Pre-service mathematics teachers' concerns and beliefs on implementing curricular reform

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In 2010, a major reform of the Irish post-primary mathematics curriculum was introduced. In tandem with this reform, in-service professional development has been made available to all post-primary mathematics teachers, with over 4,000 teachers attending such training (Project Maths Implementation Support Group, 2014). However, as these specialised professional development programmes are presently drawing to a close, newly qualifying mathematics teachers will not have an opportunity to participate in such in-service initiatives. In this research, we investigate the concerns and efficacy beliefs of a cohort of pre-service teachers (PSTs) towards the curriculum reform. 41 PSTs from post-graduate initial teacher education in four third-level institutions in Ireland participated in the research. Preliminary data based on their concerns regarding the reform (Charalambos and Philippou, 2010) and additional qualitative responses are presented in this paper. Findings suggest that at the commencement of their initial teacher education, this group of PSTs are concerned about their knowledge of the reform, have mis-information about the reform, and do not yet show significant concern for the impact of the reform.

INTRODUCTION

In the past two decades there has been wide-scale, international reform of mathematics curricula at primary and post-primary levels (Charalambos & Philippou, 2010). These reforms have often emphasised approaches to teaching and learning which have deviated from the norm and, instead of a didactic tradition of introducing mathematics, now incorporate students' communication of mathematical thinking and incorporate problem solving approaches to mathematics (e.g. Doorman et al., 2007; NCTM, 2000; Reiss & Torner, 2007). With such reform comes a focus on classroom practice and on the integral role of teachers in implementing curriculum innovation (Datnow, 2002).

Teachers' personal theories about learning and teaching influence how they value and implement reform curricula (Manouchehri & Goodman, 1998) and enacting a new curriculum may require a transformation of teachers' ideas on teaching and learning of their subject (Roehrig & Kruse, 2005). Such change inevitably leads to concerns about pedagogical issues such as the reasoning behind a curriculum reform, the implications for their classroom practices, the consequences for their students, and their sense of efficacy in implementing a new curriculum are integral elements of the success of such initiatives. Teachers' perceptions of being involved in any curriculum innovation are therefore integral to the reform process (Senger, 1999) and it is important for policy-makers and educators to have a picture of teachers' concerns and beliefs before and during the implementation of a reform (Fullan & Hargreaves, 1992).

In Ireland, a revised post-primary mathematics curriculum was introduced in 2010 which, as well as incorporating new content, places greater emphasis on problem solving approaches to

teaching and learning (Ni Shuilleabhain, 2014). This curriculum reform constitutes a deviation from the tradition of teaching mathematics in a procedural and didactic way (Lyons et al., 2003), to one which emphasises student communication and collaborative classroom practices. Recognising the importance of teachers' roles in reform, from the introduction of the revised curriculum in-service professional development was offered to all teachers of mathematics in the form of day-long workshops and modular courses (Project Maths Implementation Support Group, 2014). However, as these specialised professional development programmes draw to a close, newly qualifying mathematics teachers will not have an opportunity to participate in such in-service initiatives. Furthermore, pre-service teachers (PSTs) who commenced study for a post-graduate teaching qualification prior to 2015 have no experience of learning this new curriculum, having progressed from second level education prior to the introduction of the new curriculum. Similarly, other PSTs entering such post-graduate courses in future may not have any knowledge or experience of this reform if they are changing career etc.

In this research the authors investigate the concerns and efficacy beliefs of post-graduate PSTs towards the revised curriculum and investigate how these concerns evolve during their initial teacher education. Specifically, in phase 1 of the research project, we investigate:

1. What are the concerns of Irish post-graduate pre-service teachers of Mathematics relative to the revised curriculum at the beginning of their initial teacher education?

2. How efficacious do they feel implementing this reform as pre-service teachers?

THEORETICAL FRAMEWORK

The Concerns Based Adoption Model (CBAM) has been used to describe, measure and explain educational reforms relative to the beliefs and concerns of teachers. Originally based on a hierarchy proposed by Fuller (1969) of self, impact, and task concerns, this model has been expanded to suggest that teachers move through several 'Stages of Concern' when adopting a reform (Hall & Hord, 1987). Charalambos and Philippou (2010) adapted the CBAM model to incorporate teachers' efficacy beliefs about implementing curriculum reform. They wanted to address research which suggested that teachers with high efficacy beliefs were more willing to adopt innovations and more likely to focus on the impact of the reform on student learning (e.g. McKinney et al., 1999). In their adaptation of the CBAM survey instrument, Charalambos and Philippou suggested five factors of concern (see Table 1) which they structured into three levels (p. 13).

Table 1: Five factors of concern (Charalambos & Philippou, 2010)

Factors	Level
Awareness	Level 1
Informational	
Management	Level 2
Consequences on students	Level 3
Refocusing (negative critique)	

They found that the more aware teachers felt about the reform, the more efficacious they reported on using the reform. In addition, they found that teachers' concerns about managing the reform in their classroom and their concerns about the consequences of reform reduced according to how confident teachers were in implementing the reform.

Focusing on teacher beliefs, Luft and Roehrig (2007) investigated the beliefs of pre-service and newly qualified science teachers on implementing reform curricula. Utilising a framework based on teacher interviews (or TBI), Luft and Roehrig categorised participants' beliefs on teaching and learning as: traditional, instructive, transitional, responsive, and reform-based. While this framework does not specifically refer to concerns with regards to curriculum reform, it does provide an additional cross-categorisation of teacher efficacy when analysing their beliefs around teaching and learning of mathematics. 'Traditional' and 'instructive' beliefs are categorised as teacher-focused, where a teacher provides all information in a structured environment or views students as recipients of knowledge. 'Transitional' beliefs refer to those which involve the student, but do not merit the importance of the students' own experiences in the classrooms. 'Responsive' and 'reform-based' teaching refers to beliefs where the student is at the core of all teaching and learning activities. Referring to the initial stages of implementation of the mathematics curriculum reform in Ireland, and with the authors' specific focus on PSTs, the TBI framework provides additional insight into these PSTs' attitudes and beliefs as related to the reform of the post-primary mathematics curriculum.

METHODOLOGY

Students participating in Mathematics Pedagogy modules in post-graduate initial teacher education courses in four third-level institutions across Ireland were invited to take part in the research. A total of 41 PSTs participated in this first phase of the study. Within the initial two weeks (September 2015) of their course, participants were asked to complete a written questionnaire reflecting their concerns and efficacy beliefs regarding the curriculum reform. Completed questionnaires were returned by 97.56% (n = 40) of the participants.

Data Collection Instrument

The adapted CBAM instrument produced by Charalambos and Philippou (2010) was given to participants. The instrument consists of 35 questions focusing on 7 factors: awareness of the reform, information regarding the goals and implementation of the reform, management concerns, consequences for students, refocusing concerns, efficacy beliefs about teaching without the reform, and finally efficacy beliefs about incorporating the reform in teaching. Additional open questions were asked in order to provide students with opportunity to articulate their level of awareness and knowledge of the curriculum reform and respond to any concerns they might have with regards to the implementation of the reform.

Data Analysis

Quantitative data from the questionnaires regarding PSTs' concerns and efficacy beliefs were entered into IBM SPSS Statistics for analysis. Means and standard deviations were used to explore the intensity of the PSTs' concerns and efficacy beliefs while Kendall's coefficient of concordance W (cf. Sheskin, 2003, p. 1093-1108) helped rank teachers' concerns according to their intensity. Due to the non-normal distribution of PSTs responses to the attitudes, questionnaire medians and inter-quartile ranges were used to explore these results.

Analysis of qualitative responses was undertaken utilising the framework of teacher concerns and efficacy as outlined in Charalambos and Philippou's (2010) research. In addition, the TBI framework (Luft & Roehrig, 2007) was utilised in further analysing these PSTs' concerns with regards to the curriculum reform. Results of this mixed-methods approach are reported below.

FINDINGS AND DISCUSSION

Factor scores for each of the seven factors were calculated and the means and standard deviation scores for each are presented in Table 2. The Likert scale used was a 5-point scale and it is evident that the PSTs did not consider themselves overly concerned regarding their level of awareness of the curriculum reform ($\bar{x}$ = 2.55). However, from an informational viewpoint it is clear that the PSTs feel they need more information in relation to the goals and the implementation of the reform within the classroom ($\bar{x}$ = 4.45). While it might be expected that these PSTs would have informational concerns at the beginning of their initial teacher education programmes, the qualitative analysis provides further insight into these concerns (see below) which includes incorrect information regarding the curriculum reform.

While management concerns ($\bar{x}$ = 3.49) and concerns of the consequences of the reform on students ($\bar{x}$ = 3.48) are relatively high, these are much lower than participants' informational concerns. This is likely due to participants' lack of familiarity with teaching and learning in the classroom and their lack of experience in managing student learning in general. The low refocusing concerns are likely also due to these participants' lack of experience in engaging with the revised curriculum. The same may be said for participants' efficacy beliefs around teaching without the reform ($\bar{x}$ = 3.53) and teaching with the reform ($\bar{x}$ = 3.57). These factors will be further investigated as our investigation continues into year 2 of their initial teacher education and into their practices as newly qualified teachers.

Kendall's *W* was calculated to measure the level of consensus among the PSTs in ranking the intensity of their concerns. The result (W = 0.55, p < .000) suggests that there is good agreement among the PSTs in terms of the overall ranking of the concern factors.

Table 2: Mean and Standard Deviation scores for the concerns and efficacy beliefs factors

Factors	Mean[a]	Standard deviation	n
Awareness	2.55	0.77	39
Informational	4.45	0.41	40
Management	3.49	0.38	38
Consequence on students	3.48	0.54	38
Refocusing (negative critique)	3.11	0.47	39
Efficacy beliefs about teaching without using the reform	3.53	0.56	39
Efficacy beliefs about incorporating the reform in teaching	3.57	0.49	39

[a]On a five-point scale (1 = strong disagreement; 5 = strong agreement)

Qualitative analysis provides us with insight into the quantitative data. Responses provided by the PSTs were primarily related to Level 1 concerns: awareness and informational. The majority of PSTs (n = 23) demonstrated a lack of awareness or expressed a personal need for more information.

> *"I'm not aware of much of the changes but it mostly depends on how it is taught and examined. I think a major change did have to be made to the syllabus, but I don't know enough about Project Maths specifically to fully agree with it yet"*

It is worthy of note that some PSTs saw the introduction of the new curriculum as something introduced by third level institutions and private industry to increase the level of skilled graduates. Participants' responses to the question "What do you believe the purposes of introducing Project Maths were?" included beliefs such as:

"Increased participation at higher level. Response to demand from third level institutions and service sector employers for higher-skilled graduates",

and *"to get students into STEM careers."*

Furthermore, a number of PSTs incorrectly considered the introduction of bonus-points (incorporated within the allocation of point scores of students' final assessments in 2012) part of the introduction of the revised curriculum, listing "*25 extra points*" as the changes incorporated as part of the reform. This incorrect information on the reform should be noted by policy-makers and mathematics educators in the design of initial teacher education.

While not all of the commentary was positive, all participants were aware of the reform and the majority (n = 25) articulated a recognition for change in relation to mathematics education in the system.

Differing to the quantitative analysis of Level 2 concerns, none of the participating PSTs expressed management concerns relating to the impact on daily classroom practices in implementing the curriculum. However, as noted above, the absence of emphasis by participants on these concerns is likely influenced by these PSTs lack of classroom experience at this stage of their initial teacher education. It is interesting to note, however, that despite an evolutionary theory of concerns related to reform (van den Berg and Ros, 1999), 18 participants expressed concerns related to the consequences of the reform (Level 3). Investigating these responses further, utilising the TBI framework (Luft & Roehrig, 2007), the majority of these participants (n = 12) demonstrated transitional views representing affective responses towards student-learning, but not incorporating student-centred beliefs around teaching and learning. For example, one participant demonstrated an understanding that the reform was introduced to

"Make maths more interesting for students, increase its relevance, increase higher level maths uptake and integrate the primary and post primary maths."

Only a small number of participants demonstrated responsive views of the reform, valuing the student at the centre of the learning process. This analysis would lead us to believe that these PSTs had not yet fully engaged with the aims and objectives of the reform curriculum and there remain important nuances in the Level 3 concerns expressed by these PST participants.

Summarising the qualitative responses, despite the higher level of concerns expressed, the majority of responses were focused on the implications of the curriculum reform on the summative post-primary assessment, in particular in relation to assessment and the structure of the examination papers. Very few participants referenced students or student learning in their responses and none referenced any impact on classroom practices or students' experiences of learning mathematics.

CONCLUSION

McKinney et al. (1999) suggest that the success of any reform depends on teachers' concerns moving from the personal to impact concerns. In this research, the authors have established a baseline level of concern for these PSTs commencing their post-graduate initial teacher education and can now trace the evolution of their concerns as a longitudinal study over their initial teacher education and as newly qualified teachers. Participating PSTs show high informational concerns with regards to the revised curriculum and demonstrate lack of information or mis-information related to the reform. In their study of the introduction of

adaptive teaching, van den Berg and Ros (1999) found that teachers initially mainly express concerns related to their personal capabilities to implement the proposed changes. Van den Berg and Ros (1999) found that, over time, teachers' concerns become more focused on the classroom implications of the reform both for teacher and for the class of students. In this research, we found that PSTs showed strong personal concerns, equivalent to Level 1 concerns, little management concerns (Level 2), but strong impact concerns (Level 3). While the lack of management concerns might be expected for a cohort with no classroom experience, the high impact concerns of these PSTs is of interest. It is worthy of note, however, that for this cohort of PSTs, these impact concerns are very exam-focused and show little evidence of valuing the learning experiences of the student.

Our findings have implications for mathematics teacher educators who may wish to further emphasise the philosophical underpinnings of curriculum reform for PSTs and focus on the impact on classroom practice (as perhaps contrasting with their own learning experiences) of such reforms. It remains for further investigation how these concerns may evolve over their initial teacher education and, as newly qualified teachers, and how these concerns may manifest in classroom practice.

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