USING LESSON STUDY TO HELP PRE-SERVICE TEACHERS BRIDGE THE THEORY-PRACTICE GAP

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The challenge in bridging theory and practice within the teaching of mathematics is not a new problem for researchers. It has been widely reported that a major challenge for teacher educators is helping pre-service teachers put into practice what they have learned in their teacher education programme (Allen, Butler-Made, & Smith, 2010; Cheng, Cheng & Tang, 2010; Korthagen, 2010). Indeed, Allen et al (2010) identified "being able to strike a balance between theory and practice" (p.647) as one of the greatest challenges for all pre-service teacher education programmes since the professionalization of teaching. Although vigorous attempts have been made to address this issue it remains a central problem in teacher education and has become ever more urgent (Wittmann, 2001). This paper examines this theory-practice problem by reporting on a study that researched how a curriculum specialisation in mathematics education, modelled on the principles of Japanese Lesson Study, could assist pre-service primary teachers to bridge the theory-practice gap. Through examining the pre-service teachers' lesson planning, their weekly journals, their lessons, their reflections and their interview data, the findings revealed that using the Lesson Study model is an effective approach to help pre-service teachers bridge the theory-practice gap. They showed vast improvements in their lesson planning and implementation including: demonstrating a greater understanding of important components of the lesson and displaying a more knowledge-based anticipation of students' response

INTRODUCTION

The objective of teacher education programmes is to provide pre-service teachers with a set of skills which enable them to cope with the complex situations they find themselves faced with in their everyday teaching (Cheng et al 2010). However, it seems the challenge of teacher education is to help these pre-service teachers put what they have learned in the teacher education programme into practice (Allen et al, 2010; Cheng et al 2010). Studies of teacher education have repeatedly revealed a disparity between the theory learned by pre-service teachers in their teacher education programmes and the subsequent classroom practice of these teachers (Allen et al 2010; Cheng et al 2010; Korthagen, 2010). Indeed one of the main criticisms of teacher education programmes is their failure to enable students to bridge this theory-practice gap (Allen, 2009).

Given that as early as 1904, Dewey reported on the gap between theory and practice and presented proposals to bridge this gap, it is remarkable that it remains such a central issue in teacher education today. However, closer examination of the contributory factors to the theory-practice gap reveals the sheer complexity of the issue. Korthagen (2007) highlights "the complex psychological and sociological phenomena influencing educational processes" as posing particular difficulty in finding suitable solutions to the problems causing the theory-practice gap (p. 306). Robinson (1998) also recognised the complexity of the issue

emphasising that “narrowing the research-practice gap is not just a matter of disseminating research more effectively or of using more powerful influence strategies” (p. 17). This viewpoint acknowledged that the cause of the theory-practice gap was not simply the disconnect between university researchers and classroom practitioners but that the root of the problem lay much deeper. Several factors have been identified as contributing to the theory-practice problem. These include: the complexity of teaching (Allen et al 2010; Korthagen 2010; Leikin and Levav-Waynberg, 2007; Hiebert, Stigler, Jacobs, Bogard Givvin, Garnier, Smith, Hollingsworth, Manaster, Wearne & Gallimore, 2005), pre-service teachers’ preconceptions (Cheng et al, 2010; Hiebert, Morris, Berk & Jansen, 2007; Joram & Gabriele, 1998; Korthagen, 2010; Lortie, 1975), socialisation towards patterns existing in schools (Cohn, 1981; Frick, Carl & Beets, 2010; Veenman, 1984; Zeichner & Tabachnick,1981), the relationship between researchers and practitioners (Klein, 1992; Korthagen, 2007; Leikin & Levav-Waynberg, 2007; Wittmann, 1984) and the inadequacy of the theory (Cheng et al, 2010; Korthagen, 2010; Hiebert, Gallimore & Stigler, 2002; Hiebert et al, 2007).

Several solutions have been suggested throughout the years. These include ideas such as school-university partnerships and alternative forms of knowledge provision e.g. practice-based knowledge and alternative teaching strategies such as teacher modelling. However one approach which has been gaining increasing support is using the Japanese model of lesson study to reform teaching (Cohan & Honigsfeld, 2007; Hiebert et al, 2002; Lewis, Perry & Murata, 2006; Sims & Walsh, 2009). Lesson Study has been cited as a suitable solution as it directly connects “to the work of teachers and their students”, is “participant driven and grounded in enquiry, reflection and experimentation”, is collaborative in nature and involves “the sharing of knowledge” (Darling-Hammond & McLaughlin 1995, p.2). Cohan and Honigsfeld (2007) found that incorporating lesson study into teacher preparation was very beneficial. “Every candidate benefited from a high level of collegial support, started developing a positive professional self-concept, and exhibited dispositions that teacher educators hope to expect from all future teachers” (p. 87).

BRIEF DESCRIPTION OF LESSON STUDY

Lesson Study was introduced in Japan as a form of professional development. Lesson Study is a translation of the two Japanese words: jugyo and kenkyu, which mean lesson and study, respectively (Fernandez & Yoshida, 2004). As suggested by the term, lesson study is a process, Japanese teachers regularly engage in, to examine their teaching practice through the careful planning and observation of lessons (Cohan & Honigsfeld, 2007). Stigler and Hiebert (1999) describe lesson study as an opportunity for teachers to examine their practice “with new eyes”. Figure 1 graphically represents the lesson study cycle. As can be seen from Figure 1, lesson study consists of three critical phases: the planning phase, the implementation phase and the post-lesson phase. The focus of the lesson study cycle is the research lesson. Although these research lessons are taught in the teachers’ actual classrooms, they differ from everyday lessons in that they are comprised of a number of special features. Lewis and Tsuchida (1998) identify the following special features of research lessons:

- They are carefully planned, sometimes over several months, typically in collaboration with at least one colleague.
- They are focused. They focus either on a specific goal, such as helping students be active problem-solvers, or developing a successful approach to a specific topic, for example subtraction with regrouping.
- They are observed by other teachers. Sometimes the observers are limited to the other teachers involved in the lesson study process whereas sometimes they can be open to observers from the whole of Japan.
- They are recorded. This can be done in a number of ways: videotaped, audiotaped, narratives or copies of students' work.
- They are discussed. Subsequent to the teaching of the lesson, the strengths and weaknesses of the lesson are discussed. Particular emphasis is placed on the effectiveness of the lesson on achieving the learning goals.

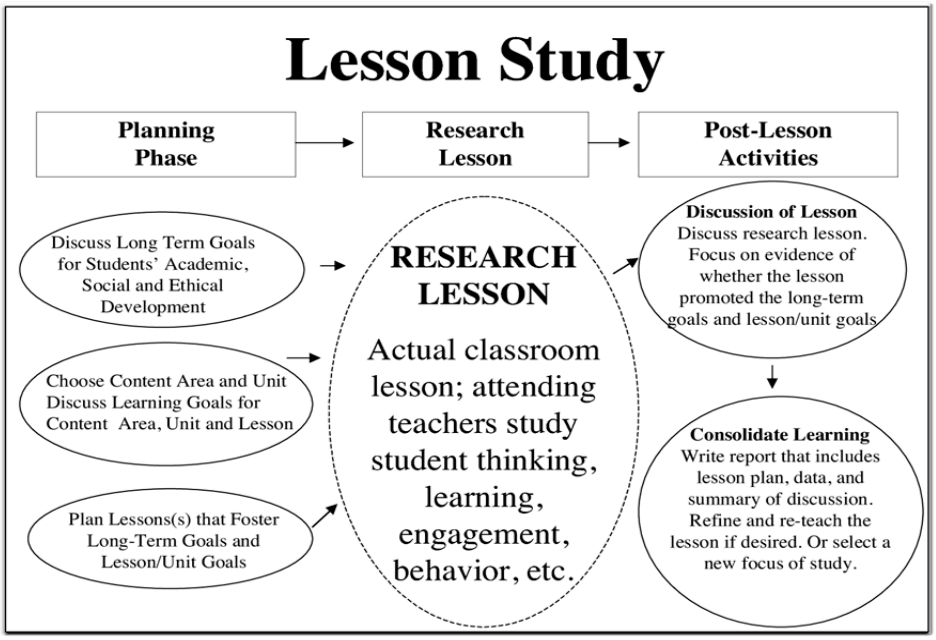

Figure 1: Lesson Study Cycle (Lewis, Perry, Friedkin, Roth, Baker & McGrew, 2012)

The Japanese approach of lesson study, which treats theory and practice as inseparable entities, has been gaining increasing support in the reform of teaching (Cohan & Honigsfeld, 2007; Hiebert et al, 2002; Lewis, Perry & Murata, 2006; Sims & Walsh, 2009) and more recently researchers have examined how the lesson study approach can be adopted in pre-service teacher education (Hart, Alston & Murata, 2011; Burroughs & Luebeck, 2010; Sims & Walsh, 2009; Cohan & Honigsfeld, 2007).

LESSON STUDY IN IRISH INITIAL TEACHER EDUCATION

As teacher educators have started to recognise the potential of lesson study to improve pre-service teacher practice, lesson study has also been adapted and developed in several Irish

colleges of education. Corcoran (2007) acknowledges that lesson study provides an opportunity for prospective teachers to develop a "meaningful understanding of the primary mathematics curriculum…by studying children during mathematics lessons, by optimising the use of the available supporting documents and organising classrooms to maximise the development of mathematics process skills"(p.286). Studies of lesson study undertaken in colleges of education in Ireland have shown that lesson study has the potential to greatly influence pre-service teacher education. Corcoran (2007) found that through lesson study pre-service teachers can improve their mathematical subject knowledge. Similarly Leavy (2010) reported that lesson study allowed her pre-service students to deepen their understanding of statistics. Corcoran and Pepperell (2009) found that lesson study enabled pre-service teachers to develop both their mathematical and pedagogical proficiencies. The pre-service teachers in their study showed significant knowledge development particularly with respect to their foundation knowledge, as classified by Rowland (2003). Leavy and Sloane (2008) reported that the "experiences in observing the impact of teaching design lessons on student learning served as the springboard for the development of understandings than could not have been facilitated within college-based clinical contexts"(p.168). These studies also highlighted several aspects of lesson study that were pivotal in pre-service teacher learning. These were: attending to what and how students learn mathematics (Corcoran & Pepperell, 2009), collaborative planning (Leavy & Sloane, 2008), observing and reflecting on the practice of teaching (Leavy & Sloane, 2008), and learning about the effects of diverse methods of teaching on students' learning (Corcoran, 2007).

METHOD

The participants in this study were a group of final year pre-service primary teachers in Mary Immaculate College who had selected the teaching of mathematics as their specialist area of study in the final semester. At this stage in their degree programme the pre-service teachers had completed all the compulsory mathematics education courses and all their required teaching practice placements of their degree. The group consisted of 25 students, 11 of which were male and 14 of which were female. 24 of the students had chosen this mathematics specialisation course as their first choice. The one remaining student had chosen it as their third choice. Three members of the mathematics education faculty were in charge of the course and they acted as mentors to the pre-service teachers during the lesson study cycle.

OVERVIEW OF THE CURRICULUM SPECIALISATION COURSE

The Lesson Study research was carried out over a 12-week spring semester in the context of a curriculum specialisation in mathematics education course offered to third year pre-service teachers in Mary Immaculate College. As part of this course the pre-service teachers were required to take part in a Lesson Study cycle. The course reflected the main components of the Japanese Lesson Study process as outlined in Figure 1. Each of the participants was involved in every aspect of the process; the planning, teaching, analysing and revising of the mathematics lesson. The initial weeks of the semester involved introducing the pre-service teachers to the Lesson Study process and preparing for Lesson Study. The participants were divided into five groups of five and then each group was assigned a different topic of either

algebra or probability. The algebra research lesson focused on growing patterns. The probability lessons were sequential and focused on describing likelihoods, comparing and explaining likelihoods, ordering likelihoods and sampling. The groups then researched the relevant theory surrounding their topic. The members of the group met twice weekly to collaboratively work on the lesson preparation. Three members of the mathematics education faculty were responsible for instructing and supervising the lesson study process. The groups met with at least one faculty member three or four times during this planning phase where they received feedback on their lesson planning.

The next phase of the lesson study process was the implementation stage. This involved one pre-service teacher from each group teaching their respective lesson to a Fifth class in a primary school while the other group members observed the lesson. Their observations involved evaluating student thinking and learning in relation to the concepts being taught, engagement with the content of the lesson and behaviour of the students during the lesson.

Following the teaching of the lesson all group members met with at least one faculty member for a post-lesson collaborative reflection. The group members and faculty members shared their observations on the first lesson and suggestions were proposed on how the lesson should be modified. The group members then met twice and modified the lesson accordingly, in preparation for the re-teaching of the lesson. The next phase involved the re-teaching of the lesson to different 5th class students in a different primary school. In some of the groups, a different teacher taught the second lesson whereas in some groups the same teacher re-taught the lesson. Once again the rest of the group members observed the teaching of the lesson.

After the final teaching of the lesson the groups met to reflect on revised lesson. These meetings included: one ninety-minute class, where groups were given the opportunity to discuss their lessons with the faculty members and watch a video recording of their second lesson, and three or four meetings in their small groups. The aim of these meetings was to consolidate what they had learned from the lesson study process and to prepare for the presentations where they had to report back to their peers on their lesson study experience. Finally the groups had to report on their lesson study experience. This included a group presentation to their peers, submitting an individual reflective journal and submitting the logs they kept from their meetings.

DATA COLLECTION

In the study only qualitative data were collected. However, a variety of data collection techniques were used. The primary qualitative methodology was participant observation which included in-class observation of teacher practice and observations of Lesson Study group meetings (which were also recorded and transcribed). Other data collection methods included pre-service teacher questionnaires, examples of pre-service teachers work, pre-service teacher interviews (recorded and transcribed), pre-service teacher presentations and pre-service teacher reflective journals. Modelled on the procedures used by Sloane and Leavy (2008) and by Leavy, Murphy and Farnan (2009), data collection methods adopted were closely synchronised with the stages of the lesson study process. Table 1 illustrates the relationship between the data collection procedure and the Lesson Study cycle.

STEPS OF THE LESSON STUDY CYCLE	DATA COLLECTION STRUCTURE AND METHOD
STEP 1: Collaboratively Planning the Research Lesson	Audio taped meetings with researcher Written logs of group discussions Record of resources used to research and design lesson
STEP 2: Seeing the Research Lesson in Action	Observation of lesson by researcher Observation notes of lesson study group members
STEP 3: Discussing the Research Lesson	Audio taped group meetings of researcher, faculty member and lesson study participants following the lesson
STEP 4: Revising the Lesson	Written logs of group discussion Record of changes made to revised lesson and justification of those changes
STEP 5: Teaching the New Version of the Lesson	Videotaped lesson Observation of lesson by researcher Observation notes of lesson study group members
STEP 6: Sharing Reflections about the New Version of the Lesson	Written logs of group discussion Record of changes made to revised lesson and justification of those changes Videotaped group presentation of their work Group interview with researcher

Table 1: Synchronisation of the data collection methods with the lesson study process

DATA ANALYSIS

Nvivo 10 was used to analyse the qualitative data. Throughout the Lesson Study process dominant themes were identified from the data collected and these themes were then further classified into categories. These categories were then validated across the various data sources. These in turn provided rich insights into the growth of these pre-service teachers during the Lesson Study process.

The Knowledge Quartet (Rowland, Huckstep & Thwaites, 2003) was used as a framework for the identification of content knowledge observed in teaching. The knowledge quartet (Figure 2) is a framework which allows mathematics educators “identify ways in which the trainees' mathematics content knowledge 'played out' in their teaching” (p. 97). It focuses on both subject matter knowledge and pedagogical content knowledge. In this way it allowed the researcher to analyse what theory they had learned from their degree programme they were putting into practice. The knowledge quartet was used as a tool by the researcher in their observation of the classes the pre-service teachers taught. While the researcher observed the lessons they identified aspects of the teacher behaviour which signified knowledge from a particular dimension of the knowledge quartet. For example, one group of pre-service teachers used pie charts to represent the law of large numbers in their lesson. This representation was particularly effective and demonstrated the pre-service teachers’ transformation knowledge.

Foundation	Theoretical underpinning of pedagogy
	Awareness of purpose
	Identifying pupil errors
	Overt display of subject knowledge
	Use of mathematical terminology
	Adherence to textbook
	Concentration on procedures
Transformation	Teacher demonstration
	Use of instructional materials
	Choice of representations
	Choice of examples
Connection	Making connections between procedures
	Making connections between concepts
	Anticipation of complexity
	Decisions about sequencing
	Recognition of conceptual appropriateness
Contingency	Responding to students' ideas
	Deviation from lesson agenda
	Teacher insight
	Responding to the (un)availability of tools and resources

Figure 2: The codes of the Knowledge Quartet (Rowland, Turner, Thwaites & Huckstep, 2009)

FINDINGS

Examination of the changes the pre-service teachers made to their lesson plans, observations from the two lessons each group taught and observations of the group meetings provided valuable insights into the pre-service teachers' learning throughout the lesson study process. The changes that they made to their lessons were based on the feedback they received from the faculty members teaching the course, from their reading of research relevant to their topics and from the observations that were made during the first teaching of the lesson. The findings from this data show that the lesson study process helped the pre-service teachers become more aware of several theoretical aspects of teaching by carefully analysing the lessons they planned and taught. The following paragraphs look in more detail at the particular aspects of teaching which were most greatly affected.

Using a context in mathematics teaching

The importance of using a context in the teaching of mathematics is strongly encouraged in the mathematics primary school curriculum. The guidelines state that "for children to really understand mathematics they must see it in context" (Department of Education and Science, 1999). The need to use a context to explore their mathematical concepts was something which

all the groups recognised at the beginning of the lesson study process. However the contexts originally chosen by three of the groups were not age appropriate or meaningful for a Fifth class group - for example, one group had chosen the fairy tale, Goldilocks and the Three Bears, as the context for their lesson. This issue was flagged by the faculty members teaching the course in the initial group meeting and the groups subsequently changed their contexts. These changes were then proven to be very successful in the subsequent teaching of the lessons, in particular for the probability group teaching describing likelihoods. Rather than the fairy tale context they had initially chosen they elected to show a video clip of the TV programme, Top Gear, and discuss the probability of two racers winning a race. In their meeting after the first teaching of the lesson, all of the pre-service teachers remarked how important their context had been in immediately sparking the students' attention and engaging them in the lesson.

Anticipating students' responses

In the planning phase of lesson study particular attention is paid to anticipating student responses in order to enable teachers to be better prepared to deal with issues that might arise during the course of the lesson (Fernandez & Yoshida, 2004). Although many of the Japanese teachers involved in lesson study are able to "draw on their past experiences" and "observations of their current students" (Fernandez & Yoshida 2004, p. 7) in order to anticipate student responses, the pre-service teachers relied on the experience of the faculty members teaching the course and research relevant to their topics to help them to anticipate student responses. Anticipating student responses allowed the pre-service teachers deal effectively with misunderstandings which occurred during the lesson. One example of this was in the algebra lesson where a student wrongly identified the algebraic pattern the class were working on. The teacher whose group had prepared for this error was able to guide the student to the correct algebraic pattern using suitable manipulatives. The teacher later commented that knowing this error may arise meant she had a solution ready when it did actually arise. This helped maintain the flow of the class and gave the teacher confidence.

Role of a mentor in the Lesson Study process in initial teacher education

However in the same algebra lesson mentioned above some responses which had not been anticipated arose and the teacher found some of these difficult to deal with. This occurred when the students were working in pairs to identify an expression to represent a new algebraic pattern. The students were calling out the expressions they had come up with in their pairs and the teacher was finding it difficult to recognise "on the spot" if their solutions were correct or incorrect. The members of faculty teaching the course suggested several strategies the teacher might use to deal with student responses. One of these was getting the students to test their answers themselves. In the following class she successfully implemented this strategy by getting the student to solve their expression and check their answer using cubes. Similarly, in other groups who were having difficulty dealing with student responses particularly if they were incorrect the members of faculty teaching the course suggested that they get the pupils to justify their answers and then discuss them as a class group. This proved to be an effective strategy for the pre-service teachers. In the second teaching of the lesson

incorrect responses were explored and corrected, whereas in the first lessons many incorrect responses were ignored.

Another extremely important aspect of the initial phase of lesson study is the identification of precise learning goals. The first draft of three of the groups' lesson plans either included no learning objectives or vague learning objectives. As a result some of the activities they included in the lesson served no purpose in achieving the objectives they had for the lesson. In other cases in meant that the activities planned for the lesson were not sequential, students were expected to complete harder tasks before they had built up the required understanding. Also because it was not clear what the students were supposed to be learning, it was impossible to determine if it was accomplished at the end of the lesson (Hunt, Wiseman & Touzel, 2009). Again the groups, received feedback from the faculty members teaching the course, to this effect and the pre-service teachers developed much clearer precise objectives and changed the activities accordingly. This led to the pre-service teachers assessing the success of their lessons in the feedback meetings by referring to how well they felt the learning goals were achieved in the lesson. Hiebert et al (2007) "propose that focusing on students' learning and explaining such learning (or its absence) in terms of instructional episodes provides a targeted but comprehensive and systematic path to becoming an effective teacher over time" (p. 48).

Finally the conclusions of the pre-service teachers' lessons often failed to reflect the purpose of a conclusion. Many of them were very lower order or unrelated to the tasks which the students had previously done. Hunt et al (2009) say that "the conclusion of a lesson is often neglected by some teachers because they tend to concentrate their attention on the body of the lesson" (p. 70). At the early feedback meetings the members of faculty teaching the course stressed the importance of the conclusion in consolidating, reinforcing and reviewing what had been covered in the lesson. They also highlighted the diagnostic assistance it offers teachers in preparing to teach future lessons. Following this feedback the pre-service teachers adapted their conclusions and they remarked in the feedback meetings after the first teach how the concluding activities such as thumbs up, thumbs down and the use of whiteboards had given them instant feedback on the success of their lessons.

DISCUSSION

Implementing the lesson study model as part of the primary pre-service course proved to be an effective approach to help pre-service teachers bridge the theory-practice gap. The pre-service teachers developed several valuable skills; they learned the importance of context in engaging their students with the mathematics they are teaching, they learned the importance of understanding students' thinking about the concepts and anticipating their responses; they learned valuable instructional techniques and they learned to analyse their lessons in view of learning goals.

Similar to the findings of previous studies, which looked at implementing lesson study approaches in pre-service teacher training, the researcher found that the pre-service teachers learned to think more deeply about learning goals (Sims & Walsh, 2009). They began to analyse the success of their own lessons in terms of these learning goals. Hiebert et al. (2007)

suggest “that assessing whether students achieve clear learning goals and specifying how and why instruction did or did not affect this achievement lies at the heart of learning to teach from studying teaching” (p.48).

However the important role of the mentor in this process cannot be overlooked. The pre-service teachers had already been taught the importance of objectives and conclusions numerous times during their initial teacher training. The mentors, in this case the members of faculty teaching the course, brought aspects of teaching which the pre-service teachers were overlooking, such as objectives and conclusions to their attention. Then during the course of the lesson study process they began to see how these aspects of teaching they were overlooking affected the overall success of their lesson.

“Learning from teaching is a critical component of successful teacher education” (Sims and Walsh 2009, p.732). The Lesson study cycle these teachers engaged in offered them an opportunity for this to happen. Implementing a lesson study approach, with the necessary support, in initial teacher education has the potential to help pre-service teachers bridge the theory-practice gap.

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