

PROFESSIONAL DEVELOPMENT OF PRIMARY SCHOOL MATHEMATICS TEACHERS THROUGH LESSON STUDY

Ronél Paulsen

Department of Mathematics Education, University of South Africa

paulsr@unisa.ac.za

Abstract

Lesson Study is a teaching improvement and knowledge building process which originated in Japan. This paper reports on a Lesson Study Project operational in Mamelodi, a suburb east of Tshwane, South Africa. Twelve Primary schools and about twenty teachers are currently involved in the project. The essence of Lesson Study is that teachers plan lessons collaboratively and then the lesson is taught by one of the teachers while observed by the other teachers. In South Africa teachers typically plan, teach and assess learning experiences in isolation. Their experiences regarding the learning that takes place in the classroom are seldom shared with other teachers. Valuable information gets lost, because it is not recorded or even observed by the teacher in her classroom. Lesson Study, as practised in Japan cannot simply be transferred to the South African context. This paper endeavours to illustrate the professional growth of the teachers since the project started.

Keywords: Professional development, Lesson Study, Primary Mathematics

1 Introduction

After the first democratic elections in South Africa, in 1994, the education system changed drastically. The most significant change was the introduction of Outcomes Based Education (OBE) in 1997. Each Minister of Education since 1994 put his or her own stamp on educational changes. By the end of 2009, the then Minister of Education declared OBE as “dead”, and the curriculum was reformed once again. Teachers were on the receiving end of all these changes. During the “OBE years”, teachers attended many in-service training sessions, but these were mostly about general issues relating to administration and not on subject specific content. Primary school teachers are often expected to teach many other subjects, and teachers often find themselves in positions where they have to teach mathematics without the necessary content knowledge. Taylor and Vinjevoold (1999) point out that

“Teachers’ poor grasp of the knowledge structure of mathematics, science and geography acts as a major inhibition to the learning of these subjects” (page139).

Content knowledge is not enough. Adler and Reed (2002) state:

“The issue is how to integrate further learning about how students in school acquire subject knowledge” (page 25).

In an endeavour to bring across some change in the classroom practices of teachers of mathematics in primary schools, the Lesson Study project was launched in 2009 at one of the eight primary schools selected to participate in the project. In 2010, eight more schools joined the project. What started off as a community project, became a research project.

2 Conceptual framework

The research is framed on three pillars. Firstly, the theory of andragogy is taken from Malcolm Knowles (1986). The theory of adult learning or andragogy is based on the assumptions that differ from pedagogical models. Adults come to an educational activity with different experiences. Knowles (1994), stated that adults’ orientation to learning is life centred and their experiences are a rich resource, which should not be ignored (Knowles, 1994, p. 31). The second pillar is that of situated learning as explicated by Lave and Wenger (2002) and Greeno (1998). With respect to professional development, situative theorists focus on the importance of creating opportunities for teachers to work together on improving their practice, and locating these learning opportunities in the everyday practice of teaching (Ball and Cohen 1999; Putman and Borko, 2000). The last pillar is the theory of constructivism, which has been popularised by, amongst others, von Glasersfeld (1984), Cobb (1984), Confrey (2002) and Ernest (1991). The main tenet of constructivism is that knowledge is not transmitted from the teachers to the student, but that students construct their own knowledge through their own experiences in their domains of knowledge.

3 Professional development

To be a professional teacher is vastly different from being a professional in any other sphere of the social environment. A professional teacher has to be equipped with different skills and knowledge to operate successfully in a classroom, where he or she has to act upon the daily

requirements of her or his duties. Deborah Ball (2008) describes these differences by comparing the “common ways of being” to the “ways of being in teaching”.

3.1 The process of change

Development of any kind is associated with change. For teachers to change their teaching practices, they must first become aware of their own day – to – day actions in their classrooms. A teachers’ view of the nature of mathematics influences the way in which he or she will teach mathematics. Teachers’ conceptions of what constitutes “good mathematics teaching” are deeply rooted, since the beliefs that underlie these conceptions are resistant to change and reinforced through extensive experience. (Martins in Pehkonen and Törner: 1999)

Shaw, Davis and Mc Carty (1991) believe that, in order for teachers to change, they need to go through a process, starting from an experience of perturbation, then making a commitment to change by being part of the vision for change, make the changes and eventually become reflective practitioners.

Often teachers are so used to their daily routine, that something in their lives should happen to cause this distinct interruption or disorder that will bring along a need or desire in the teacher to change. This need cannot be satisfied unless there is a definite commitment from the teacher to change. Furthermore, if the teacher or a group of teachers construct a goal for change, then they create something concrete to work towards. Once a goal has been set, the teachers have to become part of this goal. It must in a way be personalised. The most difficult part of change is to actually make the changes in their classrooms. Not only would their thinking processes have to change, but also their teaching habits. To continuously reflect on their own growth or development can make the teachers aware of their own commitment and encourage them to pursue their goals.

3.2 Teachers’ beliefs

Teachers’ beliefs about teaching and learning have mostly developed as a result of their own schooling. These beliefs are predominantly taken from the teaching that took place in traditional classrooms. In the traditional classroom, knowledge is seen as a body of knowledge of established facts that can be transmitted from the teacher to the students. In a constructivist classroom, knowledge is seen to be a human construction where meaning is negotiated in a

community of practice. Teaching and learning in a constructivist setting will involve a problem solving situation, where cognitive dissonance will stimulate the process of making sense of mathematical concepts.

Teachers must be able to identify themselves with a constructivist approach to teaching and learning. This “swopping” from one approach to another will by no means be easy, and it cannot happen overnight, or by attending a workshop in which the approach might, with the best intentions be made explicit. Teachers have to experience this in a much deeper context. They will have to become part of the experience. They must be practically involved in the process of teaching and learning in an environment where the ideas of constructivism are being made explicit. They must become a part of the solution.

Teachers are the implementers of the curriculum in their classroom. They are influenced by what they think of their students and about the trajectory of learning that should take place in the classroom. They work with their own understanding of the content. Their interpretation of the content shapes their actions in the classroom. They are the ones who fashion the material, choose the tasks and decide on how to focus and frame the material. In the social environment of the classroom, teachers pay attention to the discourse that might take place and the roles played by teacher and students. But they are also influenced by their own views of a broader community in the context of their profession. Thus, the way in which teachers “shape “ the curriculum in the classroom, can be seen as dependent on a variety of factors.

4 Lesson Study

Lesson Study is a popular professional development process that Japanese teachers engage in to systematically examine their practice. The goal of lesson study is to improve the learning experience that teachers provide to their students. It is a wide spread practice in Japan with a long history. The Japanese word for Lesson study is *Jugyokenkyo*.

Lesson study as a school-based strategy is primarily used at the elementary level directed by teachers within a school. Teachers decide on the content of the lesson study and proceed through a process that generally has five components: (1) teachers plan the lesson collaboratively; (2) the lesson is taught by one teacher and observed by other teachers; (3) the team of teachers meet to reflect on the lesson and improve it; (4) the lesson is taught again, usually by another teacher,

with refinement; and (5) the lesson is discussed again and made into a booklet that is available to other teachers. These steps can be referred to as the “cycle” of Lesson Study. The Lesson Study model, used in Japan, was adapted to fit in the South African context.

5 Methodology

The Lesson Study project in Mamelodi involved the continuous engagement of the researcher in the project to monitor the professional development of the teachers involved. To collect data during this process, action research would seem the most suitable method to gather information to answer the research questions. As the study was over a long period of time (2 years), data were collected by various means.

5.1 Action research

Action research is the process of using research principles to provide information that educational professionals use to improve aspects of day-to-day practice. (Mc Millan and Schumacher, 2006: 414). Action research is conducted in four main stages. These stages can be juxtaposed to the cycle of Lesson Study.

- Selecting a focus, topic or issue of study

In this research the main focus was on Lesson Study as a means to develop teachers’ professionalism.

- Collecting data

Throughout the Lesson Study Project, data were collected and used to make adjustments to the manner in which the material was presented to teachers, and how lessons were conducted during the period of involvement of the teachers and the researcher. As action research is typically cyclic in nature, it fits perfectly in the Lesson Study cycle.

- Analysing data

Action research is not limited to a specific methodology, and typically the data are used descriptively. The researcher was actively involved throughout the study thus practice and research were integrated. Both qualitative and quantitative methods were used to analyse the data. However in this study, the data analysis was mainly descriptive.

- Taking action based in the results

To take action based on the results would mean that something has to change. This “change” that takes place, can be considered as a step in the professional development process.

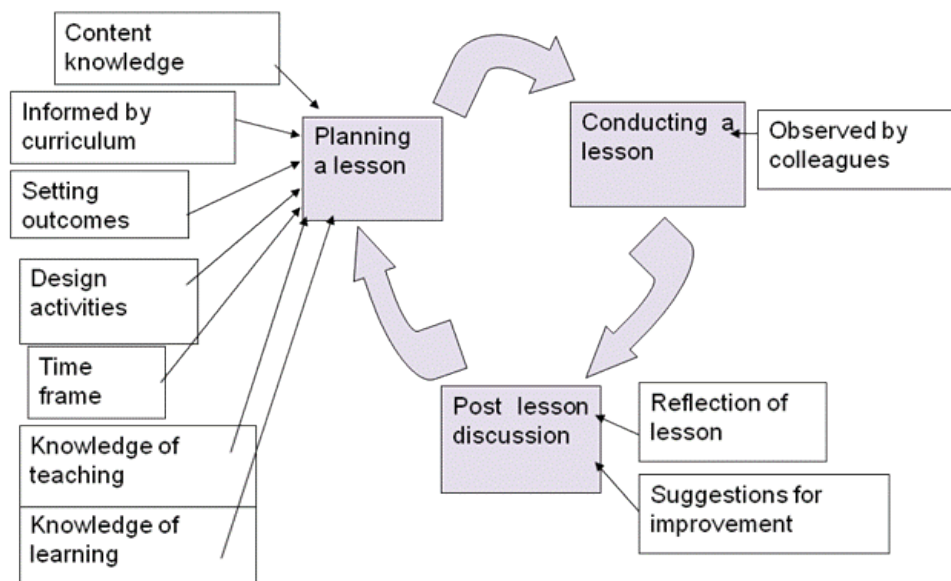


Figure 1 The Lesson Study cycle which was adapted from Ono (2008).

5.2 Data collection

Qualitative data were collected during the project in the form of:

- video recordings of workshops and live lessons
- open ended questionnaires which involved reflections of teachers during their engagement in the project
- journal entries of teachers involved in the project
- individual interviews with a selected group of teachers.

6 Results and discussion

The results can be discussed under three headings:

- Teachers' content knowledge
- Teachers' planning of lessons
- Journal entries

6.1 Teachers' content knowledge

At the onset of the project, teachers were given a baseline test, consisting of basic mathematical concepts in primary schools. From the results, it was clear that teachers would need much more than the planning of a lesson, which is the first step in the practical part of the Lesson Study cycle.

One of many examples of teachers' responses showing the poor content knowledge of teachers.

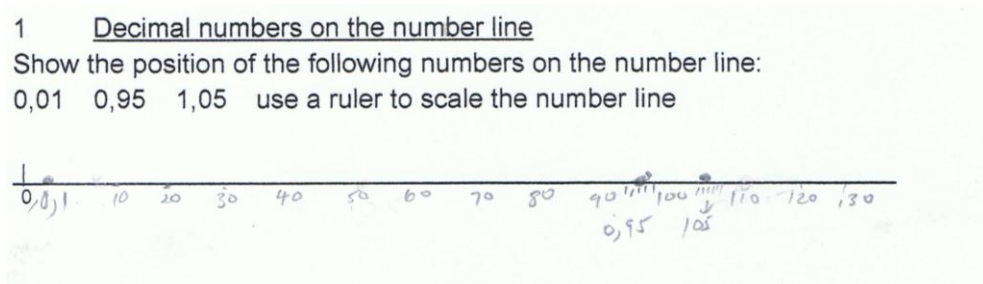


Figure 2: Placing decimal fractions on the number line


The scaling of the number line to plot some given information on a number line is dictated by the actual numbers. In this instance the scaling of the number line should have ideally been scaled in tenths of a unit. Three of the teachers ($n = 19$) scaled the number line in tenths and only one teacher placed the numbers in the correct position on the number line. Twelve teachers either did not do the question, or used inaccurate scaling, or did the question incorrectly.

The procedural knowledge to locate the tenths digit before looking at the other digits when plotting numbers such as 0.01 ; 0.95 on the number line, could lead to the development of conceptual knowledge (Rittle-Johnson, Siegler and Alibali, 2001). They claimed that procedural and conceptual understanding of decimal numbers on the number line develop iteratively (page 359). The weak performance of teachers in the baseline test was an indication that teachers in the study had a weak understanding of decimal fractions.

6.2 Planning of lessons

Proper lesson planning is one of the cornerstones of Lesson Study. A typical lesson plan designed by Lesson Study practitioners would consist of columns for teachers' activities,

students' activities, anticipated questions from students and lastly assessment or evaluation of these actions. In contrast to these, the teachers in the study had never been introduced to lesson planning other than to complete a template provided by the Department of Education. This template is generic and can be adapted for any subject. It consist of broad outcomes as laid down in the curriculum, such as a statement “decimal fractions of the form 0.5, 1.5 and 2.5 and so on, in the context of measurement” (grade 5) or “decimal fractions to at least two decimal places” (grade 6). Teachers in the project found it extremely difficult to plan a lesson where they had to think “in advance” about students’ reactions, or possible questions that students might come up with. The template for a lesson plan provided by the Department of Education does not make provision for any actions from either the teacher or the students in the class. Below is an example of a lesson plan supplied by the Department of Education



Lesson Plan: Mathematics (Intermediate Phase)

Grade: 4 **Date: Start:** 27 July 2009 **End:** _____
Duration: 18hrs

Critical Outcomes	Identify and solve problems Work effectively with others Organise and manage themselves and their activities Collect, analyse, organize and evaluate information Communicate effectively using various methods Use science and technology effectively Recognising that problem solving do not exist in isolation	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	Developmental Outcomes	Exploring a variety of strategies to learn effectively Acting as responsible citizen Being culturally and aesthetically sensitive Explore education and career opportunities Develop entrepreneurial opportunities														
Learning Outcomes	Numbers, operations and relationships Patterns, functions and Algebra Space and shape Measurement Data Handling	<input checked="" type="checkbox"/>	Assessment standards:	7.6; 10, 11.2; 1.3; 3.4;														
Theme: <u>DIVISION</u>		Integration:																
Activity Outcomes:		Learning outcome:																
• Estimate and calculate by selecting and using operations appropriate to solving problems that involve equal sharing. • Use a range of strategies to check solutions and judge reasonableness of solutions. • Recognises, describe and use the reciprocal relationship between multiplication and division. • Estimate and calculate by selecting and using operations appropriate to solving problems that involves division of whole numbers up to at least 3 digits by up to at least 1 digit whole numbers		<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td>LLC</td> <td>NS</td> <td>TECH</td> <td>EMS</td> <td>SS</td> <td>AC</td> <td>LO</td> </tr> <tr> <td>5.3.</td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td>4</td> </tr> </table>			LLC	NS	TECH	EMS	SS	AC	LO	5.3.	1					4
LLC	NS	TECH	EMS	SS	AC	LO												
5.3.	1					4												
Core Knowledge/Contexts:																		
• Estimate and calculate by selecting and using operations appropriate to solving problems that involve equal sharing. • Use a range of strategies to check solutions and judge reasonableness of solutions. • Recognises, describe and use the reciprocal relationship between multiplication and division. • Estimate and calculate by selecting and using operations appropriate to solving problems that involves division of whole numbers up to at least 3 digits by up to at least 1 digit whole numbers																		

Figure 3: Template for lesson planning (Department of Education)

6.3 Journal entries

Professional development is a personal journey. It is an attribute that cannot be measured quantitatively. Teachers in the study were requested to account their experiences in the form of journal entries. These entries were coded to come to an understanding of what it was in the Lesson Study Project that could contribute to the teachers’ professional development.

When looking at the responses of teachers who were involved in the project, one could make come to the conclusion that teachers believed that the project made some difference in their classrooms. Here are some of the responses of teachers to the question: “How, in your opinion did you make a difference in your Mathematics class since you started with the Lesson Study Project? Please explain.”

“I can now be able to explain new topics much easier than before. I have learnt new ways/techniques of teaching mathematics. I can be able to make my own resources much cheaper like using charts to make various shapes when dealing with equivalent fraction”. (*Errens* in the LS project)

“Learners were not used to work in groups. I explained to them the importance of group work, most of the lesson I used concrete learning aids to assist the learners.” (*Rosina* in the LS project)

“My planning and teaching has improved a lot. Learners are able to follow. I am also able to use new easy method and my mathematical knowledge has improved.” (*Neria* in LS project)

7 Conclusion

When working with people, there is always a degree of uncertainty if one is going to achieve what you embarked upon. When working with teachers who are adults and mostly set in their ways, this uncertainty is even bigger. The Lesson Study Project was a personal journey that I undertook to make a difference in the mathematics education in the primary schools in my country. The journey that I undertook with teachers in under privileged schools in Mamelodi was mixed with feelings of sadness and then extreme gratitude. The comradeship built up between the teachers and myself will always form a part of any future endeavours to make a difference in the teaching and learning of mathematics in South Africa. This paper cannot do justice to my personal feelings of achievement in the small role that I could play in the professional development of the teachers involved in the project, because they were much bigger than me. They allowed me to become part of their journey. This is an ongoing journey and in the years to come, I hope that we, as a team can conclude many more Lesson Study cycles.

- Adler, J. & Reed Y. (Eds). 2002. *Challenges of teacher development: an investigation of the take-up in South Africa*. Van Schaik Pretoria.
- Ball, D.L. (2008) *Building professional education for teaching mathematics: Meeting the challenges*. National Council of Supervisors of Mathematics. Salt Lake City UT.
- Ball, D.L. & Cohen, D.K. (1999) *Developing practice, developing practitioners: Toward a practice-based theory of professional education*. In G Sykes and L Darling-Hammond (Eds.) *Teaching as a learning profession: Handbook of policy and practice* (pp.3 – 32) San Francisco: Jossey Bass.
- Cobb, P. (1884) Where is the mind? Constructivist and socio-cultural perspectives on mathematical development. *Educational Research*. 23 (7) 13-20.
- Confrey, J. (2002) *Learning to listen: A student's understanding of the powers of ten*. In E von Glasersfeld (Ed). *Radical constructivism in Mathematics Education*. Kluwer Academic Publishers. New York
- Edwards, T.G. (1994) Using a model to understand the process of change in a middle school mathematics teacher. *Paper presented at the research pre-session of the 72nd Annual Meeting of the National Council for Teachers of Mathematics*. Indianapolis, Indiana.
- Ernest, P. (1991). *The Philosophy of Mathematics Education*. London, Falmer Press.
- Greeno, J.G. (1998) The Situativity of knowing, Learning and Research. *American Psychologist* 53, 1:5-26
- Knowles, M. (1984). *The adult learner: A neglected species*. Houston: Gulf Publishing.
- Lave, J. & Wenger, E. (2002). *Situated Learning: Legitimate Peripheral Participation*. New York Cambridge university Press.
- Mc Millan, J.H., & Schumacher, S. (2006) *Research in Education: Evidence Based Inquiry*. 6th edition Pearson Education.
- Ono, Y. & Paulsen, R. (2008) *Teachers' professional development through Lesson Study: a collaborative venture of Japan and South Africa*. Teacher Education at a Distance Conference. University of South Africa
- Pehkonene, E. & Törner, G. (1999) Professional development: what are the key factors for mathematics teachers? *European Journal of Teacher Education* Vol 22 No 2/3

Putman, R. & Borko, H. (2000) What do new ways of knowledge and thinking have to say about research on teacher learning? *Educational researcher*. 29 (1) 4 – 15

Rittle-Johnson, B., Siegler, R.S., & Alibali, M.W. (2001). Developing conceptual understanding and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology*, 93(2): 346-362.

Shaw, K.L., Davis, N. T. & Mc Carty B. J. (1991). A cognitive framework for teacher change. In RG Underhill (Ed). *Proceedings of the Thirteenth Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, 2 (pp. 161-176). Blacksburg, VA: Virginia Tech.

Taylor, N. & Vinjevold, P. (1999) *Getting Learning Right: Report of the President's Education Initiative* (Joint Education Trust, Johannesburg).

von Glasersfeld, E. (1984). *An introduction to radical constructivism*. In P. Watzlawick (Ed.), *The invented reality* (pp. 17-40). New York: Norton.