

THE AFFORDANCES OF ADAPTED LESSON STUDY IN SOUTH AFRICA - TWO CASES

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ABSTRACT– Teacher education programmes are often criticised for not addressing the ‘theory-practice divide’. Student teachers are left underprepared for facing the ‘coalface’ of practice. Two of the possible reasons can be didactics modules being too theory-based and a lack of mentorship at the university or (WIL) schools. According to the Japanese lesson study model teachers collaboratively design, present, refine and re-present a lesson. Two different ways of implementing lesson study, at two South African universities that focused on the professional development of life sciences and mathematics student teachers, are shared by the authors. This qualitative research resulted in findings that highlight the affordances of lesson study approaches in the process of enculturation within a community of practice. Participants include 60 life sciences and 30 mathematics (either 4th year BEd or PGCE) student teachers. Data collection methods included individual- and focus group interviews and reflective journals. The authors utilised third generation Cultural-Historical Activity Theory to provide a gaze on the findings. Findings suggest that lesson study has potential to facilitate the building of relationships between theory and practice as well as the professional development of STEM teachers within communities of practice.

Keywords: Lesson study, Life Sciences; Mathematics; professional development, communities of practice

INTRODUCTION

The Japanese have an ancient proverb ‘*I no naka no kawazu taikai wo shirazu*’, which means in a literal translation ‘a frog in a well does not know the great sea’. The meaning of this proverb is that people are often satisfied to judge things by their own narrow experience, never knowing of the wide world outside. This serves as a reminder to stakeholders in science and mathematics education to learn from global best practices. South Africa, with her dismal performance in science and mathematics education (just consider South Africa’s performance in the Trends in Mathematics and Science Study (TIMSS) (Martin, Mullis, Foy, & Stanco, 2012) should take notice of innovative professional development such as lesson study in countries excelling in science and mathematics education, e.g. Finland and Singapore.

Lesson study originated in Japan and is a collaboration-based teacher professional development approach where teachers with a shared interest in their students’ learning collectively plan a lesson that would ensure maximum student learning (Murata, 2011 p.10). The lesson study provides opportunities for teachers to do research and reflect on their teaching practice and student learning (Ono & Ferreira 2010). After planning the lesson, one of the group members teach the lesson in a real classroom (live setting) while the others observe their lesson and collect data about how well the students learn. The data is then used to critically reflect on the lesson and students’ learning, and if needed, revise and re-teach the lesson. The Japanese say that lesson study builds teachers’ knowledge when working collaboratively to make student thinking visible in a collectively owned research lesson (Cerbin & Kopp, 2006). The group then writes up their findings - what they did, what worked and didn’t work - to increase the quality of teaching and learning and share their insights publicly with other teachers.

For some reason the Japanese lesson study never gained the momentum in South Africa (Ono Ferreira, 2010) for example in the joint project of Japan and Mpumalanga 1999-2008. This is unfortunate, since

research shows that inadequate teacher professional development is one of the reasons for the underperformance in science and mathematics education (CDE, 2011; De Beer & Ramnarain, 2012).

In this article the authors share and discuss the affordances of the Japanese lesson study in teacher education, by looking at two different projects: one in Life Sciences (Gauteng) and one in Mathematics (North-West) by using adapted lesson study approaches to facilitate student teachers' professional development.

2. WHY LESSON STUDY IN SOUTH AFRICA?

Advancement in research on the human brain and more socio-constructive approaches in education brought about changes in the approach to teaching and learning. Both students and teachers construct their own knowledge by learning, un-learning and re-learning when they are socially and culturally engaged in situated teaching-learning activities (Bransford, Brown & Cocking, 2000; Lave & Wenger 1991).

The most common way that universities try to address the theory-practice divide, is by entering into partnerships with schools where student teachers are placed for the school practicum component (Work Integrated Learning) (WIL) of the teacher education programme. This is also a requirement of the policy on the minimum requirements for teacher education qualifications (Council for Higher Education (CHE), 2015).

One of the problems in South African education is the high attrition rate amongst newly qualified teachers. Whitelaw et al. (2008) has shown that one of the main reasons why neophyte teachers are leaving the profession is the strained relationship and power-issues that they often experience in what these authors call 'pseudo-communities of practice' in schools. Whitelaw et al. have shown that teacher education programmes often inadequately prepare student teachers for the dynamics of team teaching, or working as a member of a team within a subject group.

The Council for Higher Education (CHE) (2015:12) requires, in the Revised Policy on the Minimum Requirements for Teacher Education Qualifications – different types of knowledge such as pedagogical knowledge as referring to "the study of the principles, practices and methods of teaching ... includes knowledge of students, learning, curriculum and general instructional and assessment strategies", while specialised pedagogical content knowledge is defined as "knowing how to present the concepts, methods and rules of a specific discipline in order to create appropriate learning opportunities for diverse students, as well as how to evaluate their progress".

Another problem faced during student teachers' WIL is the lack of mentorship that is often experienced in schools where student teachers obtain teaching experience. In many South African schools, the student teachers are left to struggle through the problems they experience on their own, without the scaffolding from a mentor teacher.

It is therefore surprising, taking this context into consideration that the lesson study approach never really took off in South Africa.

2.1 The Life Sciences project at an urban university in Gauteng

Fourth-year B.Ed and Post-graduate Certificate in Education (PGCE) student teachers enrolled at the University of Johannesburg in Gauteng were involved for an entire year in teaching Life Sciences to students of a school associated with the university. The particular school does not offer Life Sciences, and the student teachers collectively took on the role as teachers for these students in Grades 10. In this project we implemented lesson study in a particular way, where student teachers worked in groups of four for the entire year. Student teachers had to take responsibility for planning and presenting lessons, assessing the students, and providing support to students with specific needs. The mentoring was provided by teacher educators in the programme.

Lesson study is a collaborative, cyclical and continuing professional development process, which aims to assist teachers to improve their lessons through critical reflection (Chikamori, Ono & Rogan, 2013). For this reason reflection was emphasized in the project. Reflection for practice was done with the life

sciences teacher-educators three days prior to presenting lessons to the students. The student teachers had to bring their lesson plans, and with the teacher educators they reflected on the lesson plans, and whether the planned pedagogies would be appropriate for the particular students, and whether there is evidence of open-ended inquiry (one of the outcomes of the course that these student teachers were registered for). Student teachers were also constantly reminded of the need to reflect in practice (reflecting on their teaching in the midst of the lesson). After the lesson, the students and teacher educators reflected on practice, critically discussing the lesson, and reflecting on the strengths as well as the weaknesses. Very often this reflection ended in the revision of the lesson plan, and re-teaching. (Since the school students came to the university in the afternoon (on weekdays) and on Saturdays, we had the luxury of time, and the programme was flexible enough).

2.2 The Mathematics project at an urban university in Northwest

Fourth year BEd intermediate phase (Grades 4 to 6) mathematics intermediate phase student teachers registered at the North-West university took part in this study for a semester (10 weeks). The content of the Mathematics didactics course was based on an adapted lesson study approach. The aim of the two research lessons was investigating teaching and learning of place value and fractions in Grade 6 classrooms while developing their reflective practices, mathematical knowledge for teaching for professional development purposes.

These student teachers formed communities of practice (groups of 4 to 6) to collaboratively plan, present, refine and continuously reflect on sub-sections of the two research lessons for grade 6 students. Groups had to compile a learning trajectory based on CAPS (DBE 2012) for each of their lessons' topics. The development of the concepts from the initial introduction in the foundation phase, to the senior phase (Grade 7 to 9) was captured to get a better perspective and understanding of where and how place value and fractions develop over grades and phases. Furthermore, they set both short and long term goals for a specific school, planned the lessons, predict students' responses to their planned activities, decide how they will know when and if students have learned, and search the internet and other sources for more information. During contact sessions groups reflected one another's planned lesson activities and pedagogies, while the teacher educator acted as mentor. Group(s) or individual student teachers had the option to teach the lesson at a nearby school in a real classroom or during WIL. All student teachers had to keep a reflective journal to reflect on their own and their group's experiences, insights and growth on their journey through the lesson study process.

Furthermore, both projects utilized a prolepsis approach. Prolepsis involves structuring a learning opportunity in a way that "assumes that the students know more than they actually do" (Van Lier, 2004:153). By using a proleptic approach in teaching, the teacher educator can explore the optimal distance between the student's actual and potential development (Vygotsky, 1978). Prolepsis anticipates the internalisation of yet to be attained concepts. It was especially challenging for the life sciences student teachers to facilitate lessons at the beginning of the academic year, without much theoretical- or practical knowledge and experience. The mathematics student teachers believed that preparing for a lesson is done in a short time, using the prescribed textbooks in schools as the only source.

SIMILAR METHODOLOGY OF THE TWO PROJECTS

The research question that guided the two projects' research, were similar: How can adapted lesson study facilitate student teachers' professional development, pedagogical content knowledge and reflection?"

Both projects generic qualitative research resulted in the identification of emerging themes, highlighting what the affordances are of lesson study in pre-service teacher education. Data were collected among 60 life sciences student teachers through questionnaires, Reformed Teaching Observation Protocol (Arizona Board of Regents, 2000), individual and focus group interviews, observations of lessons and written individual reflections from the student teachers. All interviews were transcribed. Data were collected among 30 fourth-year intermediate phase mathematics student

teachers' (over one semester) written reflective journals (guided by open-ended questions); lesson plans and observation of their lessons (field notes). Convenience sampling was used in both projects.

For both the projects, data were collected and analysed. Coding was done, followed by a process of clustering codes into categories, and integrating and refining these categories (Henning, Van Rensburg & Smit, 2004). Finally, categories were grouped together, which resulted in the distilling of a number of similar emerging themes in the two projects. Member checking and triangulation through consistent patterns of theme development among different data sources ensured reliability and trustworthiness. We used third-generation Cultural-Historical Activity Theory (CHAT) (Engeström, 1987) as a research lens, to study the affordances of lesson study, as well as the tensions that emerged in the activity system.

SIMILAR EMERGING THEMES FROM THE TWO PROJECTS

In Table 1 we indicate the codes, categories and emerging themes derived from the data for the two projects.

Table 1: Codes, categories and emerging themes derived from interviews, questionnaires and classroom observations (Life Sciences) and reflective journals (Mathematics)

Code	Category	Theme
Exposed to different teaching methods	Improving pedagogy	This lesson study project improves student teachers' pedagogical content knowledge.
Making provision for different learning styles		
Assessing students' prior knowledge important	Linking content to students' prior knowledge	
Contextualise the work	Content needs to be contextualised	
Improving unpacking of mathematical content knowledge	Quality of teachers' conceptual knowledge influences quality of learning	
Inquiry learning approach	Inquiry learning practice-based learning holds affordances in both Life Sciences and Mathematics learning	Student-teachers realize that problem-based, inquiry learning approaches should be followed, rather than transmission-mode approaches
Students benefit from inquiry		
Team work is beneficial	Positive experiences of lesson study; Team work continued during WIL via email or cell phone	This project, utilising lesson study, creates a community of practice, and student teachers learn to deal with conflict in such a CoP
Difficult to handle conflict in group	Negative experiences of lesson study (group work)	
Time management within the group problematic		
Literature to be studied: too much and too difficult		
Students ask challenging questions	Effective learning opportunity; complimentary to (WIL) school experience	The lesson study project provides effective learning opportunities and growth in confidence that address some of the limitations of (WIL) school experience
Intimidating experience/ nervous at first		
Teachers at WIL schools rarely do practical work/ inquiry; problem solving or lesson planning	There are limitations associated with WIL/ school experience	
WIL schools are under-resourced; difficult to do practical work		
Teacher educators are helpful mentors	Mentors stimulate professional development through feedback	
Teacher educators provide detailed and constructive feedback		
Seeking advice from mentor teachers and other experienced teachers at WIL schools		
Setting examination papers beneficial		Adapted lesson study assist students in their professional development and include aspects often not experienced during WIL.
Develop professionally		

4.1 The Life Sciences lesson study

The life sciences project showed us that the practice of emerging student-teachers in authentic teaching situations, and “throwing them in at the deep end” (prolepsis), despite the anxiety (and feeling of “bungee-jumping”) provide them with opportunities to develop professionally. These student teachers had to take responsibility for the students. Engaging in this approach in teacher education developed student teachers' Gestalts, or phronesis. Zeichner and Tabachnick (1981) have shown that many of the concepts taught during teacher education were “washed out” during field experiences. It seems though if students in this project came to realise the importance of more engaging pedagogies such as of inquiry-learning approaches and laboratory work in Life Sciences over the course of the year.

For education students in the natural sciences, it is crucial to get hands-on experience of inquiry labs, and how to structure it. At least two of the students involved in this project did not know how to use a microscope the beginning of the academic year. One of the fourth year BEd students, who had been to schools on several occasions (school experience, or work-integrated learning) has *never* witnessed a lab/ practical work session. Furthermore, the students involved in this project (bright; engaged; enthusiastic) challenged student teachers to reflect on their own PCK. Many of the students mentioned that the traditional school experience forced them to work on classroom management and discipline, but that they “could get away” with being unprepared for lessons, or having insufficient knowledge. This project, however, showed them how important PCK development is.

University teacher educators involved in the Life Sciences project had to take up the role of student mentors. This gave them a good understanding of the time consuming nature of such mentorship (if it is done well). They also came to realise that the Japanese lesson study model works well.

Not all student teachers liked working in groups (and would rather work on their own), but it is an important enculturation into a community of practice. This is a strong theme emerging from the data. The life sciences students felt like real teachers who had a responsibility towards the Grade 10 students (They were worried about the commitment of the following year's students). One of the student-teachers (Sizwe) said, “I'm praying that the students who are following us would treat our students and present themselves the way we started it (as 2013 Life Sciences teachers)”.

Prolepsis seems to have provided students with an enhanced learning trajectory within the zone of proximal teacher development. This research shows that there is merit in Van Lier's view of scaffolding within an expanded zone of proximal development (Vygotsky 1978), since the students reported on how they have learned from the teacher educators (mentors), as well as from less capable peers, more capable peers and equal peers. Student teachers learned the value of collegiality, within a community of practice. We have seen students replacing transmission-mode PowerPoint slide driven lessons with open-ended inquiry lessons. We have also seen a significant growth in student teacher understanding of the Shulman concept of PCK, and the importance of making informed choices to facilitate maximum student understanding.

Not all the students appreciated the cooperative learning associated with lesson study. One of the Life Sciences student teachers said: “A weakness of mine that is evident is that of wanting to complete and present the lesson solely as an individual, without the assistance of fellow group members. However, by doing this I would not be able to gain insight into different teaching styles and methods, and therefore this would not be beneficial to my own growth and development as an educator”.

4.2 The Mathematics lesson study

The mathematics project showed me that engagement in an adapted lesson study process student teachers' self-confidence, their pedagogical content knowledge, and their understanding of the value of working collaboratively improved.

They convinced themselves through the continuous reflections and critical discussions that students should be engaged in the lesson activities through incorporating inquiry activities, problem solving and practical work. They spend time to plan appropriate lesson activities and effective questions that will help “students to make connections in mathematics”, they predicted students' responses on processes and provided for common errors and/or misconception. “As a teacher, I learned about how to explain”

mathematics. Through their reflections they learned to think about the students in the classroom with regard to their contexts and their prior knowledge. Value were added when they first realised the complexity of teaching mathematics to primary school students (Hill, Ball & Chilling 2008) The student teachers also reported that they realized that a teacher needs sound mathematical concepts (content knowledge), to be able to "state what it is what students should know and be able to do at the end of a lesson". This linked to *unpacking* of mathematical knowledge for teaching (Hill et al., 2008).

These novice student teachers initially had poor reflective literacy but as a consequence of deep thinking that takes time and effort in giving and receiving informative feedback from reflection for (planning), in (monitoring) or on (evaluation) teaching experiences, not only their reflective literacy increased but they "gained more self-confidence to plan and to teach mathematics lessons" and "I now have a better understanding of what is expected of me as a teacher and where students should be". Two student teachers thought that more time is needed for reflection. Metacognition, through reflection acts upon cognition and regulates cognition's product: planning, monitoring and evaluating teaching (Cornoldi 2009).

The lessons observed by teacher educator showed evidence that they changed from teacher-centred to learner-centred teaching by using more engaging pedagogies and socio-constructivist approaches to teaching and learning. According to Shannon (2008) reflection is the engine that drives self-directed learning and guides adaptations and management of change in different situations

As mentor, I realised how time consuming the lesson study processes become when novice teachers, who are not experienced in collaboration with peers and who lack social skills for group work, had to collaboratively plan a lesson.

Not all the students liked the group work, but some of them changed their minds during the semester when they came to understand the value of peers' and the teacher educator's inputs and insights in the planning of lessons. They shared ideas, experiences and sources because they themselves "have learned from my peers" and incorporated group work into their lesson plans. During WIL they kept in touch with their group members "via email or cell phones" to reflect on their lesson plans to make "relevant and meaningful adjustments to the lesson" to the lessons they had to present for evaluation by university staff. They also sought their mentor's and other experienced teachers' (at the WIL school) input and experiences to reflect for, and on their planned lessons. Metacognition, through reflection for (before), in (during) and on (after) teaching and/or learning, are the medium through which we teach and learn - it guides and regulates (planning, monitoring and evaluation) teaching and learning (Cornoldi 2009).

The community of practice was, similar to the life sciences project, a strong emerging theme. Prolepsis seems to have provided students with an enhanced learning trajectory within the zone of proximal teacher development.

Lesson study made them "think differently about teaching and learning". The WIL experiences during the semester were described as being the best they have ever had. Through reflective practice, student teachers realised their identity as self-directed mathematics teachers (Graham & Phelps, 2003) who are lifelong learners.

However, five students expected the teacher educator to have provided them with e.g., a set of good worksheets, a set of well-planned lessons, and also should have taught them fractions and place value, the CAPS document, and common errors and misconceptions. These topics were addressed in previous years' courses which indicate that these students have not yet taken up their responsibility as self-directed teachers. Okoro and Chukwudi (2011) assert that students who are self-directed, activate appropriate metacognitive strategies of planning, goal-setting and monitoring and evaluation and are more likely to become responsible owners of their own teaching/learning processes (Abdullah, 2006). This was not the case of these student teachers.

LOOKING AT THE FINDINGS FROM A THIRD-GENERATION CULTURAL-HISTORICAL ACTIVITY THEORY (CHAT) LENS

Activity Theory was conceptualized by Russian psychologists during the 1920s and 1930s and it placed more emphasis on the social dimensions of learning and on semiotic tool mediation. Engeström (1987) built on Vygotsky's model and generated the third generation activity theory. The third generation CHAT is chosen as conceptual framework in this research to view the bigger picture of how the two hybrids of lesson study assisted student teachers in their professional development.

The **subjects** of the two activity systems are respectively fourth year BEd mathematics and fourth year (BEd or PGCE) life sciences student teachers were registered for subject didactics courses.

The **object** of an activity system represents the problem at which the activity is directed, namely student teachers' professional development (Hardman, 2008). In this paper we reflect on two activity systems: engaging life sciences and mathematics student teachers in hybrid adapted lesson study processes. Pedagogical content knowledge (PCK) includes the collective planning of lessons, time management, working with the official curriculum, and especially the socialization within communities of practice.

Tools are viewed as the resources available. Under tools the research focuses on the life sciences and mathematics curricula, resources such as textbooks, laboratories and ICT's (computer technology and social media), and the pedagogies that unfold in the mathematics and life science classrooms. Laboratory equipment, instruments and artefacts are all tools utilised in the classroom to support learning.

Rules refer to norms, conventions and social interactions at play in the activity system. In the context of this study, we refer to the policy frameworks, national curricula, societal rules and academic rules of the two universities in question. Also of significance, is the learning environment created in the respective classrooms.

The **community** refers to all the stakeholders involved. Student teachers, teacher educators, principals, teachers and students at schools: all influence the achievement of the object of the activity system.

Division of labour refers to responsibilities, tasks and power relations among the different stakeholders who all have a shared responsibility, to provide quality mathematics and life sciences education.

5.1 Tensions experienced in the Life Sciences project

One of the major tensions (or, what Veresov (2007) calls "dramatical collisions") that emerged in the life sciences activity system, was that the student teachers at the beginning of the project did not have sufficient control over tools to facilitate learning. And in the mathematics activity system the "dramatical collisions" that emerged was the lack of social skills for group work and the division of labour where student teachers expected the teacher educator to provide worksheets and good lesson plans.

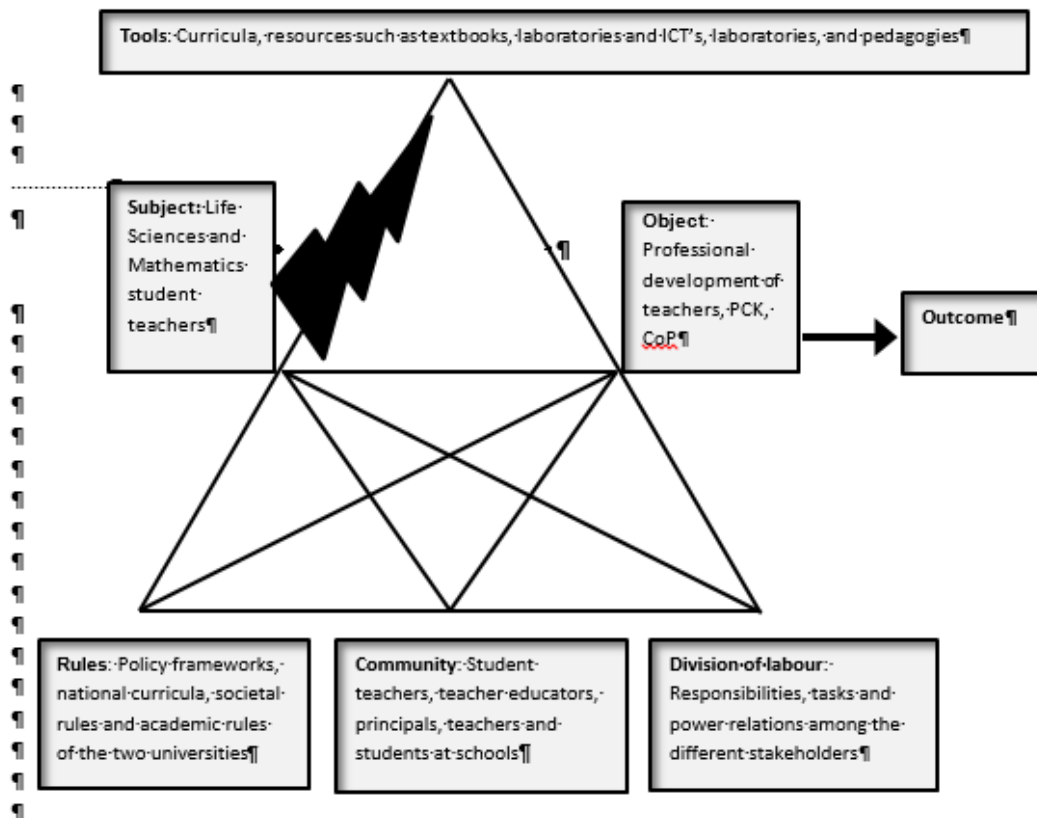


Figure 1: Third generation CHAT lens for life sciences and mathematics student teachers' professional development

Lortie (1975) coined the term “apprenticeship of observation”, referring to the fact that student teachers enter their pre-service teacher education with naive views of what it means to become a teacher, based on 12 years of school experience as pupils themselves, and often drawing on very bad role models that they themselves had as pupils. In this project we could see that. First lesson plans in the life sciences project, in most cases reflected transmission-mode pedagogies, teacher-centred approaches with minimal student involvement, lessons that contained too much factual information (content-laden), and that was not directed at developing skills, and far too little focus on inquiry learning. During the reflection after such lessons, the student-teachers indicated that they felt quite pleased with their lessons. This showed us that they were not critical reflective practitioners. Their views of quality education were informed by the practices of the teachers that they had when they were school pupils.

Another tension was the lack of understanding of the tenets of the nature of science. The student teachers demonstrated a very naive understanding of the nature of science (e.g. its empirical nature, the fact that it is tentative and inferential, or its creative nature). Many of the students in the beginning lessons did not know how to use a microscope, or how to plan open-ended inquiry lessons. However, this greatly improved during the academic year, and transmission-mode lectures were gradually replaced by inquiry lessons honouring the tenets of the nature of science. A similar tension was the lack of mathematics student teachers to unpack their content knowledge, i.e., breaking down their compact mathematical knowledge.

A major tension emerged between the subject (life sciences / mathematics student teacher) and the other students in the particular (lesson study) group (as part of the ‘community’ in the activity system).

For some of the student-teachers, it was extremely difficult to function within a group. In such cooperative learning (within the lesson study model) the following criteria should be observed: positive interdependence, individual accountability and personal responsibility, promotive interaction, and appropriate use of social skills (Johnson & Johnson, 2009). Social interdependence exists when the outcomes of the student teachers are affected by their own and others' actions. Several of the academic strong student-teachers were frustrated by the lack of commitment and ill-preparation of some of the weaker students. This often lead to conflict, or, what Veresov (2007) refers to as 'dramatical collisions'. The teacher educators' responses to these conflicts were to remind the student teachers that they would one day all function within school-based communities of practice and that conflict resolution is an important skill to acquire.

However, the relationship/ interaction of the subject (individual life sciences / mathematics student-teacher) and the community (other student-teachers) were a supportive strength to most of the student-teachers. This relationship was often characterised by a mentee- mentee interplay, where student-teachers assisted each other in their professional and PCK development.

Another tension was observed between the rules and the object. Life Sciences student-teachers would indicate that they use open-ended inquiry approaches in their lesson, yet the classroom rules that they would establish would not be conducive to attaining it. We referred to Lortie's apprenticeship of observation earlier. Many students come from schools where students were expected to quietly and passively "observe" the "sage on the stage", and they often mimic this approach in their own teaching. The teacher educators often had to remind the student teachers that it is OK if the students discuss issues among themselves- that is essential for open-ended learning to be achieved. In the mathematics project student teachers assumed that planning a lesson is an easy task: just follow the prescribed textbook.

Another affordance or tension that we should emphasize, was between the community (the mentor teachers) and the object (the student-teachers' professional development). One of the life sciences students commented: "During school experience my mentor teacher told me that I should teach all his classes, and he will be in the staff room if I experienced any problems. I had to struggle alone with all my problems. I never had the opportunity to discuss my teaching with him. During this project it was different though. At first it was very intimidating to have the professors there in class, watching your every move. At first I thought that they are there to criticize us. However, I quickly realize that they give us very constructive feedback, and they were amazing mentors".

In the mathematics project student teachers tension emerged between the student teachers (object) and division of labour. Some student teachers expected the teacher educator to save them time by providing them with worksheets and good lesson plans: a one-size-fits all approach.

CONCLUSION AND RECOMMENDATIONS

These two cases, provide evidence that lesson study holds many advantages in pre-service teacher education. Through effective mentoring, student teachers become more critical reflective practitioners. Student teachers replace lecture-style pedagogies for inquiry, problem-based learning, practical approaches. The lesson study model also provides an opportunity to learn social skills needed to function as part of a community of practice.

Life Sciences and Mathematics student teachers are both students and teachers: they are students of life sciences /mathematics and students of how to teach life sciences /mathematics and at the same time they are teachers of life sciences /mathematics and teachers of learning-how-to-learn life sciences /mathematics (to their students). Lesson study provides affordances that could greatly assist student teachers in their professional development as teachers, especially in the process of enculturation

within a community of practice. It also provides a unique opportunity to show teachers how theory could be used to interrogate practice.

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