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Benefits and challenges of lesson study: A case of teaching Physical Sciences in South Africa

Ayodele Abosede Ogegbo and Estelle Gaigher
Department of Science, Mathematics and Technology Education, Faculty of Education, University of Pretoria, Pretoria, South Africa
u15310142@tuks.co.za
Trisha Salagaram
Department of Physics, University of Cape Town, Cape Town, South Africa

This study explored teachers' experiences in the teaching of electricity and magnetism during a Lesson Study intervention. Using a case study research design, a sample of 4 physical sciences teachers was conveniently selected from schools in rural and suburban areas. Due to logistical challenges, the 4 participants were grouped into 2 separately functioning lesson study pairs. Data were collected through multiple sources including semi-structured interviews, observations of classroom teaching and Lesson Study meetings, field notes, participants' initial lesson plans and reflective writings. It was found that collaboration through Lesson Study enhanced teachers' professional teaching strategies, networking skills, lesson plan writing, classroom management, self-efficacy and positive attitudes towards teaching. However, challenges such as lack of time, lack of institutional support and insufficient instructional materials pose a threat to teachers' participation in Lesson Study. It is therefore recommended that policy makers develop strategic plans to promote the use of Lesson Study as a school-based professional development initiative. Further research on Lesson Study in pre-service science teacher education may pave the way towards professional collaboration as a sustainable practice amongst science teachers. This may ultimately improve the performance levels of science learners in South Africa.

Keywords: electricity and magnetism; lesson study; physical sciences; professional development; science teaching

Introduction

Physical Sciences is offered as a subject combination of physics and chemistry in South Africa at the Further Education and Training (FET) level. As economic development is being enhanced by innovations rooted in the application of physics, the effective teaching of physical sciences becomes very important to meeting the technological needs of South Africa (SA). Nevertheless, the number of people with the required critical, analytical, problem-solving and technical skills needed to join the South African science community seems to be inadequate, due to learners' poor performance in physical sciences. This is a serious concern for the country because it inhibits the growth of the South African economy.

The poor performance of learners in physical sciences over many years is evident in the National Senior Certificate examination results (Department of Basic Education (DBE), Republic of South Africa, 2016). Typically, less than 40% of learners achieve above 40%, indicating a shortage of well-prepared students entering engineering and science courses at universities. Compared to other countries, the Trends in Mathematics and Science Study (TIMSS) reveal that South African learners typically perform below the level expected at the international rating (Reddy, Prinsloo, Arends, Visser, Winnaar, Feza, Rogers, Janse van Rensburg, Juan, Mthethwa, Ngema & Maja, 2012). Many factors contribute to this poor performance, but the shortage of adequately trained teachers is undeniably a key factor. Of particular concern is teachers' professionalism, which includes teachers' effectiveness, professional competence, knowledge about the content of the subject, teaching methods, by these means contributing to the comprehension of difficult basic concepts (Anderson & Barnett, 2011; Reddy et al., 2012).

Electricity and magnetism have been identified as a conceptually challenging topic in South Africa (DBE, Republic of South Africa, 2015:183; Hekkenberg, Lemmer & Dekkers, 2015) as well as the international arena (Sağlam & Millar, 2006). This topic forms one of the core knowledge areas in the physical sciences curricula worldwide (DBE, Republic of South Africa, 2011; Guisasola, Michelini, Mossenta, Testa, Viola & Testa, 2008). Finding ways to improve learners' conceptual understanding of this challenging topic may contribute to an overall improvement of performance in science. Kriek and Grayson (2009:99) argued that "teachers need to simultaneously develop their content knowledge, teaching approaches, and professional attitudes" to increase the quality of passes in physical sciences.

Efforts to revamp the South African education system through improving teacher's competence, professional knowledge, behaviour, self-efficacy, classroom practice, skills and professional status as teachers have been ongoing for several years (Hofmeyr, 2015). These efforts have included the introduction of the Integrated Strategic Planning Framework for Teacher Education and Development (ISPFTED), the introduction of different ongoing continuing professional development programmes across the Nation, revision of the Curricula, teacher support through the Integrated Quality Management System, and the Quality Learning and Teaching Campaign (Department of Education (DoE), Republic of South Africa, 2007; Withers, 2011).

However, learners' performance in physical sciences remains low, supporting the call for the continuous professional development of South African physical sciences teachers.

There is a need to investigate whether research-based classroom practices may lead to achieving better learner outcomes in SA. The practice of Lesson Study has been credited with the high performance of Japanese learners in TIMSS (Pang & Ling, 2012; Stigler & Hiebert, 2009; Stols & Ono, 2016). Consequently, the approach has been widely adopted across other parts of Asia, Europe, and the United States as a means to improve learner performance. In view of its success in Japan, Lesson Study may be beneficial as a professional development strategy for SA Science teachers.

The current study seeks to explore teachers' experiences regarding the teaching of electricity and magnetism during a Lesson Study intervention. The study addressed three questions:

1. How does Lesson Study influence teachers' professional knowledge?
2. How does Lesson Study influence teachers' attitudes and beliefs?
3. What are the contextual factors affecting teachers' participation in the Lesson Study process?

The study is focused on teachers' experiences, therefore classroom practice and learner outcomes are not investigated. Though classroom practice is observed, the purpose is to understand teachers' learning during Lesson Study.

Literature Review

Teacher's competences

Blömeke and Delaney (2012) claim that teachers' competences include the professional knowledge, professional beliefs, attitudes, skills and motivational variables that support the mastery of effective teaching and learning. Shulman (1987) described professional knowledge as the knowledge base required for teaching which answers the question of what teachers need to know. Research indicates that teachers' knowledge and classroom practices are highly influenced by their beliefs, conceptions, skills, attitudes and motivation (Blömeke & Delaney, 2012; Ernest, 1989). Attitude can be described as the way an individual's personality, beliefs, values, behaviours, and motivations attained from experience is expressed through words and behaviour (Ambusaidi & Al-Farei, 2017; Gun, 2012).

The construct of teacher professional knowledge has been a subject of controversy in the research community for quite some time. There has been series of ongoing debates about what constitute the professional knowledge base of teachers (Corrigan, Dillon & Gunstone, 2011; Jones & Straker, 2006; Shulman, 1987; Tamir, 1988; Zeidler, 2002). Tamir (1988) argued that professional knowledge domains for physical sciences teachers include knowledge of specific topics taught, general pedagogy, topic-specific pedagogy, general education, personal experiences and foundational knowledge of the profession. For the purposes of the current study, teachers' professional knowledge was explored within the topic of electricity and magnetism, focusing on teachers' knowledge of the topic, knowledge about learners' difficulties and knowledge of suitable teaching strategies.

Considering the challenges faced when teaching physical sciences in the 21st century, research claims that the professional knowledge of science teachers should focus on teachers' intellectual work, work organisation, the social and cultural context of science teaching (Corrigan et al., 2011). Hence, achieving quality physical science education and better learner performance requires teachers to regularly update their knowledge base through continuous participation in professional development programmes aimed at improving their professional competence and classroom teaching to enhance learners' outcomes (Coe, Carl & Frick, 2010; Ono & Ferreira, 2010).

Lesson study

Lesson Study is described as a classroom inquiry model which requires teachers to work together in small groups as they jointly plan, teach, observe, analyse and refine classroom lessons to improve their teaching practice (Cerbin & Kopp, 2006; Coe et al., 2010; Fernandez, 2002; Ono & Ferreira, 2010; Pang & Ling, 2012; Stols & Ono, 2016). The process of developing teaching practice within the context of Lesson Study requires teachers coming together to plan a lesson, observe the teaching and learning process during the lesson, evaluate the content of the lesson and mode of delivery, use suggestions from evaluation to prepare better lessons. Lesson Study has four phases, which are:

- goal setting based on desired objectives, which involves considering life-long goals for learners' learning and progress, studying guidelines and syllabus;
- planning which involves the development of the lesson plan by selecting or revising research lessons, anticipating learners' responses, and gathering evidence of learners' learning;
- teaching of research lessons by one of the group members while others observe the lesson and collect data on learners' learning; and
- in-depth critique of research lessons by reflecting, discussing and sharing information on what is learned and its implications for instruction (Lewis & Hurd, 2011).

Research indicates that Lesson Study supports teacher learning through critical discourse by knowledge construction in a social learning environment (Dudley, 2013). Teachers have been able to build school professional learning communities and develop their professional

knowledge in terms of subject knowledge, pedagogical knowledge and pedagogical content knowledge through the phases involved in Lesson Study (Cerbin, 2011; Coe, 2010; Fernandez, 2002; Lewis & Hurd, 2011; Rock & Wilson, 2005; Stols & Ono, 2016). However, teachers' knowledge should not be limited to their cognitive abilities only, but also include their affective abilities. Studies have shown that Lesson Study also builds teachers' professional character, increases self-confidence, enhances focus on learners' learning, improves the quality of teachers' classroom practice and improves learning outcomes (Cajkler, Wood, Norton, Pedder & Xu, 2015; Cerbin, 2011; Coe, 2010; Lewis & Hurd, 2011; Rock & Wilson, 2005). It has also been reported that Lesson Study improves learners' academic achievement due to teachers' learning (Cerbin, 2011; Fernandez, 2002; Lewis & Hurd, 2011; Stols & Ono, 2016). Though Lesson Study supports teachers' natural inclination that continuously improve instruction by taking new initiatives, it focuses more on learners' thinking and learning rather than the teacher (Lewis & Hurd, 2011). Studies reveal that teachers in some part of the western world have started adopting the Lesson Study model as an instrument for promoting experienced learning among teachers and learners (Lewis & Hurd, 2011; Lewis, Perry & Murata, 2006; Ono & Ferreira, 2010).

Despite the benefits attributed to the practice of Lesson Study, there are challenges and contextual factors that also contribute to the failure of successful and sustainable implementation of Lesson Study (Adamson & Walker, 2011; Rock & Wilson, 2005; Saito & Atencio, 2013). Research indicates that establishing sincere collaboration among teachers during Lesson Study is difficult and messy (Adamson & Walker, 2011; Rock & Wilson, 2005). This could be due to teachers' nervousness in opening their classrooms to their colleagues, difficulty in criticising one another, and deliberately avoiding any kind of conflict among themselves (Adamson & Walker, 2011; Fernandez, 2002; Lewis & Hurd, 2011; Rock & Wilson, 2005). Providing constructive criticism and feedback to teachers during team discussions could create conflict and tension among Lesson Study participants (Adamson & Walker, 2011; Rock & Wilson, 2005). Similarly, unequal power relationships that exist among Lesson Study participants may cause some to over criticise observed teachers' practice (Saito & Atencio, 2013). Such power issues may pose potential threats to the successful implementation of Lesson Study.

Another major challenge that may possibly limit the effective practice of Lesson Study is time constraints (Lewis & Hurd, 2011; Yeap, Foo & Soh, 2015). Teachers have different teaching periods and responsibilities, so it is difficult to find a common time to effectively meet, engage in discussions and observe each other's classroom lessons. It is possible that the practical challenge of time and teachers' reluctance to open their classroom to other colleagues for observation, accept constructive feedback, and resistance to changing their sense of professional beliefs, responsibilities and identities are likely to pose a threat to Lesson Study practice within and across South African schools.

Theoretical Framework

This study is underpinned by social constructivism (Vygotsky, 1978) and andragogy, i.e. adult learning theory (Knowles, 1980). Social constructivism posits that knowledge is constructed through social interactions negotiated based on reflection, discussion, and explanation (Rock & Wilson, 2005; Vygotsky, 1978). Therefore, reality and truth are subjectively constructed in a social environment (Creswell, 2003; Nieuwenhuis, 2014). The basis of social constructivist theory in this study lies on individual teacher's attempt to construct knowledge during the Lesson Study process by designing, teaching and reflecting on lessons within an environment where they socially collaborate with one another. This collaborative practice created an opportunity for teachers to build a community of practice where they could learn from each other. Ability to successfully complete new tasks could increase individuals' confidence and motivation to undertake more complicated challenges during their classroom teaching. This describes how cognitive growth may occur in individual teachers as they develop their knowledge and effectiveness based on their sociocultural environment and interaction with one another during this Lesson Study intervention (Vygotsky, 1978; Warford, 2011).

The adult learning theory proposed by Knowles (1980) provides practical references to understand the improving of teachers' practice by Lesson Study. Knowles argues that adults learn based on experience, self-concept, relevance, orientation, readiness to learn, and motivation to learn. As adult learners, the self-concept allows teachers to be in control of their own learning process, as they become actively involved in planning lesson objectives aimed at addressing learners' difficulties. Teachers also draw from their experiences and reflection on learners' challenges to develop practical skills that may enhance learners' conceptual understanding and develop teachers' knowledge. This implies that andragogy describes how teachers learn to understand and support their learners while becoming self-directed adult learners.

Describing and explaining the feasibility of Lesson Study integrate both theoretical perspectives by requiring teachers as adult learners

to collaboratively create meaning and establish a link between their teaching practices and the learning process using real classroom situations as experimental activities. Teachers' willingness to engage in this Lesson Study intervention could inspire them to become lifelong learners seeking to improve their professional knowledge, skills, and classroom practice.

Method

Since the study explored the effects of a Lesson Study intervention within an interpretivist paradigm, a case study design with a small sample was required. Finding teachers who were willing to participate was a challenge, probably because participants were expected to not only attend and participate in time-consuming Lesson Study meetings, over a period of several weeks, but were also expected to agree to video recording of their lessons. Sixteen schools were approached, from which only three agreed to participate. The participants were unable to function as a single typical Lesson Study group due to logistic reasons, therefore the four teachers were grouped into two Lesson Study pairs. Two Grade 11 teachers from a rural school acted as Lesson Study pair A, while the other two participants were Grade 10 teachers from city schools who acted as Lesson Study pair B. A detailed representation of the participants' information is provided in Table 1, using pseudonyms to ensure anonymity and confidentiality.

Table 1 Biographic information of participants

Teacher	Gender	Qualification	Teaching experience	School location	Laboratory resources
Lenox	Male	ACE (Math and Science)	18	Rural	Poor
Mbali	Female	ACE (Science), Diploma (Math Literacy)	3	Rural	Poor
Alex	Male	Bachelor of Education (B.Ed.) (FET) Natural Sciences	5	Suburb	Adequate
Martha	Female	Bachelor of Science (B.Sc.) Human Genetics, Postgraduate Certificate in Education (PGCE)	7	Suburb	Adequate

Lesson Study Procedure

Each Lesson Study pair participated in this research for a period of five weeks in the Lesson Study activities. Pair A (Grade 11) participated in the third term (July to September) of 2016, while Pair B (Grade 10) participated in the second term (April to June) of 2017. Each Lesson Study pair explored three different research lessons. For each of these research lessons, only one Lesson Study cycle was conducted, due to scheduled school programmes. The phases involved in this Lesson Study intervention include the preparation phase, teaching and observation phase, discussion and reflection phase for each of the three research lessons.

At the preparation phase of each cycle, the Lesson Study pair collaboratively planned a lesson by setting goals and designing the teaching and assessment strategies. These planning sessions lasted for about 60 to 90 minutes each. During the teaching phase of the Lesson Study cycle, the jointly prepared lesson was taught by both participants in their classrooms, while video recorded from the rear of the classroom to collect information based on learners' learning and teachers' teaching. These recordings were played back during the reflection phase, where the relevant pair of teachers viewed and analysed the recorded teaching, discussed and reflected on the learners' understanding of the topic. It enabled participants to discuss whether the learning goals were achieved based on designed assessment and the lesson planned. The focus of their discussion was not only on the teachers' teaching, but also on the learners' understanding of the difficult concepts that were taught. Teachers identified teaching and learning gaps based on their reflections and generated recommendations, which could be used in future planning and improvement of their individual classroom instruction.

Data Collection and Analysis

The data were collected from multiple sources, including semi-structured interviews, observations of classroom teaching and Lesson Study meetings, field notes, narrative accounts, documents such as participants' initial lesson plans and reflective writings. The choice to use multiple sources afforded the researchers the opportunity to gather in-depth knowledge about the Lesson Study model, in a way that encourages convergent lines of inquiry (Nieuwenhuis, 2014; Small & Uttal, 2005; Yin, 1994), supporting trustworthiness.

The data were analysed using qualitative content analysis. Nieuwenhuis (2014) describes content analysis as an iterative and inductive process, which uses the similarities and differences in the text to support or disconfirm claims about the phenomenon being studied. In order to understand and interpret participants' responses as data, their words and actions were interpreted in form of codes emerging from data and a priori codes identified from the literature, keeping the research questions in mind. The recorded observations were also repeatedly viewed and supported by the field

notes. Though the first author acted as principal researcher, the second author did independent checks of data coding thereby enhancing trustworthiness.

Findings and Discussion

The findings are presented in terms of three predetermined themes derived from the research questions. These themes are teachers' professional knowledge; teachers' attitudes and beliefs; and challenges to Lesson Study.

Teachers' Professional Knowledge

The Lesson Study process enhanced participants' understanding of how learners learn. For example, Martha indicated during the first planning meeting that she would demonstrate magnetic fields, while learners observed the pattern formed by iron filings. Alex then remarked that allowing learners to observe, draw and discuss the magnetic field lines around the magnet can make the teaching of magnetic fields effective for learners' understanding. During the teaching phase, Martha asked learners to not only observe, but also draw and explain their observations as suggested by Alex. During the reflection session she remarked: "*I normally do this demonstration with learners but not asking them to observe, draw and explain what they saw*." This indicates that the collaborative planning session had a positive impact on Martha's pedagogy knowledge regarding the visualisation of magnetic field lines.

Lenox also indicated how he gained insights into knowing how learners learn:

> *This aspect of planning, where you anticipate learners' responses to questions asked in the class, has actually helped me to be in tune with how learners are likely to respond and not to respond to questions asked* (Lenox interview).

Alex indicated that he learnt to introduce lessons by using challenges from real life to engage his learners.

> *I never really took time to relate my lesson to things in learners' immediate environment* […] *So yes, relating to you made me realise the significance of letting learners know that for instance circuit is everywhere, on our phones, television, sound system and all that.* (Alex interview)

These events show how participating in Lesson Study develops teachers' knowledge of how learners learn through discussions around the planned research lesson, supporting the findings of Murata, Bofferding, Pothen, Taylor and Wischnia (2012).

In the planning meetings of the three research lessons conducted by each Lesson Study pair, discussions were focused on learners' difficulties, teaching methods and activities to be used. Participants reported on how collaborating with another teacher improved their knowledge of teaching strategies as well as content knowledge:

> *The interesting aspect of this is the group discussion, because I was able to understand how to explain the direction of magnetic field on the board using my hand and problem-solving aspect on magnetic flux which my partner fully explained to my understanding because I was finding it a bit confusing.* (Mbali)
>
> *I will say my knowledge of electromagnetism is improving and my mathematics knowledge with respect to the required concept needed in physics is also gradually improving due to participation in this practical training* (Lenox interview).
>
> *I realised that having class observations like this helped me to identify the gaps between learners' understanding of the lesson and my method of teaching the lesson* (Alex interview).

Analysis of the initial interview revealed that Mbali previously used the teacher-centred approach of teaching in addressing learners' difficulties. However, during her teaching of the planned research lessons, it was observed that she started her teaching with questions and called out learners to solve problems on the board. During the final interview, she indicated that participating in Lesson Study had improved her pedagogical approach and practice.

> *Now I know that learners have to be properly grouped before they can make meaningful discussion amongst themselves. Now I know that I have to pick the average learners and group them with the slow ones so they can motivate one another as compared to before when I just ask them to group their selves.* (Mbali interview)

However, there were incidents revealing that inadequate understanding of content was not resolved during the group meetings. This was observed with Pair A, where both Lenox incorrectly explained aspects of Faraday's law while Mbali did not distinguish between magnetic fields and *induced* magnetic fields in her explanations. These mistakes were not addressed during their reflection meetings, as it became clear that neither of them had a clear conceptual understanding of electromagnetic induction, meaning that they were not able to support one another to improve their understanding and teaching of this phenomenon. This implies that improvement in teachers' knowledge due to participation in lesson study could possibly improve learners' performance.

Teachers' Attitudes and Beliefs

Analysis of participants' reflections during meetings and the final interview revealed that participating in this Lesson Study intervention had a positive effect on their attitudes and participants reported improved competency to teach concepts that they found confusing. Mbali indicated during the first planning meeting that when teaching electromagnetism, she focuses on factual content and avoid answering some questions that learners tend to ask. Later, she reported that participating in Lesson Study improved her confidence level:

> *It has helped me to a greater extent in bringing down this wall I have built around me when teaching electromagnetism, which I initially don't answer some questions that learners tend to ask. I just teach and leave* (Mbali interview).

During the initial interview, Lenox indicated little concern about learners' problems in electromagnetism since learners are not assessed in the final Grade 12 examinations.

> *When we moderate for marking, we hardly consider electromagnetism as a difficult topic because learners are not assessed on that topic at the matric level* (Lenox interview).

This remark revealed a low level of enthusiasm and competency in teaching electromagnetism, caused by his belief. However, during the lesson observations, he did show enthusiasm when teaching the topic planned collaboratively with Mbali. This unexpected enthusiasm suggests that critical reflection on teaching electromagnetism changed his beliefs on the value of addressing learners' difficulties in the topic. This conclusion is supported by another change, demonstrated by an early remark that despite teaching for many years, teachers may lack confidence to teach specific topics, because they don't "like" those topics. In the final interview, he indicated that working together with others during Lesson Study improved his confidence to teach electromagnetism.

> *I have a feeling that I am beginning to build my own self-confidence in some aspects of this physics concept* (Lenox interview).

Alex regards Lesson Study as valuable compared to other professional development initiatives:

> *The whole process is a valuable one and significantly important. One phase serves as a building block for the other so I don't think to separate any will be effective. You know I have attended few collaboration activities but time has not permitted me to practice what I have learnt. But this one gives you the opportunity to immediately practise what you learn or what you have done with others to see how effective it works.*

Martha revealed that she changed her perception on developing new teaching methods. She previously regarded re-teaching by using explanations as the only way to assist when learners seemed not to understand. However, engaging in Lesson Study changed her perception on how to improve, as demonstrated during reflection:

> *Mr Alex's suggestion on allowing learners to observe, draw and discuss the magnetic field lines around the magnet made me realise that I could develop new ways of teaching the learners the same lesson if I take my time to critically reflect on the method I used in teaching the lesson before and not just re-teaching using the same method.*

Martha's experience implies that reflection is not only useful to enhance teachers' pedagogical practice in addressing learners' difficulties but also provides opportunity to gain an accurate understanding of how teachers' beliefs, attitudes, and practice are connected (Abd Rahman, 2005).

Contextual Factors and Challenges

Analysis of participants' reflections during the interview and Lesson Study meetings revealed lack of availability of time as a practical challenge affecting teachers' participation in this study. In the literature, time constraint is a commonly cited challenge that limits teachers' continuous practice and effective participation in Lesson Study (Lewis & Hurd, 2011; Yeap et al., 2015). During the data collection, it was observed that participants from Lesson Study Pair A, though in the same school, had different teaching periods and responsibilities, so they struggled with finding a common time to effectively meet, and to observe each other's classroom lessons and engage in discussions. The Lesson Study process is time-consuming (Fernandez, 2002) and not accommodated into teachers' usual work plan. It appears that the sampled teachers considered their participation in this study as an additional responsibility to their professional duties since specific time was not allocated in their daily or weekly schedule for participation in professional development programmes. Participants' reflection on the unavailability of time was attributed to contextual factors such as workload, shortage of physical sciences teachers in a school and other professional responsibilities.

> *Obviously ... time factor because the curriculum is loaded and we have few physical sciences teachers in school so it's difficult telling me to sit and plan a lesson with other teachers* (Lenox interview).
>
> *I think the time is the main factor because our learners struggle with the pace of physical sciences. For instance, in Grade 12, we just introduced organic chemistry and the time allowed in the CAPS* [Curriculum Assessment Policy Statements] *document is not nearly enough to cover all the content that learners need to know. And we have too many public holidays which shortens the term.* (Martha interview)
>
> *First, an idea like this should be made known and facilitated by the department. Personally, I think I will still love to do something like this probably with teachers in my school if the principal approves of it, and if the other teachers in science field are willing to because teachers are not willing for anything these days due to the many tasks involved in this profession.* (Alex interview)

Apart from time, lack of support from teacher unions, school principals, as well as district and the provincial education departments were mentioned as challenges to implement Lesson Study as regular practice. Other contextual factors that could hinder teachers' effective participation and continuous practice of Lesson Study as reported in this study include teachers' interest and commitment to professional development, fear of being criticised, lack of specialised physics teachers, professional experts or subject advisers.

Conclusion and Recommendations

This study contributes to the knowledge base research in understanding how the process of Lesson Study may be used as a form of collaborative action research to enhance teaching of physical sciences in South Africa. Results illustrated how teachers' professional knowledge as well as beliefs and attitudes can be improved during the Lesson Study process. Findings revealed that the collaborative planning was experienced as beneficial by all four participants. However, it was also found that Lesson Study may be inefficient in cases where there are gaps in teachers' content knowledge. It is therefore essential that a subject specialist participate in Lesson Study meetings to provide support where inadequate content knowledge obstructs meaningful cooperation.

Though Lesson Study combines several desired elements for an effective professional development programme, there are numerous challenges and contextual factors affecting teachers' participation and continued practice of Lesson Study in South Africa. Practical challenges like teachers' work load and the small number of physical sciences teachers in schools, compounds the problem of finding time for collaborative activities. Furthermore, lack of resources and lack of support from management and teacher unions are hindering teachers' effective and continuous practice of Lesson Study.

It is recommended that educational stakeholders should be actively involved in the formation and maintenance of organisational structures that supports teachers' effective participation in Lesson Study. This may contribute to enhance teachers' knowledge and practice, enabling SA learners to achieve at competitive levels in physical science and join the South African science community.

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Authors' Contribution

AO and TS conceived the study. AO designed the study, implemented the method, collected the data and wrote the first draft of the paper. EG supervised the study, assisted in data interpretation and presentation of results. TS co-supervised the study. All authors read and approved the final manuscript.

Notes

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