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"We've just lost six weeks of teaching": Mathematics teachers' feedback on CBAs in problem-solving – Investigating the implementation

Neururer, Roisin[a], Ni Shuilleabhain, Aoibhinn[a]
[a] School of Mathematics & Statistics, University College Dublin, Ireland

ABSTRACT

This research investigates post-primary mathematics teachers' concerns and feedback around problem-solving and the associated classroom-based assessment (CBA), following significant curriculum reform. Based on a framework of concerns (Hall et al., 1977), semi-structured interviews were conducted with 16 mathematics teachers from across Ireland, representing a range of teaching experiences and school contexts. Initial findings suggest that many teachers feel constrained in attempting any change to their traditional classroom practice due to a lack of confidence and resources in implementing problem-solving in the classroom. Furthermore, teachers directly associate the concentrated nature of the curriculum content and the associated time pressures to a lack of meaningful engagement with the CBA. Teachers' feedback also emphasises the desire to collaborate with other teachers, both in considering approaches and materials but also in building confidence in their own practice.

KEYWORDS

Problem-solving, teacher concerns, teacher professional development, curriculum reform, classroom-based assessments

CONTACT Roisin Neururer roisin.neururer@ucd.ie

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Introduction

Problem-solving has been increasingly emphasised in recent waves of mathematical curriculum reform, both nationally and internationally. In Ireland this is particularly identifiable in the new Junior Cycle mathematics specification, where one of the two compulsory classroom-based assessments (CBAs) focuses on problem-solving. However, despite the focus on problem-solving in the curriculum documents, a number of studies suggest this is not being effectively translated into classroom practice (Byrne & Prendergast, 2020; Jeffes et al., 2013). Moreover, it seems teachers are experiencing high levels of concern and uncertainty around enacting problem-solving in their classroom. Therefore, despite the curricular emphasis, students may not be experiencing the types of learning environments and activities that build their confidence, knowledge, and skills as problem-solvers.

This research aims to understand post-primary mathematics teachers' perceptions of problem-solving and the associated CBA, and to investigate the nature of their concerns in the context of significant curriculum reform. It asks the question:

> What is the nature of Irish post-primary mathematics teachers concerns with regards to problem-solving and the associated classroom-based assessment following recent curriculum reforms?

Following some background to the research, the theoretical framework underpinning the research is outlined and the methodology and initial findings are presented.

Background to the Research

In recent years significant reforms of the post-primary mathematics curriculum have taken place in Ireland. In line with international trends there has been a greater focus on problem-solving and mathematical literacy. Project Maths, introduced nationally in 2010, aimed to encourage teachers to incorporate a problem-solving approach into their classroom practice. Problem-solving was further emphasised in the revisions to the curriculum at Junior Cycle in 2017. In addition, two classroom-based assessments (CBAs) were introduced. The first of these (CBA1) is a problem-solving task where students must pose their own problem and attempt to solve it. As well explicitly incorporating problem-solving into assessment at Junior Cycle, the CBAs represent a change in students' typical experience of mathematics work and in teachers' roles assessing their students' learning.

To support teachers with enacting these reforms professional development workshops were provided by the PDST (Professional Development Service for Teachers), the public body tasked with the provision of teacher professional development. Following the introduction of Project Maths there were 10 optional day-long workshops offered to all Mathematics teachers over the five-year period from 2010 to 2015. These were organised around the five topic strands and focused on classroom practice. One of these workshops was focused explicitly on problem-solving. Following the revisions at Junior Cycle, teachers were provided with subject specific professional development one day each year, with some of the time focusing on the CBAs. However, the dominant model of professional development in Ireland, usually consisting of "one-off" workshops, does not seem to align with the characteristics of effective professional development (Darling-Hammond et al., 2017) or meet teachers' professional needs with regards to the most-recent reforms (White et al., 2021). There is little evidence that classroom practices, and consequently students' learning experiences, have significantly changed and research indicates that direct instruction remains the dominant mode of teaching (Byrne &

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Prendergast, 2020; Jeffes et al., 2013). A recent study conducted by Berry et al. (2021) suggests that teachers are not comfortable incorporating the problem-solving approaches encouraged by Project Maths in their classrooms and remain unconvinced of their effectiveness when compared to traditional teaching approaches (Berry et al., 2021).
Given that twelve years have passed since Project Maths was introduced into all schools, it is of significant concern that teachers still feel unable to implement many of the promoted teaching approaches. This points to a need to further investigate the nature of teachers' concerns regarding the reform and in order to better support them to enact the principles of Project Maths and support their students with CBA1.

Theoretical Framework – Stages of Concern

The successful enactment of curriculum reform depends on the teachers who will interpret and implement it (Spillane, 1999). However, educational reforms often impose new demands on teachers, aggravating their concerns about their own practice and about their students' learning (Charalambous & Philippou, 2010). These concerns can have a powerful influence on the implementation of reforms (Christou et al., 2004).

Hall et al. (1977) proposed seven "Stages of Concern" (SoC), outlined in Table 1, which teachers experience as they implement a reform.

Table 1. *Stages of concern proposed by Hall et al. (1977)*

	Stages	Teachers…	
0	Awareness	Express little concern about, or involvement with, the reform	Self
1	Informational	Gradually become interested in the reform and seek to learn more about it.	
2	Personal	Focus on their role in enacting the reform, their personal capabilities to implement the reform, as well as on how the change will affect them	
3	Management	Consider the practicalities of implementing the reform.	Task
4	Consequence	Focus their attention on the impact on student learning	Impact
5	Collaboration	Seek to share their experiences and work with colleagues	
6	Refocusing	Begin to consider improvements, or even alternatives, to the reform	

Although distinct, the seven Stages of Concern are not mutually exclusive. It is likely that an individual will hold some degree of concern in several stages at any given time. However, the intensity of these concerns will vary as the implementations of the reform progresses (Hord et al., 2006). These seven stages were later grouped into self, task, and impact concerns. This three-stage framework is widely used in research examining teacher concerns in curriculum reform (see Byrne & Prendergast, 2020; Charalambous & Philippou, 2010; Christou et al., 2004; Conway & Clark, 2003; Johnson et al., 2020).

Studies have indicated a pattern where teachers move through these stages as a reform is introduced, implemented, and becomes established (Tunks & Weller, 2009; van den Berg & Ros, 1999). Tunks and Weller (2009) found that this shift from self, to task, to impact concerns is associated with effective implementation of the reform and is facilitated when teachers are continuously and substantially supported. To support the successful enactment of curriculum reform, it is therefore important to identify and attend to the concerns of teachers.

Recent research found high levels of self and task concerns among mathematics teachers in Ireland following the introduction of Project Maths (Byrne & Prendergast, 2020). The

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introduction of CBAs, and the change they represent in a teachers' role, is likely to further aggravate teacher concerns. While there is a role for professional development to play in alleviating these concerns, we must first gain a deeper understanding of the nature of these concerns and the factors that contribute to them.

Methodology

Since the focus of this research is on understanding teachers' perspectives on and experiences of problem-solving and CBA1, it demanded a qualitative approach. A key feature of qualitative research is that any attempts to understand the phenomena of study are, as much as possible, based on the participants' own perspectives and frame of reference (Elliott et al., 1999; Yin, 2015). Semi-structured interviews with teachers were therefore chosen as the primary data generation tool.

Participants

To ensure a range of perspectives were included, it was necessary to recruit teachers representing a variety of teaching experiences (gender, mathematical background, years of experience) and school contexts (DEIS[1]/non-DEIS, co-educational/single sex, small/large pupil population). To address this issue, a short online survey for potential participants was designed to obtain demographic information about them and their school context. Information about the research, along with a link to the online survey, was shared through emails to mathematics teacher email groups and to teacher organisations (Irish Mathematics Teacher Association groups), as well as posts on social media (Twitter). Teachers interested in taking part were asked to fill out the short online survey. In total, 32 teachers completed the survey. From these, teachers who had not provided contact details, had not carried out CBA1 with their classes, or were unavailable to participate in an interview were removed from consideration for inclusion. The remaining 25 teachers were contacted by email and invited to take part in an interview. 15 teachers agreed to participate in the research and a further participant was recruited through personal contacts to increase the representation of teachers working in DEIS schools.

In total, 16 teachers from 15 different schools were interviewed. Relevant demographic information is outlined in Table 2. Ethical approval was provided through UCD and all teacher names used are pseudonyms. All participants had conducted the CBA1 at least once.

Table 2. *Participant demographics*

Participant	Gender	Years teaching	School Size	Cohort	DEIS	Out-of-field
Kate	F	< 4 years	Large	Co-ed	N	N
Mary	F	> 12 years	Large	Girls	N	Y
Bríd	F	< 4 years	Large	Boys	N	N
Éabha	F	> 12 years	Small	Boys	Y	Y
Aoife	F	> 12 years	Large	Boys	N	N
Dara	M	4 - 7 years	Medium	Co-ed	N	N
Emer	F	< 4 years	Large	Co-ed	N	N
Cian	M	< 4 years	Large	Co-ed	N	N
Ben	M	> 12 years	Medium	Co-ed	N	N
Lucy	F	4 - 7 years	Large	Girls	N	Y

[1] Delivering Equality of opportunity in Schools (DEIS), is a government initiative focused on addressing the educational needs of children and young people from socio-economically disadvantaged communities.

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Cillian	M	< 4 years	Small*	Co-ed	N	N
Ciara	F	> 12 years	Large	Boys	N	N
Liam	M	>12 years	Large	Co-ed	N	Y
Rory	M	7 - 12 years	Large	Boys	N	N
Billy	M	>12 years	Large	Co-ed	Y	N
Deirdre	F	7 - 12 years	Small	Girls**	Y	N

*Cillian's school was only recently established and at present has students up to fourth year. **Deirdre's school is becoming co-educational and currently has both boys and girls in first year.

Data Generation & Analysis

The SoC framework informed the development of the interview schedule, with opportunities provided for teachers to potentially address and elaborate on their concerns in each of the seven stages. In line with the qualitative approach adopted, questions were open-ended allowing participants to use their own words and take any direction they wanted with their response (Yin, 2015).

The interviews were conducted online via Zoom, lasted on average 55 minutes, and were audio-recorded. The interviews were auto transcribed using the integrated Zoom transcription function. These were then checked for accuracy against the recordings and edited accordingly. Any identifying information was removed, with pseudonyms used for all teacher and school names, before being imported into NVivo12 for analysis.

Once all interviews were transcribed and anonymised, they were read through a number of times to develop familiarity with the data. The initial phase of analysis involved coding instances of teachers expressing concerns relating to the SoC framework. Data was coded by both authors to ensure agreement in the assignment of codes and to provide further insights into teachers' responses with regards to their enactment of the curriculum reform.

Initial Findings

Although data analysis is ongoing, there are several preliminary findings emerging from this initial phase of analysis.

Management concerns were ubiquitous for participating teachers. All participants expressed concerns regarding the practicalities of implementing the reforms. Most of these were related to time pressures and constraints felt with regards to the curriculum. A number of teachers felt unable to devote the necessary amount of time to problem-solving in their classroom, due to the volume of content in the curriculum and the limited amount of time they had to teach it.

> "It's just being able to facilitate [problem-solving] in the classroom under the time constraints seems to be a serious challenge to me." (Mary)
>
> "I just find the curriculum is so busy there's so much to cover that you, I just feel that I don't, particularly with a higher-level group, that I don't have the time and the space." (Aoife)

In addition, some teachers were concerned about the six weeks assigned to the two CBAs and viewed this as six weeks taken from their classroom teaching time.

> "It's six, seven weeks overall with the assessment task (…) that's a lot of time given up to is when they still are preparing for an exam that's 90%...There's still the exact same stuff to be done, but we've even less time now, because of the seven weeks" (Cillian)

Other management concerns related to the difficulty in sourcing appropriate resources for both CBA1 and problem-solving in general. Teachers did not feel that resources provided to them in professional development were of use in the implementation of the CBA in the classroom.

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> "Finding the resources takes time. Examining them, making sure they are applicable to your class, how do you integrate them into lessons, that all takes up an enormous amount of time." (Dara)

Collaboration was a dominant theme across the interviews. Many teachers cited collaboration with colleagues as a key source of support in enacting these reforms. In addition, there was an explicit desire for more collaboration. Teachers spoke about wanting to know what other teachers were doing in their classrooms and expressed a desire to share practice with colleagues across schools.

> "I'd love… yeah to know what other teachers are doing that's working well" (Éabha)
> "I would love […] more collegiate discussion" (Aoife)

A number of teachers' wishes for increased collaboration was rooted in a desire to build assurance in their own practice. This was especially noticeable in Deirdre's and Cillian's interviews. Both of these teachers come from small schools with only one other teacher in their department.

> "I think [what would support me is] more opportunities to work with schools around, because I think the biggest thing schools are struggling with is we're so confined to our own school, you know we think we're doing a great job but there could be something we could be doing even better". (Cillian)

Regarding CBA1 and students' experiences, a number of teachers felt that it did not impact greatly on their students' mathematical learning.

> "I have concerns that some of the students wouldn't have learned a whole lot from it" (Mary)

Other teachers felt that, if not handled correctly, undertaking CBA1 could have a negative effect on students' engagement with and attitudes towards the subject.

> "I'd be afraid that if it wasn't done in a way that kind of supports the students while they're doing it, that they'll actually be really disengaged with the maths and say, well, I can't even do an easy, a seemingly easy project" (Cian)

This contrasted with other teachers' views that the CBA had the potential to positively impact on students' affective disposition with regards to mathematics.

> "[The students] reacted very positively and, and I suppose just the fact that they can see the relevance of maths in their everyday lives, has been huge." (Rory)

> "It helps them as well, in the course, they come back with a slightly more positive attitude, changed attitude towards maths because they've made something of it themselves" (Billy)

Within this research, there is limited evidence of refocusing concerns and very few teachers expressed what changes they would like to see with regards to the reform. Of the refocusing concerns articulated, they related to superficial elements such as the timing of CBA1.

Discussion and Conclusion

This research investigated the experiences of post-primary Mathematics teachers in engaging with and enacting problem-solving, and the associated CBA, in their classrooms. The prevalence of task, or management, concerns reported by teachers is consistent with previous

research on post-primary mathematics teachers following recent curriculum reform. Byrne and Prendergast (2020) found high levels of task concerns among the teachers they surveyed while Berry et al. (2021) found that time was a key factor in many teachers' low uptake of the problem-solving approaches promoted by Project Maths. The initial findings from this research suggest that time remains a key factor hindering the enactment of problem-solving in the classroom and that this may have been further exacerbated by the introduction of CBAs. Among the teachers participating in this research, there is a perception that problem-solving is time-consuming in comparison to more traditional, direct instruction approaches and that spending time on such activities is not warranted given the nature of the final formal post-primary examinations, i.e. the Leaving Certificate, that students will take. These concerns around the limited amount of time available to deliver an overcrowded curriculum is contributing to the gap between intended and implemented curriculum. Interestingly, teachers did not express concerns about their role in assessing students' work but did express concern regarding the rigid nature of the provided assessment guide and lack of opportunities to compare these with other schools.

In addition to the management concerns outlined above, the recent reforms require significant changes in teachers' daily practice and consequently demand significant time in planning. This is particularly the case as teachers feel unsure of how to meaningfully practice problem-solving in the classroom. Teachers struggled to find appropriate resources to support their enactment of problem-solving and CBA1. Professional development aiming to support teachers in enacting problem-solving in their classroom has not alleviated these efforts and teachers highlighted the lack of a broad range of examples and assessments on which to base their own classroom practice. In order to alleviate these task concerns and support teacher learning, professional development that is grounded in classroom practice and focused on teaching strategies, linked with specifically designed and accessible resources, may be useful in assisting teachers to enact these reforms (Borko, 2004; Darling-Hammond et al., 2017; Desimone, 2009).

The dominance of collaboration concerns among the teachers who participated, and the explicit requests for more opportunities to share and discuss their practice with colleagues suggests that such collaborative professional development opportunities should be provided to teachers. This may be a surprising finding, given the traditionally isolated nature of teaching in Ireland (Gleeson, 2012). At present, teacher professional development in Ireland does not seem to provide adequate opportunities for teachers to work collaboratively and meaningfully discuss their classroom practice. This has likely been exacerbated due to the Covid-19 pandemic, as professional development moved to an online format and the possibility of informal collegiate discussion has been reduced. Given that providing teachers with opportunity to share ideas and reflect together on pedagogy can be such a powerful form of teacher learning (Darling-Hammond et al., 2017; Desimone, 2009) and can contribute to successful enactment of curriculum reform (Ni Shuilleabhain & Seery, 2019), the findings of this research should be taken into consideration in the provision of support for teachers in their incorporation of problem-solving and CBAs.

The lack of refocusing concerns is worthy of note, particularly considering that the reform has been in place for 12 years. This may point to a lack of teacher efficacy in considering the enactment of the reform and requires further research.

The research is limited by the small number of participating teachers and the fact that few of the participating teachers were out-of-field, thereby potentially unrepresentative of the

population of mathematics teachers in Ireland (Ni Riordain & Hannigan, 2011). Nonetheless, we hope it contributes to the literature on the mathematics reforms in Ireland.

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