0	15.4	16.0	4.1
I am in mathematics teaching because of a sense of loyalty to it	30.8	26.0	18.9	10.1	11.2	3.0

Table 12.2 shows PDMT graduates' responses to the self-efficacy items included in the survey. Once again, shading is utilised to illustrate the most common responses chosen by participants. The response rate for these items is 56-64% – these items were further on in the survey and it is expected that participants' interest dwindled as they completed the online survey. Responses to these items reflect teachers' beliefs about their ability to cope with tasks and any difficulties that arise in their mathematics teaching context (Tschannen-Moran & Woolfolk Hoy, 2001). Generally, PDMT graduates demonstrate strong self-efficacy in relation to instructional strategies, classroom management and student engagement. In particular, responses to classroom management items demonstrate at least 75% of teachers selecting 'A lot' or 'A great' deal in relation to the relevant statements. Given that these out-of-field teachers have significant teaching experience on entering the PDMT, this may be a factor in their responses to the items, as opposed to it being an outcome of participation in the PDMT.

However, greater knowledge and confidence in their ability to teach mathematics may be a factor in this also. Similarly, participants commonly self-report 'A moderate amount' or 'A lot' to statements relating to instructional strategies in mathematics and student engagement. These findings suggest that the PDMT graduates' self-efficacy is robust on completion of the programme – "I now know when standing in front of students that I am capable of answering their questions. Previously I was nervous that I may be 'caught out'" (Emma). However, it is worth noting that one in five respondents report 'A little' in relation to use of a variety of assessment strategies in mathematics teaching and over one in three feel that they could not or only assist families a little in helping their children do well in mathematics at school. There is also room for improvement in developing self-efficacy in relation to instructional strategies – the majority of graduates chose 'A moderate amount' in relation to the statements. As Liam suggests "I found it really improved my maths base and my general maths ability, but it could have been a lot better in terms of maths teaching strategies for the classroom." Other teachers referred to the need for better connection to the "content that we teach in school". Such insights into graduates' beliefs are valuable in terms of considering how we prepare out-of-field mathematics teachers and how the PDMT might need to be modified.

Table 12.2: Percentage distribution of PDMT graduates' responses to Self-Efficacy Statements

Statement	Not at all	A little	A moderate amount	A lot	A great deal
Self-Efficacy - Instructional Strategies					
To what extent can you use a variety of assessment strategies in your mathematics teaching?	0.0	20.0	40.0	31.7	8.3
To what extent can you provide an alternative explanation or example when students are confused in your mathematics class?	0.0	4.2	28.3	41.7	25.8
To what extent can you craft good questions for your students in your mathematics class?	0.0	11.7	42.5	32.5	13.3
To what extent can you implement alternative strategies in your mathematics classroom?	0.0	11.7	39.2	39.2	10
Self-Efficacy – Classroom Management					
How much can you do to control disruptive behaviour in your mathematics classroom?	0.0	3.3	11.7	40.0	45.0
How much can you do to get students to follow the rules in your mathematics classroom?	0.0	0.0	10.8	51.7	37.5
How much can you do to calm a student who is disruptive or noisy in your mathematics classroom?	0.0	0.8	13.3	54.2	31.7
To what extent can you establish a mathematics classroom management system with each group of students?	3.3	1.7	17.5	45.8	31.7
Self-Efficacy – Student Engagement					

How much can you do to get students to believe they can do well in their mathematics schoolwork?	0.0	2.5	31.7	41.7	24.2
How much can you do to help your students value learning mathematics?	0.0	4.2	28.3	46.7	20.8
How much can you do to motivate students who show low interest in their mathematics schoolwork?	0.0	7.5	35.8	40.0	16.7
How much can you assist families in helping their children do well in mathematics in school?	5.8	30.0	34.2	20.0	10.0

12.4.2 Professional self-understanding as preparedness for teaching mathematical content

As part of the online survey, graduates were asked to respond to how well prepared (very well prepared = 1, somewhat prepared = 2, not well prepared = 3) they felt in relation to teaching post-primary mathematics curricular strands and associated topics. The response rate to these items was from 85-88% (these items appeared earlier in the survey). Table 12.3 provides the mean and SD in relation to graduates' responses for each strand of the mathematics curriculum at Junior (JC) and Leaving Certificate (LC). Overall, respondents feel very well prepared to somewhat prepared to teach mathematics at both Junior and Senior Cycle post-primary education in Ireland – "I feel the biggest impact on my teaching of maths is researching it, reacting to student needs and guiding them to achieve in mathematics" (Niamh). This is a positive outcome of the PDMT given its focus on qualifying these teachers to teach mathematics at post-primary level.

Within strand analysis of topics provides some very useful insights in terms of improving the PDMT. There were several topics that some graduates felt not well prepared to teach, and interestingly this was very much at JC level (where most out-of-field teachers teach). In particular, at least one in four respondents did not feel well prepared to teach topics relating to the JC Unifying Strand – Building Blocks (23%), Representation (22%), Connections (22%), Generalisation and Proof (24%), and Communication (20%). This strand permeates the other four strands at JC and is important for development of students' mathematical thinking and practices. With respect to mathematical content topics, some respondents report being not well prepared to teach JC Geometrical Proof (20%), JC Transformations (16%), LC Complex Numbers (17%), and LC Transformation Geometry and Enlargements (16%). Given the structure of the PDMT and a focus on traditional mathematical content modules, there may be a need to revisit the focus of these modules and how best to support teachers' preparedness to teach across all strands.

Table 12.3: Mean and SD of PDMT graduates' responses to Prepardedness to teach Mathematical Strands (1 = well prepared, 2 = somewhat prepared, 3= not well prepared)

Strand	Mean	SD
JC Statistics & Probability	1.5	0.6
JC Geometry & Trigonometry	1.5	0.6
JC Number	1.5	0.7
JC Algebra & Functions	1.4	0.6
JC Unifying Strand	1.8	0.7
LC Statistics & Probability	1.5	0.6
LC Geometry & Trigonometry	1.6	0.6
LC Number	1.5	0.7
LC Algebra	1.5	0.6
LC Functions & Calculus	1.5	0.6

12.5 Discussion

In this section we discuss our findings in relation to relevant literature in order to address our research question: *What professional self-understandings are held by formerly out-of-field teachers of mathematics who have completed an upskilling programme that confers in-field status?* We operationalised professional self-understanding in terms of teacher identity and knowledge, creating survey items that referred to job satisfaction, commitment to mathematics teaching, self-efficacy with regard to teaching mathematics, and self-reported preparedness to teach mathematical content.

Firstly, in relation to up-skilled mathematics teachers' job satisfaction, our research found strong satisfaction among participants in relation to teaching mathematics and with regards to their school colleagues. This positive finding could be attributed (at least partially) to these former out-of-field mathematics teachers' successful completion of the PDMT and hence their enhanced preparedness to teach mathematics which has been highlighted as important to teachers' self-efficacy (Darling-Hammond et al., 2002). In turn, research has shown that teachers' self-efficacy directly impacts their job satisfaction (Caprara et al., 2003) which provides a reasonable argument for the contribution of the PDMT to graduates' high levels of job satisfaction.

In addition, our findings also highlight that a significant minority – approximately a third of respondents – were not fully satisfied with their job, which would appear to be connected to some PDMT graduates' perceived lack of opportunity to teach advanced mathematics classes despite their significant investment in upskilling. This perceived lack of recognition of their mathematics teaching qualification coupled with some school principals' continued deployment of out-of-field teachers to teach mathematics could be indicative of a mismatch between these

upkilled teachers' goals and values and those of the school and principal. This is supported by Caprara et al.'s (2003) research which found that teachers' job satisfaction is influenced significantly by their perceptions of the principal's behaviour as well as their collective efficacy – the teachers' perceptions as to whether the school can effectively deal with difficulties or issues. Unfortunately, the issue of out-of-field mathematics teaching is an ongoing issue which has not been resolved in some schools, potentially leading to lower levels of job satisfaction for some of the PDMT graduates despite their satisfaction with teaching mathematics. In this way, we argue that the lack of recognition of upskilled mathematics teachers and the ongoing appointment of out-of-field teachers will negatively impact on these former out-of-field teachers' identities as mathematics teachers in terms of their *professional self-understanding* (Kelchtermans, 2009) by diminishing the *meaning* of their qualification and their position in the school.

Secondly, in relation to commitment to the mathematics teaching profession, PDMT graduates reported high levels of *affective* commitment which has been linked in the literature to job satisfaction (Canrinus et al., 2012; Meyer et al., 1993). This was also the case in our study as teachers indicated strong satisfaction with teaching mathematics as well as a strong desire to remain in the mathematics teaching profession with reasonable supposition that participation in the PDMT contributed to both. On the other hand, the PDMT graduates' responses to our survey were more moderate in terms of *normative* commitment to the mathematics teaching profession with no real sense of obligation to the profession. We suggest two possible reasons for these findings. One possibility is that these former out-of-field teachers were already qualified to teach in a chosen subject(s) and as such, mathematics is not the subject they originally entered the teaching profession to teach. Potentially, this could mean some teachers feel a stronger obligation to their original subject, although this was not measured in our study. In addition, for some teachers, participation in the PDMT was 'a means to an end' in terms of obtaining a permanent teaching position as having the additional qualification to teach mathematics was desirable to school leaders and therefore a means of obtaining job security. The second possible reason for the lower normative commitment is that, as discussed, a considerable number of teachers in our study were not fully satisfied with their current jobs due to a perceived lack of opportunity to teach advanced mathematics and ongoing appointments of out-of-field mathematics teachers. Wiener (1992) suggested that normative commitment develops through socialisation experiences that emphasise a sense of obligation to one's employer and/or through receiving benefits (as cited in Meyer et al., 1993). It is logical that the lack of opportunity and ongoing out-of-field appointments may play some role in the lower levels of normative commitment, particularly as research suggests that normative commitment tends to be more entwined with the short-term (Meyer et al., 1993) than affective commitment. Thus, while the majority of respondants in our study expressed a desire to continue teaching mathematics, they may not necessarily have developed a sense of obligation to do so in their current context. It is unclear what, if any, impact this might have on the teachers' longterm identity as mathematics teachers, as *professional self-understanding* as examined in our study can be highly contextualised to a particular moment in time (Kelchtermans, 2009), although both affective and

normative commitment have been found to correlate positively with desirable professional behaviours and behavioural intentions (Meyer et al., 1993).

Thirdly, PDMT graduates generally reported strong self-efficacy in relation to teaching mathematics, with highest levels of self-efficacy demonstrated in relation to classroom management and lowest levels of self-efficacy expressed with regards to assessment strategies and providing familial assistance. The high levels of classroom management self-efficacy are likely linked to the fact that most PDMT participants have considerable teaching experience. Yet, self-efficacy has been described as context specific (Tschannen-Moran & Woolfolk Hoy, 2001) which means that a teacher could be very confident in managing a science class, for example, but may not be as confident managing a mathematics class. As such, the high self-efficacy reported by the PDMT graduates in this regard could also be influenced to by their enhanced preparedness to teach mathematics. Moreover, the PDMT graduates reported moderate to high self-efficacy with regards to instructional strategies and student engagement which can justifiably be attributed to some extent to their completion of the PDMT. For example, Bates et al. (2011) highlight the relationship between teachers' self-efficacy and levels of teacher knowledge while the positive impact of teacher preparation on teachers' self-efficacy has also been discussed by Darling-Hammond et al. (2002). That is not to say that there is not room for improvement. In particular, some PDMT graduates believed there needed to be greater emphasis on mathematics teaching strategies and a more patent connection between the mathematics content modules of the PDMT and the school curriculum. In addition, self-efficacy was relatively low among some respondents in relation to employing a variety of assessment strategies when teaching mathematics and in providing assistance to families in helping their children to do well in mathematics, so enhancing teachers' self-efficacy with regards to these should also be considered in designing future professional development programmes for out-of-field teachers of mathematics.

Finally, our findings show that PDMT graduates felt generally well prepared to teach mathematics at post-primary level in Ireland. Responses did highlight some differences in the level of preparedness for different topics, especially at Junior Cycle level with at least one in four respondents not feeling well prepared to teach topics relating to the Unifying Strand. One possible reason for this is that recent changes to the mathematics 'specification' at Junior Cycle level, including the introduction of the Unifying Strand, only occurred in the final stages of the PDMT and therefore programme materials would not have referred specifically to this strand. While topics such as representation, connections, generalisation and proof permeated the programme materials, as discussed previously, the PDMT participants do not necessarily recognise connections to the mathematics curriculum (or in this case the 'specification') unless explicitly made. This need for enhanced connection between mathematics content modules and school curriculum content may also explain lower levels of preparedness perceived in some other school topics. Given the links between teacher preparation, teacher self-efficacy and effective teaching (Darling-Hammond et al., 2002), it is essential that out-of-field teachers of mathematics are fully prepared to teach effectively across all strands in future upskilling programmes. This may require revisiting the focus of mathematical content

modules, creating enhanced connections between this content and the school curriculum and/or ultimately enabling these teachers to recognise the connections between university and school mathematics content themselves.

12.6 Conclusion and recommendations

Many out-of-field teachers have been found to experience significant anxiety, stress and feelings of inadequacy arising from their perceived lack of subject matter and pedagogical content knowledge in their out-of-field subject. Professional isolation is therefore a significant concern for out-of-field teachers if they do not have support from school leaders, and especially if those in leadership positions fail to recognise or understand the impact of an out-of-field assignment on teachers' sense of professional 'self'. For teachers, including those teaching out-of-field, 'who I am' is intertwined with 'what I know' and 'what I do', both in the classroom and in the school community more broadly.

The findings from our survey of PDMT graduates, when considered in light of previous research into teacher professional self-understanding (Kelchtermans, 2009) and out-of-field teachers' identity formation (Hobbs, 2013), give rise to three recommendations for consideration by school leaders:

1. Give careful attention to the rationale behind selecting and assigning teachers to classes, prioritising teachers' subject-specific qualifications wherever possible to maximise the number of students who are taught by fully qualified teachers.
2. Encourage teachers who are given out-of-field assignments to participate in professional development aimed at developing subject matter and pedagogical content knowledge in their out-of-field subject.
3. Create a professional environment in which all teachers can learn with and from their colleagues, for example, through peer observation, collaborative planning, or assigning mentors to less experienced teachers.

While there is evidence that upskilling programmes such as the PDMT are effective in improving (formerly) out-of-field teachers' subject and pedagogical knowledge, job satisfaction, commitment and self-efficacy, professional development cannot provide all the support needed by teachers who are crossing boundaries between subject disciplines. School leaders have a vital role to play in establishing practices, policies and support mechanisms that nurture the personal resources that teachers bring to their out-of-field experience.

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