PLANNING FOR TEACHING EARLY MATHEMATICS: NEGOTIATION OF SHARED INTENTIONS

Siún Nic Mhuirí[1], Thérèse Farrell[1], Córa Gillic[1,2] and Mary Kingston[1]

[1]Dublin City University, [2]Millview Childcare

This paper uses thematic analysis to investigate how shared intentions for the Maths4all project were negotiated. Individuals or pairs prepared seven mathematical activity guides for preschool and primary school groups. These plans were then reviewed in team meetings using the Teaching for Robust Understanding framework (Schoenfeld, 2013) as a conversation guide. Thematic analysis of field notes taken at these meetings shows that the framework acted as a catalyst for discussions in which the ideological focus of the project became more defined. Other key themes that informed this development included looking across primary and preschool contexts; consideration of teacher interpretation of project output; the curricular context; and interrogation of frequently used language.

INTRODUCTION

This paper details the early phases of the Maths4all project funded by Science Foundation Ireland (SFI). The project will develop a website hosting continuous professional development (CPD) resources to support the teaching of early mathematics. The research team comprises of practicing teachers and academic staff from Dublin City University. Four of the academics are primarily involved with mathematics education while one specialises in Early Childhood Education. Team members who are practicing teachers have extensive teaching experience, one in preschool-settings and one in the primary school system. Both are pursuing postgraduate studies and have contributed to the development of this paper. Here, we analyse our approach to the first phase of the project. This involved planning and reviewing activities that would later be filmed in primary and preschool settings. We will discuss how review of plans using the Teaching for Robust Understanding (TRU) framework (Schoenfeld, 2013) facilitated a negotiation of shared intentions for the project.

THEORETICAL FRAMEWORK

First, we outline Wenger's (1999) theory on communities of practice. Then we present an overview of the Teaching for Robust Understanding (TRU) framework (Schoenfeld, 2013).

Communities of Practice

The three defining features of a community of practice (CoP) are mutual engagement, joint enterprise and a shared repertoire (Wenger, 1999). Engagement with the joint enterprise requires negotiation and "creates among participants relations of mutual accountability that become an integral part of the practice" (Wenger, 1999, p. 78). Our joint enterprise is defined by the structure of the SFI project. We intend to create resources for a website which will support high-quality early mathematics teaching. Within this remit much remains to be negotiated, for example, the teaching practices that we wish to foreground in CPD materials. This paper charts our first engagement with the joint enterprise. For this reason, the repertoire of resources for negotiating meaning was evolving. This is discussed further below.

Wenger (1999) contends that meaning is negotiated in the interplay between participation and reification. Participation refers to the process of taking part in social practice as well as the relationships arising from the process (Wenger, 1999). In our case, participation involved individual planning and reflection as well as collective participation in team meetings. Reification is understood as both process and product and is concerned with abstractions that reify something of the practice of a community in "congealed form" (Wenger, 1999, p. 59). Meeting notes, agreed plans for teaching, even this research paper can be considered a reification around which the negotiation of meaning was organised.

We recognise that it could be fruitful to work at the *overlap* between an academic CoP and a teaching CoP (figure 1, i). However, the teacher-members of our team operate in two distinct communities and research highlights discontinuities across primary school and preschool settings (Dunphy, 2017; O'Kane, 2016). Our CoP might also be theorized as engaged in work at the *periphery* of a teaching community (figure 1, ii) but we choose to conceive of our work as an example of a *boundary practice*. Wenger's (1999) elaboration of boundary practices draws from only two communities (figure 1, iii). We locate our CoP somewhere between an academic CoP, the CoP of our primary-teacher member and the CoP of our preschool teacher member (figure 1, iv). Positioning our team as a distinct CoP in its own right, acknowledges the expertise of all individuals. It also highlights the complexity of what we are hoping to do in drawing from and reinterpreting the practices of the original communities.

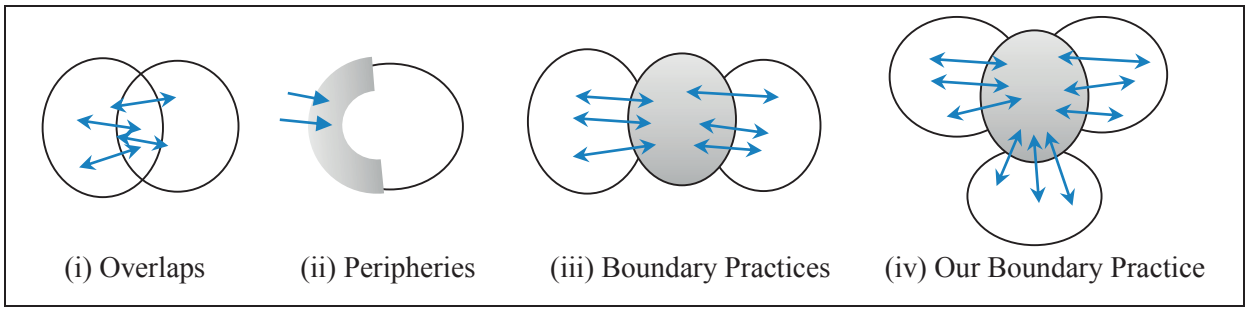

Figure 1: Practices at borders of CoPs. Images (i), (ii), and (iii) are based on Wenger (1999, p. 144). Image (iv) shows our boundary practice drawing from, and contributing to, three distinct communities.

The Teaching for Robust Understanding (TRU) framework

The TRU framework (Schoenfeld, 2013) describes five dimensions of classrooms which have been identified by research as critical for children's mathematics learning. The dimensions are: the *mathematics*; *cognitive demand*; *access to content*; *agency*, *authority and identity*; *uses of assessment*. The *mathematics* involves the disciplinary concepts and practices made available for learning. *Cognitive demand* aims to capture the extent to which children have opportunities to engage in 'productive struggle'. *Access to content* addresses the extent to which activity structures support the active engagement of all children. *Agency, authority and identity* refers to the extent to which children have opportunities to contribute to discussions in ways that build agency, mathematical authority and positive identities. *Uses of assessment* relates to how classroom activities elicit and build on student thinking. Use of the framework had been written into the SFI application by the lead author at the project outset and team members had varying degrees of familiarity with it. The need to appraise the suitability of the

framework for early mathematics teaching was recognised (further details below) but the TRU conversation guide (Baldinger, Louie and the Algebra Teaching Study and Mathematics Assessment Project, 2014) was adopted for use as a way to structure coherent conversations about planning for mathematics teaching. This paper focuses on the first stage of the project where we were creating and reviewing plans for teaching.

METHODOLOGY

Seven plans for teaching were prepared by individual team members or pairs and four review meetings took place with three or four team members present each time. The lead author was present at all meetings. The introduction to each meeting involved discussing queries that had arisen previously. Two to three plans were then considered in each session. Four of the plans were edited in minor ways, if at all, after the initial meetings. The remaining three plans, which were discussed at a second meeting, were altered in more comprehensive ways.

The data considered here consists of field notes taken by the first author during meetings. These notes consisted of introductory notes on general issues and sections dealing with each of the five dimensions of the TRU framework. The notes were circulated to attending members after each meeting for comments and corrections. We wanted to investigate in what way, if any, the review meetings facilitated development of shared intentions for the project. We decided not to focus on individual contributions because the research interest was in the evolving practice of the community not the practices or beliefs of individuals (Grundén, 2019). This aligns with our aim of working as co-researchers rather than interrogating the experience of teacher team-members and follows a constructionist perspective where meaning and experience are understood to be socially produced and it is not appropriate to "focus on motivation or individual psychologies" (Braun & Clarke, 2006, p. 85).

Data was shared on Google Drive as coding software that would allow collaboration was not available. Interesting segments were highlighted and the comment function was used to name codes. This allowed for data to be coded with multiple codes. We tracked through the phases of thematic analysis outlined by Braun and Clarke (2006): familiarisation with the data; generating initial codes; searching for themes; reviewing themes; defining and naming themes; producing the report. All authors, academics and practicing teachers, engaged in stage 1 and the first author lead on the second two stages. All collaborating authors reviewed themes and contributed to the remaining phases. This analysis was not undertaken in a linear manner. Instead, initial codes led to consideration of possible themes which in turn lead to refining of codes and a reconsideration of themes. We recognise that themes are constructed by researchers rather than 'discovered' in the data (Braun & Clarke, 2006). It was decided that tests of inter-rater reliability were not warranted for this small data corpus. Instead, we note that the quality of qualitative research is largely connected with notions of trustworthiness and rigor (Golafshani, 2003). For this reason, the quality of our analysis rests on our efforts to make explicit and justify the decisions we have made (Braun & Clarke, 2006).

We used a semantic approach to generating inductive codes where codes were identified within the explicit meanings of the data and only at later stages was there an attempt to theorize the broader meanings. When searching for and reviewing themes (stages 3 and 4), we

recognized that a number of codes were pervasive across the data. We tested whether these codes could be considered as themes by tracking, in the data and theoretically, their relationship with other codes and each other. We also referred to Braun and Clarke (2006, p. 82) who state that a theme "captures something important about the data in relation to the research question" and is indicative of some level of patterned meaning within the data". The analysis has resulted in identification of a cluster of major and minor themes (shown in grey and white respectively on figure 2). We have chosen to use this terminology rather than 'subtheme' as no hierarchy is obvious and the minor themes appear densely connected to each other and to the overarching themes. This is likely to be due to the limited quantity and nature of the source data where we returned to central questions at the start of each meeting. Our discussions were furthered structured by the TRU conversation guide.

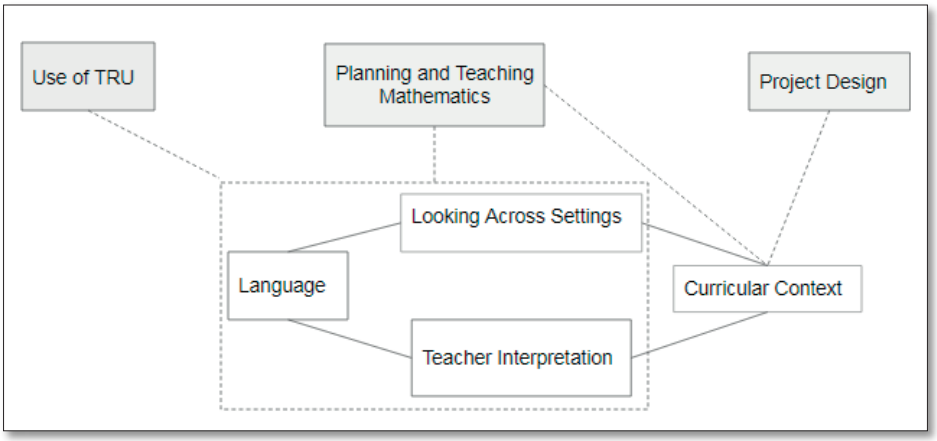

Figure 2: Overview of themes. Overarching themes shown in grey, minor themes in white.

RESULTS

We begin by discussing the minor themes and conclude by relating these to the overarching themes of: *Planning and Teaching Mathematics; Project Design* and *Use of TRU*.

Curricular Context and Looking across Settings

Curricular context, in particular interrogating the expectations of the draft specification for the new primary mathematics curriculum (NCCA, 2017), became a key focus. For example, challenges arose in how to pitch a tangram activity for first class due to a perceived jump in expectations of the shape strand (meetings 3 and 4). We were also cognisant of the recommended practices in the research reports underpinning the redeveloped curriculum. For example, we aimed to create meaningful contexts for learning and selected play-based and picture book contexts for early years settings (Dooley et al., 2014) noting that these activities could be extended to make them suitable for an infant classroom (Meeting 1).

The curricular context for preschool is a notably different space (Dunphy et al., 2014). *Looking across settings* and interrogating affordances and constraints of primary and preschool contexts became a feature of our meetings. We noted that play-based approaches are recommended in both settings as outlined by *Aistear, The Early Childhood Curriculum Framework* (NCCA, 2009) but a tension exists for primary teachers who also have a duty to teach the content specified in the primary curriculum (Gray & Ryan, 2016) (Meetings 1 and

2). There is still an expectation that primary mathematics activities should be structured and comprehensive assessment records collated (Meetings 2, 3, 4). Teachers in preschool settings may have greater pedagogical scope than infant teachers in primary schools which can lead to a more responsive approach to young children's thinking. For example, the affordances of smaller group numbers in preschool settings was noted (Meeting 1) and we discussed how it may be more feasible for teachers to orchestrate equitable access to content and opportunities to develop children's agency and identity in small group settings.

Opportunities for learning exist in having teachers look across early years and primary settings to make curricular connections explicit. The use of cognitively demanding tasks is one of the metapractices recommended in the research reports underpinning the redeveloped primary curriculum (Dooley et al., 2014). In our discussions of how such tasks may play out with young children, we made connections to the skills and dispositions outlined in Aistear, in particular the notion of perseverance (Meeting 1). Aistear, Síolta (CECDE, 2006) and the new draft primary curriculum have something meaningful to offer teachers across settings. Síolta standard 7, component 7.6, indicates that curriculum planning should be "based on a child's individual profile, which is established through systematic observation and assessment for learning" (CECDE, 2006, p. 56). This approach to planning is in line with the new draft primary curriculum, where progression continua charting key stages in the development of children's mathematical thinking are provided. Teachers are expected to use the continua to create "appropriately challenging" and playful learning experiences for children at different levels of learning (NCCA, 2017, p.13). In practical terms, we noted that it is possible to use the lower levels of the progression continua for the draft new primary curriculum to consider the development of children's thinking in early years settings (Meeting 1).

Language and Teacher Interpretation

The *Language* theme incorporates attention to the meaning of particular terms, some of which might be considered to be associated with either teachers or researchers. We have chosen the term language rather than terminology because this theme relates to essential aspects of meaning and communication rather than technical discussions of definitions. There were a number of terms that provoked debate across the meetings. These included: cognitive demand/problem solving; lesson plan/activity guide; mathematize; prior understandings; enrichment/extension. Our deliberations on these terms might be understood as the CoP developing a repertoire of shared meanings (Wenger, 1999). For example, the following notes were taken in meeting 2 when we discussed the terms 'problem-solving,' and 'cognitive demand' (which is a TRU framework dimension).

> ...many infant teachers will claim that they are not doing problem-solving because of associations with word problems. Many are actually doing cognitively-demanding tasks so it was felt that 'cognitive challenge' was preferable to 'problem-solving'

This extract also has significance to the theme of *Teacher Interpretation.* This refers to our consideration of how teachers may interpret the products of this project, i.e., teaching plans and CPD materials. Consideration of teacher interpretation was also evident in our discussion of the terms 'lesson plan' and 'activity guide'. Consider the following extract from meeting 1.

> The preferred term for the early years setting is 'activity guide'. It was felt that in general, practitioners may have negative associations with the more formal connotations of 'lesson plan' while 'activity guide' positions the resources as more in line with a play-based approach. We spoke about the opportunities of adopting this language for the primary school lessons, not only to encompass the possibilities of incorporating play-based approaches but also to signal the need for flexibility and the importance of being responsive to student thinking

When we returned to discuss this issue in meeting 3, it was stated that "student teachers tend to see lesson plans as a 'finished product' which they could enact verbatim. Suggestion that we have no control over how our end products will be interpreted so should operate on ideological grounds". This highlights the tight connections between themes as our discussion of particular language (provoked in part by the TRU framework) led to questions about teacher interpretation which in turn fed into the evolving project design.

Major Themes

Use of TRU was identified as an overarching theme because of the way in which it underpinned our discussions. At times, we explicitly discussed how and why we were using the framework and appraised its suitability in the context of early mathematics (meetings 1 and 2). While there was agreement that using TRU was worthwhile for moderating planning, there was concern about how teachers in early years settings might interpret the language of the framework (meeting 1). There was also suggestions about how the conversation guide could be clarified to support observations of early mathematics learning. Under the 'Access to Content' dimension of the TRU conversation guide, one of the questions is:

> What is the range of ways that students can and do participate in the mathematical work of the class (talking, writing, leaning in, listening hard; manipulating symbols, making diagrams, interpreting text, using manipulatives, connecting different ideas, etc.)? (Baldinger et al., 2014, p. 9)

It was suggested that the examples in brackets do not pay sufficient attention to how children may engage in mathematical work in play-based approaches (meeting 1) and that we must remain cognisant of this when we use the TRU framework to structure our observations in real settings (meetings 1 and 3). Using the TRU framework to structure our review of plans meant that we viewed fine-grained planning decisions through a research lens, evaluating and refining plans according to whether the dimensions of the framework were evident or not. This was significant for choices we made in specific activities but using TRU also acted as a catalyst for us to consider broader issues in the teaching of mathematics, e.g., the use of cognitively demanding tasks with young children (meeting 1 and 2). As detailed below, these conversations became vital, not just in relation to the original proposed activities, but also in terms of how they impacted our sense of purpose in project design and how they connected with more generalized ideas about the planning and teaching of mathematics.

Planning and Teaching Mathematics, an overarching theme, can be traced to a code which originally sought to attend to fine-grained decisions about the proposed plans. This code was refined to capture issues relevant across all contexts and activities. In this guise, it became so

fundamental that it was eventually recognised as a theme. Captured here were ideas about planning and teaching such as; making connections when selecting and sequencing tasks; anticipating and preparing for student responses; how to assess and build on prior understandings; choosing representations; choosing and supporting children's understandings of contexts in mathematics problems; how to support young children's recording strategies; developing accurate terminology while respecting students' own language and thinking and ensuring all learners are catered for. The literature supports the contention that these ideas are of high significance in mathematics teaching (c.f., Dooley, Dunphy & Shiel 2014). The added import here stems from the fact that we were experiencing these issues from the 'inside' and the 'outside', operating on both sides of a boundary at once (Wenger, 1999). This boundary is described with reference to children's prior understandings in the following extract.

> Very difficult to consider prior knowledge for a class we don't know. This is not a problem for a teacher in general but is for the teacher in this research context. (Meeting 2)

We were planning mathematical activities as teachers might but this was still a theoretical undertaking as we were planning for children that we could not know.

Project Design, the final overarching theme, underpinned all of our discussions. *Looking across settings* and planning specific details according to the *curricular context* was important on a technical or practical level. Our attention to *Language* and *Teacher Interpretation* led to an expansion from attention to practical issues in earlier meetings to more explicit consideration of project purpose and attendant possibilities and limitations. For example, this extract from meeting 3, discusses the cognitive demand of a proposed task:

> A note that this relates as much to how tasks are mediated as to the lesson plans themselves. An acknowledgement that the CPD element is very important in this. Discussion of the insignificance of a single lesson for both child and teacher.

Our boundary practice created opportunities for us to engage in teacher practices such as planning. Considering how these activities might play out highlighted the centrality of the teacher's role which in turn led to a recognition of the need to foreground this in supporting CPD documentation. The intricate analysis of the possibilities of different options in planning mathematical activities was balanced with a realization of the limitations of individual planning guides for student and teacher learning. Despite awareness of the constraints of the project, there was also a growing sense of purpose as evidenced in the first extract above under *Language and Teacher interpretation*, where ideological rather than practical grounds were identified as way of selecting terminology. Similarly, in later meetings, we explicitly discussed the need to foreground inclusive practices so as to "empower (student) teachers to address diversity" (meeting 3) and decided to mandate mixed-ability groups for all activities (meeting 4). We also discussed how we could present extra follow-on activities (meeting 1, 3, 4) so that they would not be "understood as suggestions for higher achievers only…Need to consider how to present this so as be clear that all children are capable of engaging" (meeting 4). Our boundary practice was also influenced by our research orientation and noting issues worthy of further research was a regular occurrence across all meetings. This feeds into our vision for how the project, and how this CoP, may evolve over a longer timescale.

Conclusion

This paper details only the first steps of a multi-layered, dynamic project. Limitations include the small data set and lack of attention to individual participation trajectories (Wenger, 1999). To date, the project has opened a discursive space for team members. Whether the artefacts produced by our CoP will have impact on the wider constellation of CoPs engaged in early mathematics education in Ireland remains to be seen.

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