Lesson study and Project Maths: A Professional Development Intervention for Mathematics Teachers Engaging in a New Curriculum

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Since 2010 there has been a phased introduction of a new post-primary mathematics curriculum in Ireland entitled 'Project Maths'. This new curriculum places a greater emphasis on problem solving and on an investigative approach for students. This implies not only changes in the curriculum content, but also changes to teaching and learning approaches within the classroom. This research aims to provide teachers with a school-based professional development structure through which they can engage with the curriculum and attempt new teaching and learning strategies. This structure involves mathematics teachers engaging in lesson study as a professional development intervention and is investigated in two schools (phase 1 and phase 2 of Project Maths). Teachers engage in lesson study cycles repeated throughout the academic year and the research questions how effective an approach this may be in encouraging teachers to engage with and implement a new centralised mathematics curriculum. The research also investigates how effective an approach this may be in developing teachers' pedagogical practices. In this paper, initial findings will be discussed from teacher research meetings and interviews.

Keywords: curriculum reform; lesson study; Project Maths; Ireland

Introduction

This research aims to employ a curricular framework for a community of mathematics teachers engaged in lesson study during a time of curriculum change (Charalambos and Philippou, 2010; Fernandez, Cannon, and Chokshi, 2003; Grossman, Wineburg and Woolworth, 2000; Lewis, 2006; Lewis, Perry and Hurd, 2009). In this research a community of mathematics teachers are engaged in the practice of lesson study, where they collaborate in an iterative cycle of planning, teaching, observing and reflecting on research lessons. The objective of this research is to evaluate this model as a sustainable, school-based professional development for mathematics teachers which may enhance their practices and thus positively impact student engagement and learning within the classroom. This paper will question how effective an approach this model may be in 1) cultivating the teaching and learning approaches envisaged by this new curriculum and in 2) engaging teachers more with the content and learning outcomes included therein. This study contributes to the literature by examining how lesson study can contribute positively to the implementation of a new mathematics curriculum and in establishing how lesson study may be implemented and sustained within an Irish post-primary setting.

Project Maths

In Ireland in 2010, the national phased roll-out of a new centralised mathematics post-primary curriculum, entitled Project Maths, began. Project Maths was designed to change not just what students learn about mathematics, but how they learn and how

they are assessed (Jeffes et al., 2012) and represents a philosophical shift in Irish post-primary classrooms from a highly didactic approach with relatively little emphasis on problem solving (Lyons, Lynch, Close, Sheerin and Boland, 2003; Oldham, 2001) towards a dialogic, investigative, problem-focused approach to teaching and learning mathematics. The curriculum is based on a discovery learning approach where learners' active participation and sense-making is an important basis in designing the teaching and learning approaches experienced within the classroom (Lynch, 2011).

Implementing a new curriculum

Effective curriculum reform requires a change at the individual teacher level (Harris, 2003; Hopkins and Reynolds, 2001; Wallace and Priestley, 2011). In addition, the knowledge that teachers already hold, both content and pedagogical, will ultimately determine the shape and direction of the experienced curriculum (Van Driel, Bulte and Verloop, 2007; Van Driel and Verloop, 2002). However, when teachers are encouraged to modify curriculum materials supplied to them, they are more likely to implement them within their own classroom (Hanley and Torrance, 2011). It has also been found that the most significant learning for teachers occurs during teachers' processes of enacting and observing curriculum in the classroom (Remillard and Bryans, 2004). It is thus important in attempting to translate the intended curriculum to an enacted one that teachers are afforded opportunities to engage meaningfully with the curriculum, with curriculum materials, and to observe curriculum approaches being implemented.

Professional development

In order to change a teaching approach that may impact on teachers' beliefs, there is a need to move from the more traditional form of professional development to one that provides opportunity for reflection on practice (Fetters et al., 2002). Research increasingly points to the importance of considering the social dimension of learning for teachers. When teachers work collaboratively to create resources, it fosters a sense of ownership and leads to changes to classroom practice (Hindin, Morocco, Mott and Aguilar, 2007; Priestley, Miller, Barret and Wallace, 2011; Voogt et al., 2011) and teachers often use knowledge of their colleagues' teaching strategies to initiate changes in their own practices (Meirink, Meijer, Verloop and Bergen, 2009). Experimentation and reflection within the classroom is efficacious for lasting change (Remillard and Bryans, 2004; Wallace and Priestley, 2011). Teachers' content knowledge and pedagogical content knowledge (Shulman, 1986, 1987) affect their practices and this knowledge should be challenged and enhanced through teacher learning. In this research, it is hoped to implement a model of professional development that includes these opportunities noted above.

Lesson study

Lesson study is a teacher-oriented and teacher-directed practice where members of a group determine a particular goal for their teaching, observe and examine their practice through planning and conducting lessons (Fernandez, 2002; Lewis, Perry and Murata, 2006). The lesson study model encompasses many factors necessary for successful curriculum reform or policy initiatives: teachers collaborate with their colleagues; have opportunity to see curriculum enacted; are encouraged to modify curriculum materials; have opportunity to observe student engagement in a lesson;

and explicitly reflect on classroom practice. It is important to note that it is not the 'product' of the research lesson or lesson plan which is of import, but rather the process of teachers collaborating and conversing with one another on curriculum and pedagogy that is of worth.

Methodology

The investigation is conducted as a case study in two sites (Merriam, 2009; Yin, 2009) with two schools involved at different phases of the national curriculum roll-out: Crannog school where the mathematics department have been teaching the Project Maths curriculum since 2008; and Doone school where the new curriculum is currently introduced on a phased basis to differing year groups. Participating teachers taught students in all year-groups of varying abilities.

The research was undertaken during the 2012-2013 school year and data was generated during teacher meetings in both sites; through individual semi-structured interviews; and utilising field notes from teacher meetings. The researcher was present as a facilitator during the lesson study cycles and entered the research as a former mathematics teacher in a phase 1 school. All interviews and teacher meetings were transcribed, reviewed for correction and an initial coding system emerged relating to curriculum themes. All references to participating teachers are pseudonyms and initial findings are discussed below.

Framework of analysis

The revised mathematics syllabus encourages teaching and learning approaches which form a frame of analysis for this research. These approaches may be summarised as follows:

1. A greater focus on learners' relational understanding (Skemp, 1976) of mathematical concepts, building from the concrete to the abstract and from the informal to the formal (Lynch, 2011).
2. An approach to teaching and learning which gives prominence to developing learners' skills in communicating their mathematical understanding with others with teachers as facilitators of discussions (NCCA, 2008, 2012a, 2012b).
3. An approach to teaching and learning mathematics which encourages an investigative, problem-focused approach with emphasis on application in real-life settings and contexts where students become active participants in developing their mathematical knowledge and skills (Cosgrove, Perkins, Shiel, Fish and McGuinness, 2012; Lynch, 2011).
4. A move for teachers to use supplementary resources instead of a traditional over-reliance on textbooks as a curriculum source (Cosgrove et al., 2012).

Data and findings

Initial findings from the data suggest that participation in lesson study impacted on teachers' content knowledge and pedagogical content knowledge. The majority of teachers participating in this research also expressed a change in their thinking when planning research lessons with an increased focus on how students would express their ideas, engage with, and interact during the lesson but also, significantly, when planning their own lessons. While teachers did feel that the reform was being imposed

upon them, in these schools teachers were enacting the new curriculum to the best of their abilities and were eager to engage in lesson study as a model which could assist them in engaging with more of the Project Maths approaches and resources. Findings within the frame of the new curriculum will now be discussed with explicit reference to how teachers changed their teaching and learning approaches and engaged with the curriculum.

Relational understanding

In Crannog, teachers explicitly referenced their wish that students understand why they were doing an activity as opposed to just 'how' to do that activity. In planning research lesson 2 in Crannog, Fiona and Peter discuss the lesson objective:

> **Fiona:** Are we going to lead them into just multiplying out brackets or are they never going to see that? Are they always going to see it by an area model?
>
> **Dave:** No, sorry, I would have thought they need to see this but I think this probably helps, just as a concrete tangible way of getting started or seeing *why* this result works, *why* this result makes sense, rather than just learning how to multiply stuff out, following procedure and not understanding….

As the lesson study cycles continued in Doone, their objectives also became more focused on students' understanding a concept before utilising an associated skill.

Teacher as a facilitator of learning

In Crannog, Eileen describes how her approach to teaching a topic has changed from one where she readily gave the answer to students, to one where she is challenging the students to do more while she acts as a facilitator of their questions. She acknowledges that her participation in the lesson study group has given her the confidence to allow students to discover an approach for themselves and in this following quote from her second interview, she describes employing a new way of factorising quadratics:

> **Eileen:** I would say I am a bit more willing to put them in pairs, in groups now just to see how it goes, just let them at it and even, I suppose, it was factorising this week - it's not saying much and seeing what they come up with themselves. I would say maybe this time last year I would have been like "do this".

Students working in groups

The introduction of group work into more classrooms specifically addresses the curriculum aim of encouraging students' communication of their mathematical understanding. While Crannog had experienced the new curriculum for three years prior to Doone, and while the teachers seemed to agree with the teaching and learning approaches in the curriculum, very few of the teachers had changed their practices to encourage students working in groups. By the end of the year, teachers in both schools had experimented with utilising group work and some teachers changed their classroom environments to permanently seat students in groups. Teachers were also allowing more time during the lessons for students to work with each other.

At the beginning of the year Owen in Doone was adamant that he did not like his students working in groups. However, after two lesson study cycles, one in which he taught the research lesson, his negative opinion of group work appears to have changed.

> **Owen:** I just think I'm more open-minded to the fact that they will learn. And the fact that I've seen it in practice and been able to be an observer, so standing in behind someone's class and say "this is fantastic" that helped big time. Standing in Lisa's room was great. Just to even see them even when they were off-task, to see what they were talking about and how can you get them back on task in a group work situation.

Martin, a very experienced and senior teacher in Crannog, acknowledged that he didn't use group work in his teaching as much as he could, but that observing the research lessons gave him the confidence to attempt this new practice.

> **Martin:** ...from sitting in a classroom observing how groups work it is easier to know what to expect, you know, when you go to do it yourself, but you observe how students learn...I suppose in terms of planning future lessons, it does help to maybe get sort of the timing right, the timing I mean of, if it's a lesson discovery, when to give out information, maybe also how to maybe get the kids interested... So I think in terms of timing of the lesson and in terms of expectations of feedback and that sort of thing…what I saw in those lessons is where the teacher couldn't see all groups at once, therefore there's a necessity to move around groups fairly frequently and that's a hard skill, do you know. Not to get bogged down in one group.

A focus on problem solving

While it was not an explicit goal of either of the two lesson study communities, both groups of teachers focused on encouraging students in developing problem solving skills. In Crannog, teachers regularly tried to contextualise problems to make them interesting to students and attempted to direct students as little as possible in finding a solution to a problem. In Doone, a clear focus on problem solving emerged in planning lessons 3 and 4.

> **Lisa:** ...I think again we need to stress the problem-solving technique, this, the context, what's important here, can you identify the right angled triangle and what information on the paper is going to help, what are we being asked to do, what maths do we know that'll help us do it?

In this school, teachers began to provide specific, relevant scaffolding for students' questions and developed a resource for all students to use in solving problems.

Textbook as a resource and not a curriculum source

Teachers felt that they had accessed the syllabus more due to lesson study and were more familiar with it from having to directly reference it when planning the research lesson. Teachers were also using the new curriculum as a primary teaching resource for planning lessons instead of referencing the textbook.

> **Michael:** I refer to the syllabus a whole lot more now.
>
> **Researcher**: Before you wouldn't have had as much?
>
> **Michael:** Maybe, maybe not. It depends on how I felt you know? I've always been conscious of the fact that there is a syllabus there but I find I always go to it, but now I might go to it and say okay this is what's expected, then I will think how would I go about it, you know what I mean? And then I might go and talk to somebody else and say this is what I was thinking, what did you do for this? Or how were you going to do?

While this research does not assess student learning or changes to student engagement in mathematics lessons due to these research lessons, Lisa, in Doone

school, acknowledged in their final research meeting that lesson study benefitted both teachers and students:

> **Lisa**: Yeah. And it benefited…our audience, which is our kids. Like...we got a benefit but the kids are the ones who benefit from this.

Conclusion & Discussion

In this research, I claim that teachers modified their teaching practices to more reflect the Project Maths curriculum as a result of participating in lesson study. These changes to classroom practice supported the introduction of the new curriculum with implications that would, hopefully, extend beyond the participants' classrooms and also impact on student learning. While Crannog had longer experience of the new curriculum and had embraced the philosophies behind the changed approaches, teachers had not enacted these within their classrooms and required time to experiment with resources and approaches which had been introduced to them as part of Project Maths. In Doone, teachers were more willing to engage students in discussion and to scaffold students' learning during problem solving more as they engaged further in lesson study.

This study was limited to teachers in two schools who voluntarily participated in this research and were thus active in wanting to engage in the new Project Maths curriculum. As such, the findings may represent teachers who are already engaged in and aware of curriculum changes. However, all participating teachers would recommend lesson study as a form of professional development and wished to continue the intervention in their school. Teachers did note the lack of time available to engage in in-school professional development and it is perhaps worth noting how teaching contracts are constructed within the Republic of Ireland. Further questions are also raised by the research: how was teachers' pedagogical content knowledge and mathematical content knowledge enhanced through engagement in lesson study? How did these groups of teachers develop as communities? What features of such communities are necessary in order to develop and sustain such a model of professional development? Further research on these and other questions is important for understanding the advantages and restrictions of school based professional development for mathematics teachers.

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