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School–University Partnerships for Professional Development of Teachers: A Case of Lesson Study Intervention in Mathematics

Maleho D. Letloenyane* and Loyiso C. Jita**

Abstract

School–university partnerships for the professional development of teachers continue to be used extensively in South Africa to enhance the quality of teaching and learning, especially in mathematics. The success of such partnerships in changing teachers' classroom practices, however, remains in doubt, in part because very few studies present empirical evidence of the changes. This paper assesses the impact of one such partnership, which resulted in perceived changes in teachers' instructional practices and curriculum decisions after the intervention. Using retrospective pre-testing design, the study established that there were significant differences between teachers' pre- and post-test scores, which suggests that teachers changed their instructional practices and curriculum decisions after the intervention. The findings provide some empirical evidence that partnerships of this nature, between schools and universities, may prove valuable in attempts to improve the teaching of school mathematics, especially in the South African context.

* ICT Lab Manager, School of Open Learning, University of the Free State, South Africa. Email: letloenyanemd@ufs.ac.za

** Professor and SANRAL Chair, School of Mathematics, Natural Sciences and Technology Education, University of the Free State, South Africa. Email: jitalc@ufs.ac.za

Résumé

Les partenariats écoles-universités pour le développement professionnel des enseignants continuent d'être largement utilisés en Afrique du Sud pour améliorer la qualité de l'enseignement et de l'apprentissage, particulièrement en mathématiques. Cependant, la capacité de ces partenariats à changer les pratiques pédagogiques des enseignants est incertaine, en partie parce que très peu d'études présentent des données empiriques sur les changements. Cet article évalue l'impact d'un tel partenariat, qui a entraîné des changements patents dans les pratiques pédagogiques des enseignants et les décisions concernant les programmes scolaires après l'intervention. En utilisant un modèle de pré-test rétrospectif, l'étude a établi qu'il y avait des différences significatives entre les scores des enseignants enregistrés lors du pré- test et du post-test, ce qui suggère que les enseignants ont changé leurs pratiques pédagogiques et leurs décisions relatives aux programmes après l'intervention. Les résultats fournissent des preuves empiriques montrant que de tels partenariats entre les écoles et les universités peuvent se révéler précieuses pour l'amélioration de l'enseignement des mathématiques à l'école, en particulier dans le contexte sud-africain.

Introduction

Since the Jomtien conference on Education for All in 1990 called for an increase in partnerships in education, various kinds of partnerships have proliferated. These partnerships include school–university partnerships (Bartholomew and Sandholtz 2009), university–university partnerships (Samoff and Carrol 2004) and school–university–donor agency partnerships (Bukari and Jita 2009). The present study involved a school–university partnership, which was designed to improve the teaching and learning of mathematics in the Free State province of South Africa.

Researchers have, for some time, been calling on universities and schools to collaborate systematically to achieve school reform and teacher development (Allen, Howells and Radford 2013; Walkington 2007). Partnerships in education provide a way of achieving more with less, in that they enable maximum utilization of available resources to achieve educational goals and to foster innovation (Walkington 2007). Universities and schools have a symbiotic relationship – both organisations produce and implement knowledge for reform and research purposes. It is no surprise that researchers such as Borthwick et al. (2003: 356) boldly state that 'school and university partnerships are here to stay'.

Schools and universities often work together in initial teacher preparation, when universities place their pre-service teachers in schools for work-integrated learning (Zimpher and Howey 2005). In some cases, the partnership may be

for research purposes to encourage teachers to conduct research together with university academics (Burton and Greher 2007). There are also reports on the use of partnerships for the preparation and empowerment of school principals (Browne-Ferrigno and Barber 2010). Internationally, there is renewed interest in systemic and effective school–university partnerships to improve the quality of in-service teachers through professional learning (Walkington 2007).

School–university partnerships create opportunities for teachers and university academics to learn by drawing on each organization's knowledge and expertise (Bartholomew and Sandholtz 2009). By virtue of their mandate of training and producing teachers, university academics have the capacity to assist teachers in choosing the appropriate teaching methods and strategies for specific topics (Walsh and Backe 2013). In the same vein, schools assist universities academics to comprehend the realities of the classroom, and therefore, schools provide the necessary information that allows university academics to design professional development interventions that address their needs. A number of researchers (e.g. Darling-Hammond and Richardson 2009; Desimone 2011; Guskey and Yoon 2009) describe ideal conditions for professional learning to occur effectively. The best way to create most of these conditions is through partnerships.

The school–university partnership described in this paper uses Lesson Study, an innovation that is credited with the consistent improvements of Japanese teachers' instructional practices and student achievement in mathematics (Stiegler and Hiebert 1999). Lesson Study is a school-based professional development approach that is completely driven by teachers and where teachers work collaboratively to improve instruction and student learning. The common activities of Lesson Study in which teachers participate involve research and common planning, teaching and peer observation, and post-observation group reflection (Lewis 2009).

Many studies report that teachers' classroom practices improve as a result of professional learning in a partnership (Mogari and Onwu 2004; Saito et al. 2007), but there is very little work to demonstrate sustainability of such improvements beyond the life of the learning interventions. Similarly, South Africa grapples with the reality of identifying interventions that can impact on teachers' practices beyond the usually brief periods of intervention. Given the popularity of Lesson Study as a school-based, self-sustaining professional development approach for mathematics teachers in other parts of the world, little is known about its effectiveness in the South African context (Posthuma 2012). This paper assesses the impact of a school–university partnership by answering the following research questions:

- What are the effects of Lesson Study intervention (i.e. research and common planning, teaching and peer observation and post-observation group reflection) on teachers' curriculum decisions?
- What are the effects of Lesson Study intervention (i.e. research and common planning, teaching and peer observation and post-observation group reflection) on the participating teachers' instructional practices?

Review of the Relevant Literature

School–University Partnerships

As mentioned above, in many countries, partnerships are regarded as valuable structures for facilitating the professional development of teachers. A study conducted in Indonesia, for example, assessed the impact of a school–university partnership on teachers and the university faculty (Saito et al. 2007). The intervention used a derivative of the Lesson Study approach called Piloting Activities to improve teacher attributes. The findings suggest that teachers' ability to deal with 'visible practices' (students' worksheets, students' process skills and lesson planning) improved as a result of participation in the Piloting Activities.

In South Africa, a partnership was established between the University of Venda and the Limpopo Department of Education called UNIVEMALASHI, which sought to assist teachers with the implementation of educational reforms (Mogari and Onwu 2004). Here too, the authors reported success regarding the ability of the approach to assist teachers to alter their classroom behaviour. The teachers reportedly worked more closely with their learners and improved their questioning skills, which led to increased curiosity and autonomy on the part of the learners.

There are a number of similar studies that report on the positive impact of school–university partnerships on teachers' classroom practices that have prompted the present investigation into the impact of Lesson Study within partnership in the Free State province.

Lesson Study

Lesson Study is a reflective teaching approach, where teachers work collaboratively to examine teaching and learning in the classroom. Although Lesson Study has been employed by Japanese schools for over four decades, it was only brought to the attention of the international education community in the 1990s by the Third International Math and Science Study (Stiegler and Hiebert 1999). Lesson Study has since spread and is practised in many countries, including the Unites States of America, Australia, Kenya, Malaysia and South Africa.

The aim of the Lesson Study is, fundamentally, to improve instruction by promoting collaboration and sharing of practice. The underlying principles of Lesson Study are that teachers are likely to alter and improve their instructional practices after observing other teachers who are knowledgeable about the subject matter and pedagogy (Perry and Lewis 2009). The Lesson Study group usually comprises four to six members who teach the same subject or grade. The activities of a Lesson Study group are usually referred to as a cycle that begins with research and common planning of a lesson and concludes with further research and (re-)planning or refinement of the lesson.

Research and Common Planning

After the formation of the Lesson Study group, the members choose a research theme (Lewis 2009). The members then identify a unit of study, plan for a series of selected lessons from a unit and one research lesson to be presented by one member of the group.

Teaching and Peer Observation

The research lesson is then presented by one member using the formulated lesson plan, while the other members of the group observe the lesson presentation. The observations focus mainly on the students' learning and their engagement during the lesson (Perry and Lewis 2009).

Post-observation Group Reflection

After the presentation and observation, the group reflects on the lesson and discuss strong and weak points of the lesson (Lewis 2009). If necessary, the group then revises the lesson plan and nominates another member of the group to present the revised lesson to a second group of students, thus completing the cycle.

Lesson Study is not completely new to South Africa. It was used, for example, as an approach to professional development in the Mpumalanga Secondary School Initiative (MSSI) partnership (Jita, Maree and Ndlalane 2008). In their final reflections about the MSSI partnership, Ono and Ferreira (2010) note that the partnership failed to institutionalize Lesson Study as a form of school-based in-service education and training, partly due to implementation difficulties. While the Lesson Study approach struggled to take root in the province of Mpumalanga, Ono and Ferreira (2010) note that the partnership in general had a positive impact on teacher practices, although the impact varied from teacher to teacher. Jita, Maree and Ndlalane (2008) believe that the MSSI partnership contributed to reducing the gap between professional development interventions and teachers' classroom practices.

In yet another study, also in South Africa, five teachers were introduced to a derivative of Lesson Study in the Free State province (Posthuma 2012). Posthuma (2012) reports that the participating teachers were able to reshape their behaviour and to critically reflect on avenues for improving their instructional practices in order to enhance student achievement.

The studies provide tentative evidence of the effects of Lesson Study on South African teachers. The present study therefore continues this strand of research by presenting quantitative data on a South African case of a Lesson Study intervention for mathematics classroom improvement using a relatively large sample of primary- and secondary-school teachers from the Free State province.

Conceptual Framework

Teacher Learning

Teachers are likely to consider altering or improving their practices in a classroom if they acquire new perspectives on their current practices. The acquisition of these new perspectives constitutes what we call teacher learning. Teachers require quality and sustained learning opportunities to change their 'traditional' practices (Hubbard, Mehan and Stein 2006). Furthermore, as Putnam and Borko (2000) argue, learning and cognition are entrenched in social and physical contexts, thus making learning a social process. For this reason, many scholars believe that teacher learning will be more effective when undertaken collegially (Borko 2004; Darling-Hammond and Richardson 2009; Desimone 2011). That is, teachers are likely to learn more within communities of practice (CoP).

Communities of Practice

Communities of practice, as described by Wenger, McDermott and Snyder (2002), have been used in numerous contexts. Wenger, McDermott and Snyder (2002) define CoP as a group of people who share a problem, concern or enthusiasm about a certain topic, and improve their expertise and knowledge by frequent interaction. While research on CoP is positive about their potential benefits to members, questions have been raised regarding the sustainability of CoP. Supovitz (2002) notes that CoP are successful initially, but tend to disintegrate over time. Buysse, Sparkman and Wesly (2003) argue that CoP flourish when they endure over time and offer sufficient learning opportunities for teachers. This study originated from the premise that Lesson Study groups constitute a form of CoP, where teachers examine their own classroom practices with the goal of improving it. The partnership between the schools

and university in this study also represents CoP, where the teachers are supported to enhance their skills through collaborative professional learning in the Lesson Study groups. The situated nature of Lesson Study and the fact that the intervention is driven largely by the mathematics teachers themselves may, in this case, address the concern raised by Buysse, Sparkman and Wesly (2003) relating to the longevity of CoP.

While teachers may learn a variety of skills in CoP such as Lesson Study, this article limits itself to the impact of CoP on the teachers' instructional practices and curriculum decisions. Curriculum decisions are central to events in the classroom, and shape the teachers' classroom practices, which, in turn, determine the students' opportunities to learn (Chabongora and Jita 2013).

Curriculum Decisions

As early as 1983, Shavelson (1983) recognized that teachers' decisions, both conscious and unconscious, are an important part of quality teaching and learning. Curriculum decisions refer to what students are taught, as well as planned and unplanned skills, attitudes and information. In his book, Klein (1991) categorizes the decisions that should be considered when dealing with curriculum, *viz.* decisions about (i) content; (ii) purposes, goals and objectives; (iii) materials and resources; (iv) activities and teaching strategies; and (v) evaluation, grouping, time and space. This paper draws on Klein's framework to examine the changes resulting from the Lesson Study intervention.

Instructional Practices

It is widely accepted in the education community that enhanced instructional practice could have a positive impact on student achievement. Windschitl et al. (2012) propose a core set of instructional practices for teachers that we adapted in our context for mathematics teachers. The set includes (i) developing active learners; (ii) orchestrating collaborative discourse; (iii) varying teaching formats; (iv) employing integrated learning; and (v) encouraging critical thinking, and engaging in reflective practice. These practices are similar, in many ways, to those that were proposed authoritatively by the National Council of Teachers of Mathematics (NCTM), for instance (NCTM 2000).

Method

We used a survey to assess the impact of the Lesson Study intervention on the decisions and practices of mathematics teachers who participated in the study (Cresswell 2014). Retrospective pre-testing was the preferred approach for data collection in this study. Howard, Schmek and Bray (1979) describe a discrepancy called 'response shift bias', which confounds most pre- and post-

test self-reports. Response shift bias is a phenomenon that involves participants evaluating themselves from different frames of reference. To overcome this phenomenon, Howard, Schmek and Bray (1979) suggest that the pre-test should be administered around the same time as the post-test. Researchers agree that retrospective pre-testing may be a more effective approach for assessing the impact of interventions using self-reports than the traditional pre- and post-test approaches (Hetcher 2011; Kistler and Brier 2003).

Participants

The sample consisted of primary- and secondary-school teachers of mathematics from the Free State province who participated in the Lesson Study intervention. The participants (n = 110) were nominated by their employers for the intervention. In total, ninety-three questionnaires were completed and returned, with only eighty-five participants (77 per cent of the original sample) answering the questionnaire correctly to enable analysis. The biographical data profile of the participants is presented in Table 1 below:

Table 1: Biographical Information

Variable	Description	Quantity
Gender		
	Male	36.5% (n = 31)
	Female	63.5 % (n = 54)
Age		
	Under 25	2.4% (n = 2)
	26–29	7.1% (n = 6)
	30–39	12. 9% (n = 11)
	40–49	57.6% (n = 49)
	50–59	20.0% (n = 17)
Teaching experience		
	Under 2	3.5% (n = 3)
	2–4	14.1% (n = 12)
	5–9	15.3% (n = 13)
	10–15	14.1% (n = 12)
	16–20	24.7% (n = 21)
	Over 20	28.2% (n = 24)

Qualifications		
	3 year Diploma (Education)	15.3% (n = 13)
	3 year Diploma + ACE	28.2% (n = 24)
	4 year Bachelors (Education)	14.1% (n = 12)
	3 year Bachelors + Teacher certificate	8.2% (n = 7)
	4 year Diploma (Education)	3.5% (n = 3)
	Senior qualification (Hons, MSc, PhD + Teaching certificate)	8.2% (n = 7)
	Senior qualification (Hons, MEd, PhD in Education)	17.6% (n = 15)
	Other	4.7% (n = 4)
Number of interventions (Previous 2 years)		
	None	14.1% (n = 12)
	1	20.0% (n = 17)
	2	24.7% (n = 21)
	3	17.6% (n = 15)
	4	10.6% (n = 9)
	5	12.9% (n = 11)

Programme Description

The Lesson Study intervention was a product of a partnership between the University of the Free State (UFS) and the Free State Department of Education (FSDoE). The partnership sought to develop a sustained, intense and focused professional development intervention to address the challenges encountered by teachers and students in their day-to-day teaching and learning of mathematics in primary and secondary schools. The backdrop of the intervention is the unsatisfactory performance of primary and secondary school mathematics students in South Africa over the past few years (HSRC 2011).

The Japanese Lesson Study approach was used as a vehicle for the intervention. The workshops were presented over a period of six days spread over six months. The two-day, face-to-face sessions every second month were hands-on and teachers participated interactively in researching, planning and delivering exemplary lessons on selected mathematics topics during the workshop. After each workshop, the teachers were expected to implement what they had learned and compile a portfolio of evidence to document their implementa-

tion at school. The implementation began with a request that the teachers set up Lesson Study groups at their schools, where they would practice the ideas learned at the workshops. During the workshops, the teachers engaged in the learning of mathematics through the use of laboratory activities and manipulatives designed to improve the necessary conceptual and process skills that are essential for understanding and presenting content to diverse groups of learners. The intervention was divided into three modules as follows.

Module 1: Lesson Study Approach (Contact Session)

The module introduced teachers to the Japanese version of Lesson Study through both literature and video clips. Furthermore, the module offered the teachers several opportunities to actually engage in the various stages of the Japanese version of a Lesson Study, including doing preparatory research for a lesson topic, planning a lesson, delivering the lesson and collaborative reflection on the lesson.

Module 2: Mathematical Knowledge for Teaching (Contact Session)

In this module, the teachers worked on identifying the key themes of each topic in the mathematics curriculum. Examples were taken from sections of the content that had been identified as the most challenging and problematic for teachers and learners by the FSDoE. The module was designed to improve and develop the teachers' Mathematical Knowledge for Teaching (Ball, Thames and Phelps 2008), which includes deeper conceptual understanding of key mathematical topics and the ability to identify common errors and misconceptions among learners.

Module 3: Teaching and Lesson Study Practicum (School-Based)

This module was designed to provide teachers with the opportunity to create and sustain Lesson Study groups for mathematics in their own schools. The teachers had to take part in at least one Lesson Study cycle at their schools or districts, and had to present at least one collaboratively planned lesson in mathematics to a group of learners. A portfolio of evidence (PoE) also had to be submitted, together with specific endorsements by a school supervisor (such as the principal, deputy and/or head of department).

Data Collection

In the last session of the workshop (six months later), the teachers were requested to complete a questionnaire regarding changes in their instructional practices and curriculum decision-making that resulted from participating in the intervention. One of the researchers personally administered the 45-minute questionnaire to the teachers.

Instrument Design

The instrument was a five-point Likert-scale questionnaire with responses ranging from strongly disagree to strongly agree. The questionnaires contained before- and after-the-intervention parts, in line with retrospective pre-testing protocols.

Using guidance from Klein (1991) on curriculum decisions, and framing on instructional practice components by Windschitl et al. (2012), we developed items and/or modified others from accessible unpublished theses and published research papers (for example, Rock and Wilson 2005; Wright 2009) that measured the impact of Lesson Study on teachers. The items were then grouped into their respective subscales.

Reliability

Cronbach's alphas were calculated to determine the internal consistency of the instrument (McMillan and Schumacher 2010). SPSS was used to calculate the Cronbach's alphas and the results (Table 2) indicate that they were all above 0.7. Reliability coefficients of over 0.7 suggest that the items were reliable (Cohen, Manion and Morrison 2007).

Table 2: Cronbach's Alphas

Construct	Subscale	Cronbach's alpha	Number of items
Teacher practice			
	Research and common planning	0.72	7
	Teaching and peer observation	0.73	5
	Post-observation group reflection	0.70	4
Curriculum decisions			
	Research and common planning	0.87	6
	Teaching and peer observation	0.72	4
	Post-Observation group Rreflection	0.75	3

Data Analysis

Percentages and mean ranks were calculated, using SPSS, to show differences between the pre- and post-test scores. We further calculated means for the subscales to show general trends in the data. For the purposes of this article, the means are used to show differences in pre- and post-test scores together with the mean ranks.

The Wilcoxon signed rank test (see Cohen, Manion and Morrison 2007: 552) was used to establish if there were significant differences between the pre- and post-test scores. The Wilcoxon signed rank test, which is the non-parametric equivalent of a paired sample t-test, assesses this difference by comparing mean ranks, not the means of the pre- and post-tests scores for significance. In essence, a *two-tailed* Wilcoxon signed rank test ($p = 0.01$) was used to test the following null hypotheses:

Curriculum Decision

- There is no difference in teachers' perceived curriculum decision scores before and after the intervention as a result of *research and common planning*.
- There is no difference in teachers' perceived curriculum decision scores before and after the intervention as a result of *teaching and peer observation*.
- There is no difference in teachers' perceived curriculum decision scores before and after the intervention as a result of *post-observation group reflection*.
- *Instructional practices*
- There is no difference in teachers' perceived instructional practices scores before and after the intervention as a result of *research and common planning*.
- There is no difference in teachers' perceived instructional practices scores before and after the intervention as a result of *teaching and peer observation*.
- There is no difference in teachers' perceived instructional practices scores before and after the intervention as a result of *post observation group reflection*.

Ethical Considerations

Permission was obtained from the FSDoE and the required ethical clearance processes of the UFS were followed. Informed consent was also obtained from the participants, who were informed of their right to withdraw from the study at any point, should they wish to do so (McMillan and Schumacher 2010). All the data were secured using encryptions on SPSS.

Findings and Discussions

Research Question No. 1

What are the effects of a Lesson Study intervention on the teachers' perceived curriculum decisions?

Retrospective pre-test scores indicated that there were differences in the teachers' curriculum decisions after the intervention. We illustrate this point by means of one of the items in the research and planning subscale.

After the intervention, there was an increase of forty-two (49.4 per cent) teachers who *strongly agreed* that they were able to choose the appropriate content for their lessons, bringing the total to fifty-nine (69.4 per cent). The data indicates that most teachers changed their choices to *strongly agree* or *agree* after the intervention, with the majority choosing *strongly agree* (see Table 3). This trend could be traced through all the items in the subscales assessing the intervention's impact on teachers' curriculum decisions.

Table 3: Participant Scores in Research and Common Planning Subscale: Curriculum Decisions

	I choose the appropriate content for my lessons				
	Strongly agree	**Agree**	**Not sure**	**Dis-agree**	**Strongly disagree**
Before Lesson Study	20.0% (17)	60.0% (51)	16.5% (14)	3.5% (3)	0% (0)
After Lesson Study	69.4% (59)	30.6% (26)	0% (0)	0% (0)	0% (0)
Change	49.4% (42)	-29.4% (25)	-16.5% (14)	-3.5% (3)	0% (0)

The mean ranks for the subscales provided an overall view of the trends in teachers' scores. The mean ranks and means for the subscales *research and common planning*, *teaching and peer observation* and *post-observation group reflection* before the intervention were 114.08 (2.16), 113.63 (2.19), 111.63 (2.14) and 56.92 (1.47), 57.37 (1.47), 59.37 (1.41) after the intervention respectively (Table 4). The data provided further evidence that most teachers changed their opinions to either *agree* or *strongly agree* after the intervention

Table 4: Mean Ranks and Means
for the Summed Curriculum Decisions Subscales

	Before Lesson Study		*After* Lesson Study	
Subscale	Mean rank	Mean	Mean rank	Mean
Research and common planning	114.08	2.16	56.92	1.47
Teaching and peer observation	113.63	2.19	57.37	1.47
Post-observation group reflection	111.63	2.14	59.37	1.41

Furthermore, the Wilcoxon test statistic revealed that all the hypotheses for the curriculum decisions construct were not supported, as the p-value was below 0.01 in each case. There were significant differences in teachers' curriculum decisions as a result of their participation in research and common planning ($Z = -7.52$; $p < 0.01$), teaching and peer observation ($Z = -7.20$; $p < 0.01$) and post-observation group reflection ($Z = -7.11$; $p < 0.01$). Effect sizes (r) for the subscales revealed that the difference between the pre- and post-test scores was moderately large for all the subscales (Table 5).

Table 5: Wilcoxon Test Statistics and Effect Sizes: Curriculum Decisions

Subscale	**Z**	**p-value**	**r**
Research and common planning	-7.54	0.00	-0.82
Teaching and peer observation	-7.20	0.00	-0.78
Post-observation group reflection	-7.11	0.00	-0.77

The findings suggest that teachers' perceived curriculum decisions improved after their participation in Lesson Study. The mean ranks and means show that teachers were aware of improvements in their curriculum decisions after participating in the intervention. This result is further substantiated by the Wilcoxon test statistic and the p-value, which suggest that these improvements in teachers' curriculum decisions were not due to chance. Lastly, the magnitude of the improvement after the intervention is moderately large, as shown by the effect sizes. The findings support the argument of Darling-Hammond and Richardson (2009) namely, that professional learning interventions tend

to be effective when the focus is on specific curriculum issues in the classroom. Borko (2004) posits that if teachers are to impact student achievement positively, they must have a thorough understanding of concepts, facts and interconnections that are central to the discipline. It could be suggested that in line with findings by Lewis, Perry and Hurd (2009), the teachers' understanding of mathematics content changed significantly after the Lesson Study intervention. Thus, our findings demonstrate that teacher interactions during the research and common planning may have led to improvements in knowledge and/or understanding of important concepts in the mathematics curriculum. By observing other teachers and students in the classroom situation, the teachers' awareness of student thinking during the learning process seems to have improved. Posthuma (2012) argues that teachers derive meanings that inform decisions relating to their actions as a result of group reflection. Reflection is important for teachers, enabling them to assess aspects of their curriculum decision-making; that is, during reflection teachers are able to measure the success of their lessons by evaluating the effectiveness of the decisions taken during the lessons (Lewis 2009).

Research Question No. 2

What are the effects of Lesson Study intervention on teachers' perceived instructional practices?

In a pattern similar to that of the first research question, the data showed significant differences in teachers' pre- and post-test scores after the intervention. An item from the subscale post-observation group reflection is used to demonstrate these differences.

After the intervention, there was an increase of forty-five (53 per cent) teachers who *strongly agreed* that they discuss instruction with their colleagues, bringing the total to fifty-six (65.9 per cent). Once again, a large number of teachers changed their opinions to *agree* and *strongly agree* after the intervention. This trend could be traced through most of the items on perceived instructional practices.

Table 6: Participants' Scores in the Post-observation Group Reflection Subscale: Instructional Practices

	I discuss instruction (teaching) with my colleagues				
	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Before Lesson Study	12.9% (11)	54.1% (46)	12.9% (11)	17.6% (15)	2.4% (2)
After Lesson Study	65.9% (56)	32.9% (28)	1.2% (1)	0% (0)	0% (0)
Change	53.0% (45)	-21.2% (18)	-11.7% (10)	-17.6% (15)	-2.4% (2)

The mean rank for the subscales *research and common planning, teaching and peer observation* and *post-observation group reflection* before the intervention were 113.86 (2.27), 110.92 (2.04) and 117.02 (2.26) and 57.14 (1.59), 60.08 (1.47), 53.98 (1.40) after the intervention respectively (Table 7). The findings suggest that there were significant changes in teachers' perceived instructional practices as a result of participating in the three activities of Lesson Study.

Table 7: Mean Ranks (and Means) for the Summed Instructional Practices Subscales

	Before Lesson Study		*After* Lesson Study	
Subscale	Mean rank	Mean	Mean rank	Mean
Research and common planning	113.86	2.27	57.14	1.59
Teaching and peer observation	110.92	2.04	60.08	1.47
Post-observation group reflection	117.02	2.26	53.98	1.40

Once more, hypotheses relating to the perceived instructional practices were not supported, as the p-values were below 0.01. There were significant differences in teachers' instructional practices as a result of their participation in research

and common planning ($Z = -7.41$, $p < 0.01$), teaching and peer observation ($Z = -7.05$, $p < 0.01$) and post-observation group reflection ($Z = -7.50$, $p < 0.01$). The effect sizes indicate that the magnitude of the difference between the pre- and post-test scores was large for each of the three subscales (Table 8).

Table 8: Wilcoxon Test Statistics and Effect Sizes: Instructional Practices

Subscale	**Z**	**p-value**	**r**
Research and common planning	-7.41	0.00	-0.80
Teaching and peer observation	-7.05	0.00	-0.76
Post-observation reflection	-7.50	0.00	-0.81

The findings therefore show that the teachers' perceived instructional practices may have improved significantly after their participation in the Lesson Study intervention. These findings are indicative of a shift in teachers' perceived instructional practices as a result of the intervention. The Wilcoxon test statistics illustrate that the improvements in teachers' instructional practices were not due to chance and that the magnitude of the differences in their pre- and post-test scores were, like the finding for the first research question, moderately large. The review of literature carried out by Vescio, Ross and Adams (2008) supports the finding that teachers' practices improve when they focus more on their students. Taylor et al. (2005) report that teachers' interactions during research and common planning results in improved lesson plans, which have a positive effect on student learning. Our findings therefore suggest, in agreement with Lewis, Perry and Hurd (2009), that teachers' conceptions of what constitutes students understanding, and the means to help students learn, may have changed significantly as a result of the Lesson Study intervention. Fernandez (2005) argues that it is imperative to consider student thinking when planning a lesson. The observation of a lesson offered teachers the opportunity to observe students learning without the burden of teaching. As such, teachers were able to jointly plan instructional practices that assist students to learn better. Our results also point to the importance of group reflection for the improvement of instructional practices. Taylor et al. (2005) found that group reflection afforded teachers the opportunity to question assumptions, share information and re-evaluate their practices.

Conclusion and Recommendations

It is evident from the findings that teachers believe that partnership for professional development had a positive impact on their perceived curriculum decisions and instructional practices. The teachers' participation in each of the three major activities of a Lesson Study seems to have contributed significantly to changes in their perceived decision-making and classroom practice. Specifically, teachers reported improvements in their ability to collaborate with other teachers, which helped to improve their knowledge regarding classroom practices and the way students acquire and process knowledge. These results provide evidence that partnerships of this nature could prove valuable in attempts to enhance the standard of mathematics teaching in South Africa and elsewhere. We therefore recommend that teacher learning should, where possible, be orchestrated within the context of partnerships, such as those that involve schools and universities.

Although our results are encouraging, they should be approached with caution. The methodology used to collect data, viz. retrospective pre-testing, has its own inherent weaknesses. For example, participants in the study may feel the need to score the intervention in a way that makes it seem more effective than it actually is. Memory effects also present a challenge, where the assumption is that participants will remember their initial state after a period of time (six months in this case).

Another methodological limitation is the fact that we could not categorically ascertain the external consistency (Confirmatory Factor Analysis, CFA) of the instrument because the number of participants was not sufficient to obtain meaningful results from the analysis. As this methodology uses self-reports, it would be interesting to determine if the perceived changes in teachers' instructional practices and curriculum decisions are visible and enacted in their classrooms. There may also be a need to use more robust methods of determining the impact of partnerships for professional development, not only on teachers but on students as well.

The next phase of our research, which is ongoing, involves a qualitative study of the classroom practices and instructional decision-making by the teachers involved in our study.

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