AN EXAMINATION OF THE DEVELOPMENT OF OUT-OF-FIELD MATHEMATICS TEACHERS' PROFESSIONAL SELF-UNDERSTANDING

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The Irish Context

- **Out-of-field teachers:** "Teachers assigned by school administrators to teach subjects which do not match their training or education" (Ingersoll, 2002, p.5).

- A national statistical study in the Irish context revealed that **48% of teachers** teaching mathematics at post-primary education (approx. age 12-18 years) are **out-of-field** and are primarily assigned to the **lower years** and **weaker student groups** (Ní Ríordáin & Hannigan, 2009).

- Accordingly, a two-year part-time **Professional Diploma in Mathematics for Teaching (PDMT)** has been established nationally to **up skill these out-of-field teachers** (commenced in September 2012 – new version of the funded programme in place since January 2021).

The PDMT

Content Requirements: 60 ECTS

Participants complete 10 content modules and must pass a common exam for each.

Content Modules (6 ECTS each)

Module Title	University level
Calculus 1	Year 1
Calculus 2	Year 1
Calculus 3	Year 2
Algebra 1 (Linear Algebra and Geometry)	Year 1
Algebra 2 (Algebra and Number Theory)	Year 1
Geometry	Year 3
Probability	Year 2
Statistics (with inference)	Year 2
Problem solving and mathematical modelling	Year 3
History of Mathematics	Year 3

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The PDMT

Pedagogy Requirements: 15 ECTS

Pedagogical Studies Part 1:
Content-Specific Workshops and Portfolio of Work: 9 ECTS
- Five distinct workshops in subject-specific pedagogical studies,
- Taken concurrently with the associated content module.

Assessment: Portfolio of work, including an action research project and a lesson plan for each of the five content areas.

Pedagogical Studies Part 2:
Summer Institute in Mathematics Teaching and Learning: 6 ECTS
One-week summer Institute in Mathematics Teaching and Learning supporting participants in exploring international trends, current national/international issues, action research and recommended best practice in mathematics education.

Introduction

- 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.

Professional Self-Understanding

- 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 acting in it

Focus of our Study

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).

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).

Survey and Participants

An anonymous online survey was emailed to graduates of the PDMT from 2014, 2015, 2016 and 2017.

In total, 822 graduates were emailed in November 2018 - 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.

Survey

- 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.
- Survey items:
  - Job satisfaction (Caprara *et al.*, 2003), 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 (Meyer, Allen & Smith, 1993) 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 (Tschannen – Moran & Woolfolk, 2001) 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.

Survey

- 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 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).

Findings – Job Satisfaction

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

"…stretched me. I am proud of my achievement and grateful for the opportunity. I just wish I was teaching LC maths." (Kate)

"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).

Statement	SD	D	SWD	SWA	A	SA
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

Statement	SD	D	SWD	SWA	A	SA
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

Findings - Commitment

"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" (John)

"It got me what I needed. The piece of paper saying I am a qualified maths teacher. For that I am eternally grateful." (Annie)

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

Statement	Not at all	A little	A moderate amount	A lot	A great deal
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

Statement	Not at all	A little	A moderate amount	A lot	A great deal
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

Findings – Self-Efficacy

"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).

"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." (Liam)

Preparedness for Teaching Mathematical Content

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

Within strand analysis of topics - 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%).

Conclusion

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.

Conclusion

PDMT graduates felt generally well prepared to teach mathematics at post-primary level in Ireland. Given the links between teacher preparation, teacher self-efficacy and effective teaching (Darling-Hammond *et al.*, 2002; Wilson *et al.*, 2002), it is essential that out-of-field teachers of mathematics are fully prepared to teach effectively

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.