




Lesson Study in Eritrea: Its Impact on Middle School Science Teachers' Learning and Classroom Practice

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ABSTRACT

This research explores effects of lesson study on science teacher learning and classroom practice in three purposively selected middle schools of Eritrea. An extended teacher development program that combined training workshops with actual practising of lesson study contributed in enhancing conceptual understanding and pedagogical skills of teachers. The participants valued lesson study as worthwhile teacher development strategy because it brought teachers together and hence significantly contributed in minimising teacher isolation. The finding of this research provides new insights into teacher professional development in Eritrea concerning implementation of lesson study as professional development process for science teaching.

Key words: Eritrea; teacher development; lesson study; teacher learning; classroom practice

INTRODUCTION

The country Eritrea¹ has a long history of colonisation which extends as far back as the 1800's and which included various colonisers. The country eventually gained independence in 1993. This research is linked to education changes following independence. Pankhurst (1972) associates the introduction of Western-styled education in Eritrea with the arrival of missionaries in the late nineteenth century. From the colonial period to date, education in Eritrea experienced a series of reforms. The successive colonisers and the post-independence government of Eritrea reformed education to promote their agendas (Ghebremuse, 2004). The two most recent reforms took place after liberation, in 1993 and



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¹ Eritrea is a small country located in North East Africa. It shares borders with Djibouti, Ethiopia, Sudan, Saudi Arabia and Yemen.

2002. These reforms aimed at addressing the inequalities and inefficiencies in education through rehabilitating the war damaged schools, revising the curricula and expanding it to satisfy the needs of independent Eritrea. This expansion of education led to shortages of teachers at all levels, which in turn forced the Ministry of Education to employ unqualified teachers into the system (Ministry of Education, 2009).

The reforms expected teachers to shift their teaching to student-centred approaches. In addition to the requirements of reforms that differed from the practices that the teachers in Eritrea are accustomed to, teacher development opportunities are less frequent and, if any, are often organised in traditional formats. Theoretically, it was assumed that teachers who receive training through these traditional formats are expected to pass the knowledge and skills gained during the training to colleagues in their schools. Studies indicated that such type of traditional approaches produced little changes in classrooms (Lieberman, 1995; Reddy, 2004). In addition to the professional development opportunities being less frequent and being arranged in traditional formats, teachers in Eritrea work in isolation. Such isolation is assumed to restrict efforts to improve classroom practices.

Lesson study can become an alternative way to bring changes in the context of teaching and learning in Eritrea. Stigler & Hiebert (1999) stated lesson study, a form of teacher professional development originated in Japan, as a key factor in improvement of mathematics and science education. Lesson study involves small groups of teachers meeting regularly to engage in a collaborative process planning, teaching, evaluating and refining of lessons (Lewis 2002a; Lewis 2002b). Chassels & Melville (2009) found that lesson study provides opportunities for teachers to build professional learning communities, to deepen understanding of curriculum and pedagogy, and to develop habits of critical observation, analysis, and reflection. Fernandez (2005) also identified that teachers who participated in lesson study shifted their teaching to a more student-centred pedagogy. As supported in the literature, this research utilised lesson study as a strategy to support teachers and bring them together to collaborate and share experiences in order to improve their classroom practices (Hiebert, Gallimore & Stigler, 2002).

Purpose and Research Questions

The purpose of this research was to try lesson study in three middle schools of Eritrea and then explore its effects on learning and classroom practices of science teachers. One main and three sub-research questions guided the study. The questions were developed based on the work of Guskey (2000). Guskey's (2000) model was appropriate because of its wide acceptance in the field of education, which implies that any conclusions drawn can be considered valid.

- (1) What is the effect of lesson study on learning and classroom practice of middle school science teachers in Eritrea?
 - (a) What are reactions of teachers to the professional development arrangement?
 - (b) To what extent did teachers who used lesson study in their classrooms gain knowledge and skills?
 - (c) To what extent did teachers who used lesson study apply the knowledge and skills gained into their teaching?

What is Lesson Study?

Lesson study began in Japan. It is a well-established classroom-based and collaborative form of teacher development strategy (Lewis & Tsuchida, 1998; Lewis, Perry, & Hurd, 2009; Murata, 2011; Stigler & Hiebert, 1999) used by teachers to systematically examine their practice to become more effective teachers (Fernandez & Chokshi, 2002).

According to Stigler and Hiebert (1999), lesson study is a collaborative approach of planning, teaching, observing, revising and re-teaching of lessons. Teachers who experiment with lesson study will identify a topic that they want to teach by conducting series of discussions on several issues such as the alignment of the topic to the curriculum, the strengths and weaknesses in student learning, and the strengths and weaknesses in their teaching strategies and means of improving them (Watanabe, 2002). After identifying a topic, teachers collaboratively plan a lesson and when one teacher teaches the lesson, others examine and observe it to gather relevant data for its improvement. The next step is reflecting on the lesson as a team. Following the discussion, another team member teaches the revised lesson to another group of students if the team members decide to revise and improve the lesson. The re-teaching is followed by a second debriefing session (Lewis, 2002b). Lesson study is distinguished from other forms of teacher development strategies because its focuses on a lesson not on the teacher who taught the lesson, on observing student learning not on the individual teacher performance and on collective work not on the individual performance of teachers (Stigler & Hiebert, 1999; Rock & Wilson, 2005; Puchner & Taylor, 2006; Stepanek, Appel, Leong, Mangan, & Mitchell, 2007).

Steps of lesson study

Lewis (2002b) divides the activities of lesson study into three categories: identifying a long-term goal or topic, teaching the lesson to explore the goal, and reflecting on the process. The first activity can be established by looking at the gaps between where the students are in their learning experience and what the teachers expect for their students (Lewis, 2002b; Watanabe, 2002). The second activity is accomplished by a team of teachers coming together to prepare a detailed plan on what and how to teach. When one teaches the lesson, other team members observe it. At last, teachers engage in reflection process (Lewis, 2002b). Reflection often focuses on the research lesson and not on the teacher who taught the lesson (Puchner & Taylor, 2006; Rock & Wilson, 2005; Stepanek, et al., 2007; Stigler & Hiebert, 1999).

A five-step cyclical model was developed for this study (see Figure 2). These steps are forming lesson study groups, selecting a suitable topic, planning a research lesson, teaching and observing research lesson, and reflecting and re-teaching a research lesson. The lessons taught during lesson study are known as research lessons (Chokshi & Fernandez, 2005; Lewis, 2002a, 2002b; Murata, 2011). They are different from ordinary lessons because they are collaboratively planned, observed, recorded and discussed by a group of teachers who share common objectives (Lewis & Tsuchida, 1998).

In summary, publication of Stigler and Hiebert (1999) inspired many educators to use lesson study. Since then lesson study has spread substantially and experimented in many countries. There are reports of successes that cannot be ignored. It is believed that if teachers in Eritrea participate in lesson study, they would be able to improve their classroom practices

because its collaborative nature will allow them to share ideas, observe and provide feedback to one another. Thus, the researchers experimented with lesson study in selected middle schools to create a professional development opportunity for science teachers. The structures of professional development are wide and varied. In the next section, teacher professional development is conceptualised in brief.

TEACHER DEVELOPMENT AND LEARNING

Teacher development refers to a continuing learning process that starts with initial teacher education, followed by induction and then culminating with continuing teacher development (Earley & Bubb, 2004; Feiman-Nemser, 2001). The latter stage is the focus of this research as indicated in Figure 1.

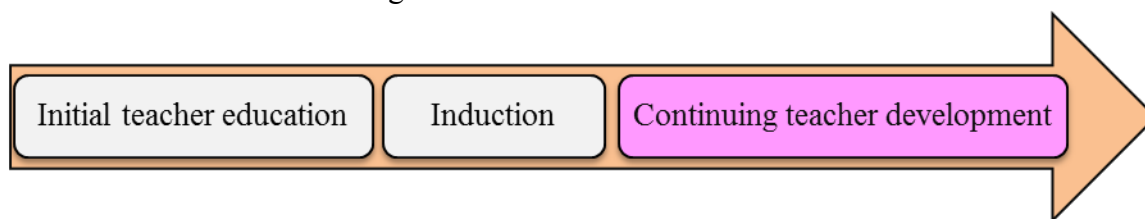


Figure 1: Teacher development continuum Source: Abdella (2015, p. 30)

Teacher development approaches are categorised as either traditional or reform-based based on duration, form, participation, content, type of activity and coherence (Garet, Porter, Desimone, Birman, & Yoon, 2001). In this study, reform-based professional development considered as an approach that would best suit the context of Eritrea. The teacher corps in schools was not highly motivated and familiar with teacher centred approaches in which mainly textbooks are in use as resources for teaching. Teachers are accustomed to traditional professional development processes as outlined below.

Traditional approaches are often arranged in the form of short workshops, seminars and conferences (Feiman-Nemser, 2001; Little, 1993). These approaches give teachers with clearly defined body of knowledge and skills through well-structured process (Carl, 2008). However, they provide little attention to teacher statements by limiting them to mere 'recipients' of information (Carl, 2005, p. 223). Traditional approaches do not provide sufficient time for the teachers to study the presented material (Garet, et al., 2001). Since the sessions are not linked to real problems in classroom, teachers fail to connect the newly gained ideas to their contexts and thus unable to produce changes in their classrooms (Kennedy, 2005; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). Moreover, these approaches lack of appropriate support and follow-up strategies (Feiman-Nemser, 2001; Guskey, 1994; Guskey and Yoon, 2009; Lieberman, 1995; Loucks-Horsley, et al., 2010) and lack of opportunities for teachers to collaborate with one another (Feiman-Nemser, 2001; Loucks-Horsley, et al., 2010).

On the other hand, the reform-based approaches are extended over a long duration of time, are school-based, allow collective participation of teachers, provide opportunities for deeper understanding of content, provide active learning opportunities, and consider professional development as integral part of teacher learning (Garet, et al., 2001). Since the traditional approaches have become ineffective and inadequate in offering the required time,

content, active leaning opportunities and support for teachers, teacher development approaches recently shifted their focus towards reform-based approaches. Mentoring, coaching, study groups and lesson study belong to the reform-based category (Loucks-Horsley, et al., 2010). The characteristics of traditional and reform-based approaches of teacher development are summarised in Table 1.

Table 1: Characteristics of traditional and reform-based approaches of teacher development

Features	Components	Traditional	Reform-based
Structural	Duration	Conducted in the form of short workshops, seminars and conferences.	Arranged for longer duration in the form of mentoring, coaching, lesson study and study groups.
	Form	Focuses on transmission of knowledge to passive recipients by external experts. Usually arranged outside schools.	Oriented towards construction of knowledge by active teachers and relies on internal expertise. Usually arranged in schools.
	Participation	Directed towards individual teachers as the primary recipients.	Directed towards formation of professional learning community.
Core	Content	Offer fragmented and unrelated topics in piecemeal.	Aimed at improving and deepening teachers' content knowledge that is relevant to the day-to-day practice.
	Active learning	Focuses on passive learning.	Encourages teachers to become more engaged in discussion, planning, and practice, observing and feedback.
	Coherence	Professional development lacks relevance to the problems that teachers have at hand.	Professional development experience is part of the integrated program of teacher learning.

Source: Garet, et al. (2001)

The researchers argue that lesson study is a good choice that has the potential of providing effective and sustainable professional development opportunity for teachers in Eritrea to help them implement the reform initiatives because lesson study embodies the essential features of reform based professional development approaches discussed above (Bocala, 2015). Moreover, lesson study minimises teacher isolation by bringing teachers together to collaborate and share professional ideas and experiences (Abdella, 2015).

Transformative professional development, as indicated in the table below, formed the underlying thinking of this research. An idea from the transformative approach is that the duration is much longer than traditional processes and that there is active involvement of participants. In Eritrea, this transformative idea provides both the time and space for interaction among teachers on the programme, a factor that can assist with breaking the isolation. Active participation in lesson planning and critical discussions of the lessons taught also turns participants from passive receivers into active creators of “knowledge” in these transformative approaches of professional development. This is directly possible through lesson study.

Kennedy (2016) reviewed professional development programmes and tried to sort programs according to their underlying theories of action. The theory of action includes two

important parts. The first is the main idea that teachers should learn. The other is the strategy for helping teachers enact with the idea within their own ongoing systems of practice. She reviewed research on professional development programs with an eye toward learning, more specifically, on how different approaches to professional development actually foster learning. She included questions about what teachers need to learn, what kind of professional development activities foster learning, about how learning in one context such as a professional development workshop affects behaviour in another such as a teachers' own classroom. Moreover, Kennedy highlighted the importance of programme content as well as enactment processes followed on the professional development programme as important factors that determine success of these programmes Kennedy (2016).

According to Kennedy (2016), lesson study is a process by which teachers engage in critical discussion and deliberative interactions to improve the process and develop ideas that they can implement in their own classrooms. The critical discussions and deliberative interactions link lesson study to what is considered "good" forms of professional development and highlights that lesson study has important core elements that foster teacher development.

The ideas about lesson study highlighted above are important for teacher development in Eritrea. The education system in Eritrea was largely dysfunctional after many years of war where classroom interactions are reduced to unidirectional teacher driven pedagogies. This study focuses on the possible impact of lesson study on professional development of middle school science teachers.

RESEARCH METHODOLOGY and DESIGN

a) Research design

A qualitative, inductive and exploratory case study was chosen. According to Yin (1984), case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context" (Yin, 1984, p. 23). For Walker (1980, p. 33) the essence of case study lies in the "examination of an instance in action". An instance could either be an individual child, a classroom of children, an innovative program or a school (Stake, 1995). These definitions indicate that case study is a methodology of choice when an in-depth investigation of a phenomenon is required as in the case of this study. This research is a collective case study that took place in three separate middle schools (Stake, 1995) and with clear boundaries (Merriam, 1998; Stake, 1995). Agreeing to Yin (1984), this research is a holistic case study with a group of middle school science teachers as its unit of analysis.

A framework indicated in Figure 2 guides this research. The framework indicates that the research process took place in two steps. Firstly, the training workshops were organised to provide the participants with the concept and skills of lesson study. Secondly, teachers were allowed to practise lesson study in their classrooms for two academic semesters. In latter step, the iterations of lesson study activities that resemble action research enable the teachers to work collaboratively. The framework also shows that participating in workshops and practising lesson study at classroom level enhance teachers' learning in personal, social and professional dimensions as suggested by Bell and Gilbert (1996), which in turn contribute to teachers' change in classroom practice. These two steps, training workshops and practicing

lesson study, are further discussed in subsequent sections.

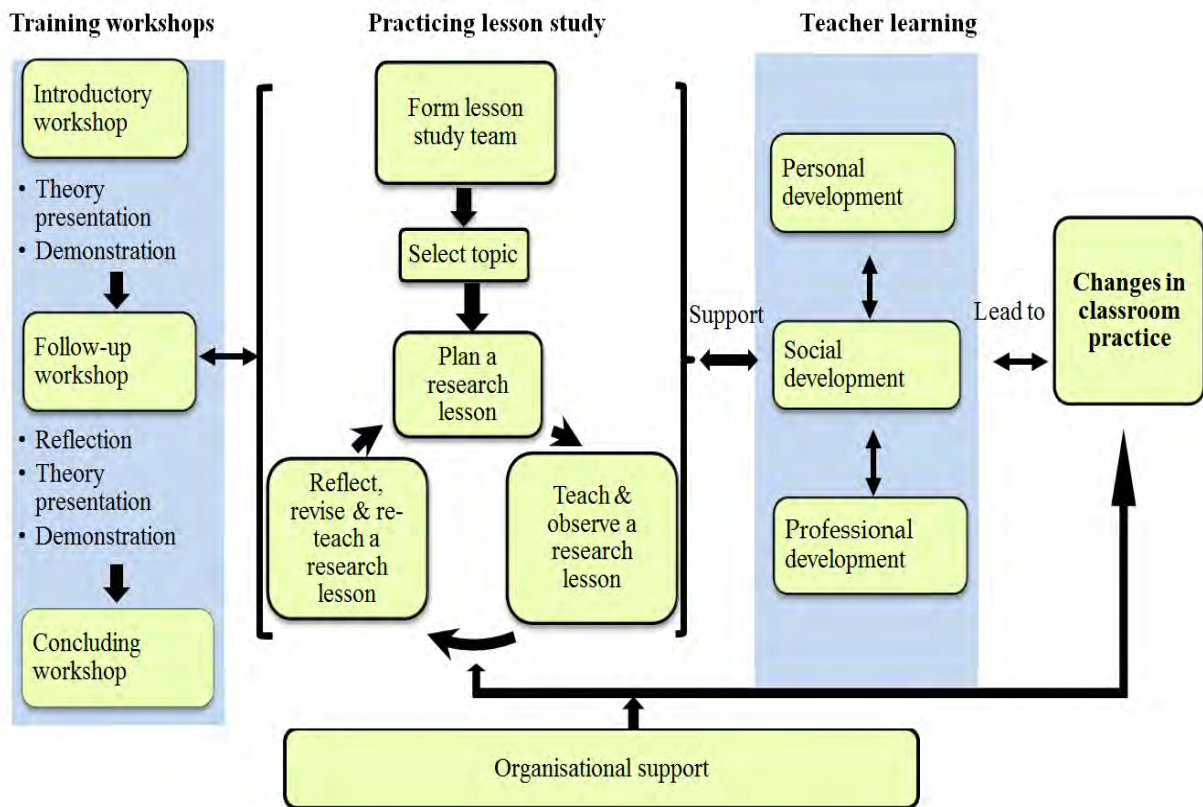


Figure 2: A framework that guided the study *Source:* Abdella (2015, p.63)

b) Lesson study training workshops

Participants received trainings on lesson study during the introductory and follow-up workshops (see Figure 2 and Table 2). These workshops contained presentation of theory and demonstration of lesson study skills as their components (Joyce & Showers, 2002). The presentations of theory were aimed to acquaint teachers with the concepts underlying lesson study whilst the demonstration (using video clips²) sessions to provide visual support on how to conduct and implement lesson study in classrooms (Joyce & Showers, 2002). The concluding workshop was aimed to formally end the process and convey words of thanks to all the participants.

² The videos were downloaded from lesson study sites <https://www.collaborativeclassroom.org/lesson-study> and <https://www.youtube.com/watch?v=0xgko79kO94>

Table 2. Structure and components of training

Duration	Structure	Components
First semester (23 Feb - 29 Jun 2013)	Introductory workshop	Theory presentation Demonstration of lesson study skills
	Practicing of lesson study	Practising lesson study Guidance and support Organisational support Support from Knowledgeable-other
Second semester (02 Sep - 31 Dec 2013)	Follow-up workshop	Theory presentation Demonstration of lesson study skills
	Practicing of lesson study	Practising lesson study Guidance and support Organisational support Support from Knowledgeable-other
End of the project	Concluding workshop	Thanking and distributing certificates

Source: Joyce and Showers (2002)

c) Data generation

Multiple instruments were used to generate data namely through questionnaires, semi-structured focus group interviews and through documents generated during lesson study events. Using multiple data generation methods ensured methodological triangulation as suggested by Patton (2002). Biographical information was obtained using a questionnaire (D) prepared to that effect. Another questionnaire (E) was administered to obtain participants' reactions towards the workshops. Three focus group interviews (H1, H2, and H3) were conducted with the teachers at different stages of the lesson study process. One focus group interview (J) was conducted with the school principals and pedagogic heads at the end of the process. All interviews were conducted in local language. The interviews were first transcribed and then translated into English. The teachers were requested to report their experiences of the lesson study process on formats designed to generate data (F, G and L). They reported their experiences during observation sessions (F), after debriefing sessions (L) and end of lesson study cycles (G). The teachers were requested to respond to these documents in either English or local language.

Data obtained through these instruments were made available for data analysis. The first author recorded field notes during observations, interviewing and discussions held with the participants. These field notes were not coded and analysed. However, they were used to supplement the data analysis. In addition to the methods that generated textual data, video and photographic media were used to capture the details of the natural settings and activities of the research. These video and photographic data were neither coded nor analysed but used a supplementary source of information, as they provide powerful stimuli to recall the setting.

Credibility and trustworthiness was ensured, during conducting of the research and reporting of the findings, through prolonged engagement at study site, triangulation, collection of referential adequacy materials, description of context, and peer debriefing (Guba, 1981; Lincoln & Guba, 1985; Merriam, 1998; Mertens, 1998).

d) Participants

This research was undertaken in three purposively selected middle schools (Cohen, Manion, & Morrison, 2011; Merriam, 1998) from Zoba Maakel region of Eritrea. Fifteen science teachers volunteered to participate in this research. In addition to the teachers, one school principal and one pedagogic head from each school participated in the study. Pseudonyms were used to protect the anonymity of the participants and the schools. The names of the teachers were coded as T1, T2, T3, T4, T5 and T6, school principal as P and pedagogic head as PH. The schools were named as “A”, “B”, and “C”. Table 3 summarises the background information of the participants.

Table 3: Participants’ background information

School	Teacher	Gender	Age	Qualification	Teaching load/ week	Participated in workshops	Years being a teacher	Years at this school	Grade currently teaching
A	SAT1*	M	60 +	Diploma ³	18	Yes	40	15	8
	SAT2	M	60 +	12+1 ⁴	18	Yes	39	3	8
	SAT3	M	20-29	Diploma	18	Yes	5	5	7
	SAT4	F	40-49	Diploma	24	Yes	26	6	8
	SAT5	F	20-29	Diploma	21	Yes	4	4	7
	SAT6	M	50-59	12+TTI ⁵	18	Yes	34	16	7 & 8
B	SBT1*	M	30-39	Diploma	18	No	7	4	8
	SBT2*	M	30-39	Diploma	18	No	14	1	6
	SBT3	M	60 +	Diploma	18	Yes	43	3	8
	SBT4	F	20-29	Diploma	18	No	2	2	8
	SBT5	M	50-59	Diploma	18	Yes	36	1	8
	SBT6	M	20-29	Diploma	24	Yes	4	4	6
C	SCT1*	M	50-59	Diploma	24	Yes	35	3	8
	SCT2	F	40-49	Diploma	24	Yes	24	2	7
	SCT3	M	30-39	12+TTI	28	Yes	11	1	6

*Head of departments

Table 3 indicates that four (27%) of the teachers were females and 11 (73%) were males. In terms of age, teachers in Schools “A” and “C” were older than teachers in School “B”. Two third of teachers in Schools “A” and “C” and one third of teachers in School “B” were older than 40 years of age. Regarding teaching experience, teachers in Schools “A” and “C” were more experienced than teachers in School “B”. Four out of six teachers in School “A”, half of teachers in School “B”, and all teachers in School “C” had more than ten years of

³ Diploma is the minimum qualification requirement for teaching in middle schools of Eritrea.

⁴ 12+1 stands for a one-year university level education after completion of secondary school. Such teachers are not trained to be teachers.

⁵ 12+TTI stands one year at certificate programme at Teacher Training Institute (TTI) after completion of secondary school level. Such teachers are trained to teach in elementary school level and are unqualified to teach in middle school level.

experience. In terms of qualification, all teachers in School “B” were qualified to teach in middle schools, because they had a diploma from college of education, a minimum requirement to teach in middle schools of Eritrea. One third of teachers in Schools “A” and “C” have no credentials required to teach at middle school level. Concerning teaching workload, teachers in School “C” had higher teaching workload than teachers in Schools “A” and “B”. In terms of participation in professional development processes, all teachers in Schools “A” and “C” indicated that they had participated in some form of professional development opportunities. However, half of the teachers in School “B” did not have any chance of participating in professional development processes. Those who had the opportunity, indicated that the professional development focussed on issues such as methods of teaching, student-centred and interactive pedagogy, questioning skills, special needs, lesson planning, classroom management, orientations on new curriculum, utilisation of laboratory and continuous assessment.

e) Practicing of lesson study

Following the workshops, the science teachers were allowed to practise lesson study in their respective schools. Five steps were followed during practicing of lesson study (see Figure 2). Forming lesson study team was the first step of lesson study process. Stepanek et al. (2007) suggest that multiple perspectives are ensured by having a minimum of three members in lesson study teams. They warn that having more than six members may pose a problem of getting common time when all group members are available. In the second step, teachers chose topics that are either difficult for their students to understand or difficult for them to teach. The third step was planning a research lesson collaboratively. Matthews, Hlas, and Finken (2009) believe joint planning enhances teacher collegiality and collaboration. Teachers used a four-column lesson plan format to plan their lessons (see Figure 3). In the fourth step, when one teacher taught the jointly planned lesson, others examined and observed it to gather relevant data for its improvement. The last step was to analyse the research lessons, as a team, based on the data gathered during observation. This step began with the teacher who taught the research lesson by detailing what parts of the lesson worked as planned and what required improvement. Based on the data that they have collected, the other team members forwarded their feedback for improving the research lesson (Joyce & Showers, 2002; Stigler & Hiebert, 1999). Based on the discussions, they revised the research lessons and another team member taught the lesson to another group of students. The re-teaching was followed by second observation and reflection. During the second debriefing sessions, teachers reflect on whether the lessons met the goal and discussed on any necessary refinements of the lessons for their re-teaching in the future.

Learning activities	Student activities/ expected student responses	Teacher's responses to student reactions	Goal and method of evaluation

Figure 3: The four-column lesson plan format
Source: Lewis (2002b) and Matthews et al. (2009)

While practicing lesson study, the teachers received guidance and support as suggested by Joyce and Showers (2002). This was performed by establishing supportive school environment and creating platforms for teachers to come together to collaborate, share ideas, guide and coach one another. The school principals, pedagogic heads and department heads were involved to create supportive school environment for the practicing teachers. The department heads and experienced teachers within the groups played an important role in supporting and coaching their colleagues. Moreover, the first author acted as knowledgeable-other in addition to the role of a researcher. By assuming the former role, he provided training on lesson study during the workshops and guided the teachers through lesson study process. Stepanek et al. (2007) define knowledgeable-other as an individual who works and supports lesson study team members with subject matter knowledge, pedagogical knowledge and lesson study practice. The process is summarised in Figure 2 and Table 2.

RESULTS and DISCUSSION

Based on the traditions of grounded theory, thematic analysis was used to analyse the data (Auerbach & Silverstein, 2003; Charmaz, 2000; Strauss, 1987; Strauss & Corbin, 1990). The research questions were used to categorise the data and not the questions on the research instruments. The first research question was answered from data generated through questionnaire. The second and third research questions were answered from interviews and data obtained from formats designed to generate data from lesson study events.

The data analysis begun by reducing textual data obtained through the questionnaires, semi-structured focus group interviews and documents generated from lesson study events into manageable units called codes and then categorising them into data sets to look for emerging patterns as suggested by Bogdan and Biklen (2007).

Three types of coding were used, namely open coding, axial coding and selective coding (Strauss, 1987; Strauss & Corbin, 1990; Henning, Van Rensburg & Smit, 2004). Open coding, the first step in the coding process, used to break the raw data into segments called codes and then sort them into similar subcategories. This was done by listening to the interviews and reading the transcripts repeatedly sentence by sentence, line by line and word by word to generate codes inductively from the raw data. Axial coding, the second step in the coding process, focused on the codes created during the open coding rather than on the raw data (Strauss, 1987; Neuman, 2011). It was an iterative process in which the initial codes were reviewed and examined again to generate additional ideas and codes, merge closely related concepts into one or drop some of the ideas (Neuman, 2011). The subcategories were further compared to one another and then grouped into higher order concepts to form generic categories. Finally, the generic categories were integrated to form abstract categories called main categories. The generic categories were matched to the research questions to form main categories that were mainly used to structure the presentation and discussion. This rigorous process of coding ensures validity and reliability of data produced (see Figure 4).

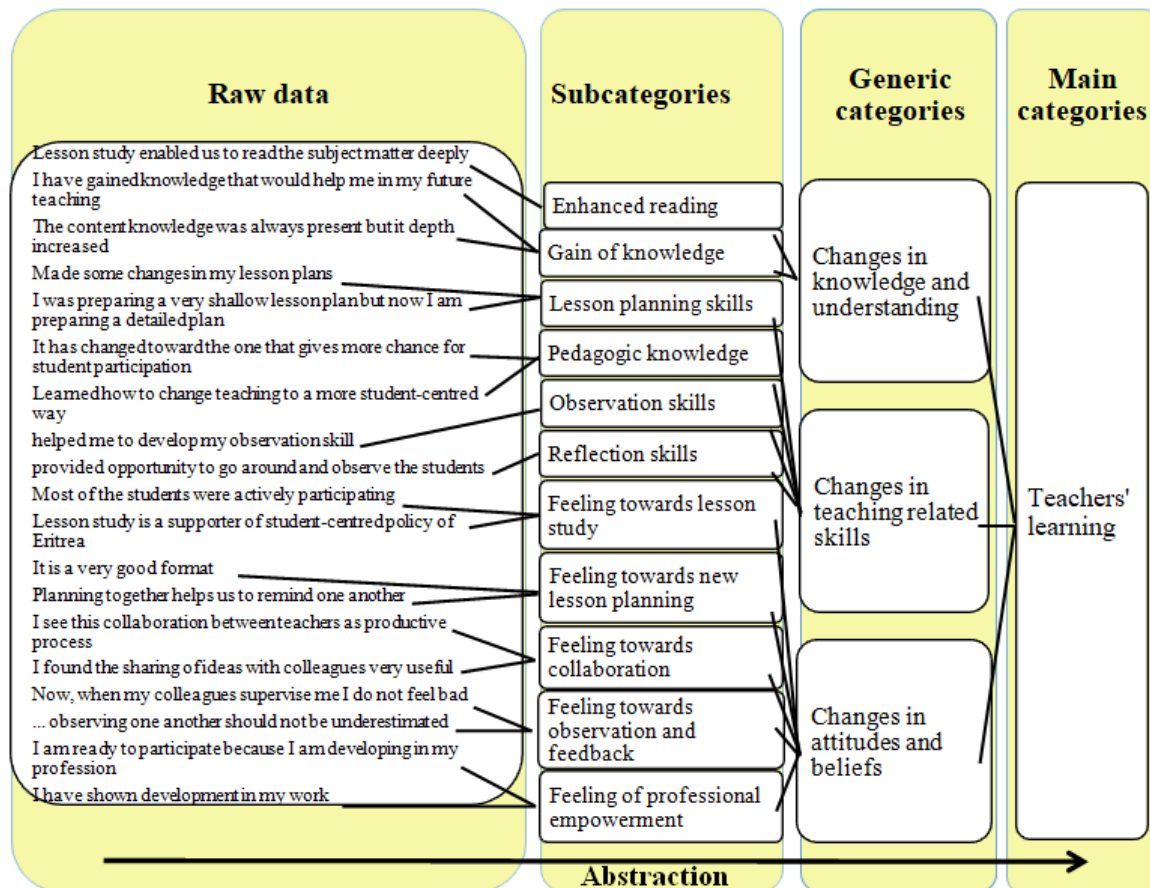


Figure 4: Example of categorisation Source: Elo and Kyngas (2008, p. 111)

Participants' reactions to the training workshops

The first research question was intended to measure participants' reactions to the workshops. The initial satisfaction of teachers with the context, process and content is fundamental to higher level learning (Guskey, 2000). The reaction of participants towards the training workshops was obtained through a questionnaire and the results are categorised into context, process and content (see Table 4). Firstly, the context deals with whether the participants were satisfied with the food and drinks and comfort of the workshop settings. The results revealed that most of the participants valued the contexts in which the workshops were conducted. They appreciated the food and drinks served during the workshops. They also described the workshop settings as well-lighted, quiet and within travel distance.

It was enjoyable because there was enough time to break, enough water and good lunch (SAT3-E)
 The place was suitable [...] and it was quite place and there was no sound that distracts us. (SAT1-E)
 [...] distance of the venue was suitable. (SAT6-E)

However, a pedagogic head from School "B" indicated that the workshop setting was not suitable for group discussion as the noise of one group created distractions as the groups were in hearing distance from one another.

Narrow to discuss freely without noise. (SBPH-E)

Table 4. Summary of the results

Main categories	Generic categories	Subcategories
Participants' reactions	Reactions to context, process and content of workshop	Context of workshop
		Process of workshop
		Content of workshop
Teachers' learning	Change in knowledge and understanding	Enhanced reading
		Gain of knowledge
	Change in teaching related skills	Pedagogic knowledge
		Lesson planning skills
		Observation skills
		Reflection skills
	Change in attitudes and beliefs	Feeling towards lesson study
Feeling towards new lesson planning		
Feeling towards collaboration		
Feeling towards observation and feedback		
Feeling of professional empowerment		
Teachers' use of new knowledge and skills	Change in teaching methods Increased use of teaching-learning resources Collaborative work Peer observation	

Secondly, the process deals with whether the organisation of the workshops made sense and whether the organisers were knowledgeable and helpful (Guskey, 2000). All the participants appreciated the organisation of the workshops. They appreciated the theory presentation and the video demonstration sessions. They also founded the expertise of the organisers to be effective.

It was effectively organised. (SBP-E)

[...] all the sessions were effective. (SBT3-E)

Good facilitators. (SAT2-E)

On the other hand, some participants from Schools "A" and "C" indicated that the introductory workshop interfered with their Saturday schedule which they could earn some extra income.

It clashed with Saturday classes of many teachers. (SAP-E)

Finally, the content refers to the usefulness of the materials and the presentations. The majority of the participants indicated that they have acquired new knowledge and skills. They also appreciated the idea behind lesson study because they expected lesson study to enhance teamwork, their teaching and student learning.

We came to know new knowledge that we did not know it before. (SAP-E)

The workshop was very useful because I got new information and knowledge. (SBT2-E)

However, teachers unanimously indicated that the workshops were short in duration to fully equip them with necessary knowledge and skills. They recommended for longer workshops in the future when similar workshops are held.

The time given for the workshop was very short. (SCT1-E)
Rushing was observed in order to cover all the topics (SAT3-E)

After attending the workshops, the participants indicated their confidence to practise lesson study in their classrooms as follows:

I am confident that I will be able to implement what I have learned (SAT3-E)

Although the participants found the workshops to be effective and helpful, much of the literature are sceptical about the effectiveness of such workshops (Feiman-Nemser, 2001; Fullan, 2007; Guskey, 1994; Guskey & Yoon, 2009; Kennedy, 2005; Lieberman, 1995; Loucks-Horsley, et al., 2010). The reason why the participants valued and described the workshops as effective could be due to three reasons. Firstly, teachers in Eritrea rarely participate in such professional development strategies. Secondly, the activities of the workshop were organised based on an effective professional development model that allowed active participation of the teachers (Garet, et al., 2001), relevant to the day-to-day practice of teachers (Guskey, 2000), and organised based on teachers' identified needs (Loucks-Horsley, et al., 2010; Sparks, 2002). Finally, a framework that combined workshops with classroom practices was designed instead of using workshops alone. Combining two or more strategies provided teachers the opportunity to apply in their classrooms what they have learned at the workshops as supported in the literature (Kennedy, 2005; Loucks-Horsley, et al., 2010). Hence, the participants reported their satisfaction with the arrangement and organisation of the workshops.

Impact of lesson study on teachers' learning

The second research question focuses on learning gains of teachers. Three generic categories namely change in knowledge and understanding, change in teaching related skills and change in attitudes and beliefs were identified from the data analysis, (see Table 4).

Change in knowledge and understanding

All teachers from Schools "A" and "C" and the majority of the teachers from School "B" reported that participating in lesson study improved their conceptual understanding through reading books, peer observation, and collaborative work. They further indicated that the peer observations and collaborative works enabled them to share ideas and learn from one another. This finding is consistent with the findings of Fernandez (2002) and Rock and Wilson (2005) where teachers who used lesson study learned more content as a result of collaborative planning, teaching, observing, revising and re-teaching of lessons.

Lesson study helped me to have deep knowledge about the subject matter [...] because [...] I referred to several books in order to prepare for the lessons. (SAT3-G3)

Most of the teachers who participated in this research considered themselves as

learners and acknowledged that they have learned by participating in lesson study. However, two teachers from School “B” indicated that they have not gained new knowledge by participating in lesson study as illustrated in the extract taken from end of lesson study cycle reporting format.

No changes in the knowledge of subject matter. (SBT4-G1)

Unlike the teachers who indicated that they have learned from the lesson study process, these teachers seemed to view themselves as complete professionals who do not require additional knowledge. It was observed that these teachers did not want to be perceived as learners. They were reluctant to indicate that they have gained new knowledge related to subject matter. This may be because these teachers wanted to maintain their self-image or did not want to be perceived as less competent. Unlike the teachers who search for new information, such teachers are prone to work in isolation and maintain their old attitudes and practices as indicated by Lortie (1975).

Change in teaching related skills

The teachers agreed that participation in the lesson study enabled them to develop pedagogical skills, lesson planning, observation, and reflection as discussed below (see also Table 4).

Enhanced pedagogical knowledge: Consistent with the literature, the teachers held deeply rooted belief about teaching (Stigler & Hiebert, 1999). Before participating in lesson study, they thought that it is impossible to teach student-centred lessons because of contextual constraints that are present in Eritrean schools, such as pressure of content coverage, heavy workloads and large classes as illustrated in the following interview extracts.

We were saying class-size is a hindrance to implement a student-centred teaching. We were also saying that 40 minutes are not sufficient for such type of teaching. Now, we used the same 40 minutes for teaching student-centred way. (SAT3-H1-00:05:41)

Earlier, we were thinking that teaching big class-size, like our classes, using discussion method kills time. (SBT4-H2-00:11:50)

Given the limiting contexts, the teachers indicated that they used student-centred methods more frequently than before. Thus, they claimed that lesson study enhanced their pedagogical knowledge. All teachers from the three schools claimed that they have used more participatory teaching methods that gave hands-on experiences to their students. They indicated that they have shifted their role from mere providers of information to facilitators of learning and were able to organise activities that satisfy the needs of a range of students.

After participating in lesson study, I am taking the role of facilitator and enabling the students to participate more in the learning process. (SAT2-G3)

Interview extracts of teachers also illustrate:

In earlier teaching, we focused on how to cover the content. Now, we are thinking about what concept the students would grasp and how to achieve the goals of the lesson. (SAT3-H2: 00:09:06)

[...] we used student-centred teaching more frequently during our participation in lesson study. This is because lesson study encouraged us to use student-centred way of teaching. (SCT3-H1-00:45:31)

In an interview, a teacher from School “A” emphasised on the role of textbooks in simplifying their practising of lesson study by guiding them what to teach and how to teach as follows:

The science textbooks are extremely good. They prescribe exactly what we were doing during lesson study. The lessons in the textbooks start with ‘let us discuss’ and then go to motivation. The lessons guide how to allow students to participate. The subject matters in the textbooks are related to the students’ daily life activities. If we properly follow to lesson study, it will enable us to achieve the goals prescribed in the textbooks. [...] What is in the textbook is what we have practiced in lesson study. This way of teaching has already been in the textbook before you brought to us. The Ministry of Education instructs us to teach that way. Lesson study has initiated us to think about implementing what is proposed in the textbooks. We are practicing to implement it now. (SAT1-H1-00:08:49)

These findings support the personal development argument of Bell and Gilbert (1996), where teachers identified that their teachings were not participatory, collaboratively designed hands-on activities that enhanced students’ participation and finally indicated their satisfaction with the new teaching strategies.

Enhanced lesson planning skill: Although teachers agreed on the importance of lesson planning, they admitted that before participating in lesson study, they paid less attention to it. As a result, they prepared sketchy lesson plans as illustrated by the following comment given on the end of lesson study cycle feedback form:

Before participating in lesson study, I was preparing very shallow and short lesson plan (SAT3-G3).

During interview, School “B” teachers indicated that they did not refer to the lesson plans once they submitted them to the authorities for fulfilling the formalities. Thus, they acknowledged that what they taught in classrooms were different from what they wrote on the lesson plans.

Once we prepared the lesson plan, we throw it to the office and we do not refer to it again. What we teach in the class may be different from what is written on the lesson plan. (SBT3-H2-00:06:16)

After participating in lesson study, however, teachers took lesson planning process seriously and spent more time on it to prepare detailed lesson plans. As a result, they developed their lesson planning skills and produced improved lesson plans as indicated in the literature (Lewis, 2002b).

I am preparing a detailed lesson plan in collaboration with other teachers. (SAT3-G3)

I have started making maximum preparation. (SAT4-H1-00:15:33)

The fourth benefit of lesson study is that it leads to improved quality of lesson plans

(Lewis, 2002b). This is supported by Taylor, Anderson, Meyer, Wagner, and West (2005) who indicate that lesson study enables teachers to prepare detailed plans that facilitate student learning. This is also in agreement to the progression of personal development suggested by Bell and Gilbert (1996). Accordingly, the participants first identified deficiencies in their lesson planning and then collaboratively produced lesson plans that addressed the problems. They planned lessons that focused on how students learn rather than what they learn. Finally, they indicated their satisfaction with the new experiences of collaborative planning as well as using of the new four-column lesson plan format (see Figure 3).

The lessons were products of our discussion on how best we could prepare and present them. As a result, we were able to prepare effective lesson plans. (SCT2-H3-00:09:00)

Contrasting to the above opinions, one teacher reported that he had not made changes in his lesson planning apart from using a different format.

There are not many changes in lesson planning. The only difference is that we were not using table format. Using such type of lesson plan format could be considered as change. (SAT1-G4)

Overall, participating in lesson study helped teachers to develop their lesson planning skills and be able to prepare better lesson plans.

Developed observation skills: Since one of the main steps of lesson study is to carefully observe learning, participation and behaviour of students (Lewis, 2002a, 2002b), the teachers supposed that in order to be able to comment during debriefing sessions, they had to observe the lessons and record their observation carefully. As a result, they claimed that they had developed observation skills. They were able to observe subgroup formations and at the same time devise means of minimising the problem by changing the sitting arrangements of their students. They were also able to observe that their participation in the lesson study cycles improved the discipline and attentiveness in their students.

[...] a unique experience that we have practiced during lesson study was peer observation, an experience that appeared to us like climbing a mountain. We got an opportunity to observe lessons of one another. (SCT2-H2-00:21:18)

I have also developed observation skill. I was able to develop a skill of explaining my observations. (SBT2-G2)

I have never focused my observation to what students were doing. (SAT4-H1-00:06:58)

I have never thought about creation of subgroups. After providing a task as a group work, we were assuming that all students are discussing as a single group. Now, I have learned that it is important to circulate and go around the class in order to avoid the creation of sub-grouping. (SAT5-H1-00:16:54)

Participation in the lesson study cycles helped teachers to improve their observation skills. Likewise, Lewis (2002a, b) reports that Japanese teachers developed observation skill when they observed research lessons. Bell and Gilbert (1996) describe participating in new activities such observing one another and observing students' learning as evidence of professional development. Thus, this research confirmed the goal of lesson study as a process of promoting teacher capacity of observing learning, motivation and behaviour of students as highlighted in the literature (Chokshi & Fernandez, 2004; Lewis, 2002a, 2002b).

Improved reflection skills: All teachers from the three schools indicated that lesson study provided them opportunity to reflect on their own weaknesses and strengths. Lesson study also enabled teachers to give and receive constructive feedbacks on several aspects such as use of chalkboard, use of teaching and learning resources, arrangement of desks, design of learning activity and students' participation. These reflective skills promote classroom practice since teachers participate in more lesson study cycles over time. Such effect of reflection on enhancing teaching is in accordance with the finding of Cimer and Cimer (2012).

The content of the lesson matched the ability of the outstanding students, but it was difficult for the weak students. (SAT2-F8)

[...] the lesson was supported with real teaching aids and model e.g. car, ball and shoes and majority of the students participated in the lesson. (SBT2-L8)

Even though the teachers managed to speak publicly about their weaknesses and strengths and provide feedbacks to one another, they were observed to be more comfortable speaking about their students' learning and weaknesses rather than their own as observed in the above quotes. Moreover, the teachers were observed to be more comfortable in giving positive feedbacks than criticising their colleagues. Fernandez, Cannon, and Chokshi (2003) highlighted the inability of teachers to reflect on their own teaching practices and being unable to engage in critical dialogue about teaching learning as a common challenge to implementing lesson study. They suggest that teachers must see themselves as researchers and learn to generate powerful questions around the professional dialogue.

Change in attitudes and beliefs

The analysis of teacher responses revealed that teachers had changed their attitudes and beliefs as a result of participating in lesson study as discussed below.

Feeling towards lesson study: Data revealed that teachers had developed positive attitude towards lesson study. In the interviews, teachers described lesson study as important, supportive, enjoyable, good, useful, helpful, productive, and creative because it allowed them to come together to collaborate, share ideas, and prepare participatory learning process for their students.

Lesson study is supportive. It helps teachers to exchange experiences. [...] It encourages student-centred way of teaching, which is also necessary at this time. (SBT1-H2-00:29:55)

Lesson study was helpful in working together, identifying problems together and then solving the problems together. (SCT2-H2-00:13:18)

A teacher from School "A" indicated that much of the changes are in their minds and not in the actual teaching practices as follows:

I can say there is change to some extent, but much of the change is at attitude level. It is in the mind. (SAT1-H2-00:40:20)

Despite the positive feelings, teachers expressed that lack of time, heavy workload, and large class-size as potential constraints to the implementation of lesson study in Eritrea.

[...] it is difficult to implement because it takes a lot of time and we are overloaded. (SCT2-H2-00:13:18)

[...] conducting lesson study with students ranging from 40-50 and bulky load is a little bit difficult. (SCT1-H2-00:14:05)

Feelings towards new lesson planning: The analyses of responses revealed that all the teachers appreciated the joint planning process and the lesson plan format because it enabled teachers to work collaboratively and share ideas. Thus, the participants were proud that they were able to prepare better lesson plans than the ones prepared individually.

[...] we were preparing lesson plan individually but now we are planning in groups collaboratively. Therefore, the new plans became better than old plans. (SAT1-G5)

Planning collaboratively is better than planning individually because one can obtain support from colleagues in topics that are not clear and difficult to understand. Because of working together, one would be able to prepare a better plan. (SCT1-H2-00:03:27)

This finding corroborates the finding of a research conducted by Matthews, et al. (2009), where joint planning process enhanced teacher collaboration. The participants used lesson plan format that contained four items (see Figure 3) that the teachers included in their plan, namely learning activities, expected student responses, teacher responses to student reactions and ways of assessing student understanding (Lewis, 2002b). Analysis revealed that all the teachers valued the four-column lesson plan format, because it enabled them to think and predict student responses to the learning activities and prepare appropriate reactions to the responses. This process of predicting student responses enhanced teacher lesson planning skills and enabled teachers to stick to what has been planned.

The lesson plan [...] helped us to stick to what we have planned. This makes the lesson plan format ideal for preparing teaching learning activity. (SAT1-G1)

The new lesson plan enabled us to write our duty and the duty of the students. (SBT2-H2-00:44:28)

Although teachers appreciated the planning process and the four-column lesson plan format, they found the meticulous planning required for every lesson to be unsuitable to Eritrean schools due to several contextual constraints such as lack of time, large class-size, and heavy workload. This substantiates earlier findings by Chokshi and Fernandez (2004) and Sengul, Cetin & Gur (2008).

Now, using the new plan would be a challenge for us taking the amount of our workload we have into consideration. (SBT2-H1-00:52:24)

Preparing for one lesson takes a lot of space and time. (SBT4-H1-00:54:40)

Feeling towards collaboration: In accordance with the second step of Bell and Gilbert's (1996) social development, the teachers expressed their positive feeling towards working and collaborating with colleagues. They found collaborating with colleagues enjoyable and helpful than working individually because it allowed them to share ideas and learn from one another.

From working alone, working in pairs is better. From working in pairs, working in threes is better, because a rope made up of three threads does not break easily. From lesson study, we have learned that collaborating with one another gives strength. (SCT2-H1-00:12:59)

The teachers linked their experience of collaboration to a local proverb “two heads are better than one” as corroborated in the literature (Fernandez & Chokshi, 2002).

As commonly said since two heads are better one head, meaning lesson plans prepared by two people are better than the ones prepared by one person. They are better because they are enriched by ideas from different teachers. (SCT1-H2-00:03:27)

Feeling towards observation and feedback: The teachers indicated their positive feeling towards opening their classrooms to external observers, observing colleagues, providing feedback, and receiving feedbacks. They indicated that lesson study enabled them to engage in open and rich professional dialogues around topic selection, lesson planning, teaching method selection and preparation of teaching learning resources.

If you ask me about my feeling of being observed by a colleague, I feel nothing, even I feel happy. Since I do not know my weaknesses and my strengths, I would learn from the one who observes my lesson. (SCT1-H3-00:07:05)

At this time, no one is afraid of being observed and no one is concerned about the feedbacks. [...] I do not feel bad when an external observer comes to observe my lesson. (SAT2-H2-01:21:15)

The teachers considered the feedback sessions as opportunities for learning to be able to examine their weaknesses and strengths for the improvement of the lessons and this agrees with what has been observed by Joyce and Showers (2002).

Feeling of professional empowerment: The analysis of the teacher responses revealed that they felt change, development and empowerment as a result of participating in lesson study. Similar findings have been documented in the literature where lesson study increased the confidence and sense of professional growth of teachers (Rock & Wilson, 2005).

Now, I am using a teaching method that has been developed and evaluated by all of us. Therefore, I feel that I have changed (SAT1-G1).

This sharing of ideas helped me to develop. I have showed development in my work because of sharing ideas with colleagues. (SBT4-H2-00:12:20)

As a result of these positive feelings, all the teachers volunteered to continue participating in this research. The desire of the teachers to continue in lesson study indicates that these teachers believed that lesson study had assisted them in gaining knowledge and improving their classroom practice. They also wished similar teacher development programs for themselves and other teachers.

I would like to continue with lesson study, but the challenge that we have is getting time and our living situation. (SAT1-H2-01:34:28)

I recommend lesson study not only for teachers in one school, but also for teachers from many schools teaching the same subject. (SCT2-H1-01:06:37)

After the research however, they would continue working in lesson study only if

certain conditions are fulfilled, namely if their workloads are reduced, their living conditions are improved, and class-sizes are decreased as follows:

Sufficient time should be given. Those participating in lesson study should be free from load. The participants should be given training-workshop for about one month. A person dedicated to support lesson study should be assigned. The participants should be motivated. Number of students in a class should be reduced. (SAT6-H3-01:34:02)

Moreover, they indicated that they require additional training, a coordinator who facilitates lesson study process and support from school leadership. The importance of having a facilitator who organises resources, guides, and supports teachers through the lesson study process is supported in literature (Rock & Wilson, 2005).

Impact of lesson study on teacher use of new knowledge and skills

The third research question focuses on the extent of teacher use of newly acquired knowledge and skills. More specifically, it checks whether the current teacher practices are different from what they used to do in the past (Guskey, 2000). Even though literature indicated that teachers require sufficient time to be able to internalise and adapt the newly acquired knowledge and skills to their settings (Garet, et al., 2001; Guskey, 2000), this study identified several changes in the classroom practices of teachers in a relatively shorter period. These are change in teaching methods, increased use of teaching-learning resources, collaborative work, and peer observation. All these new activities provide evidence of teacher professional development as suggested by Bell and Gilbert (1996).

Change in teaching methods

The results revealed that the teachers used mainly teacher-centred teaching styles where they considered students as passive receivers of information prior to participating in the lesson study cycles. After participating in the lesson study, they shifted their focus to student-centred teaching that gave more attention to student learning. An important component of the student-centred learning is giving students the chance to participate actively in the teaching and learning processes, resulting in increased student learning.

[...] during lesson study we used student-centred way of teaching where the students made more talk than the teachers did. (SCT1-H1-00:19:19)

After participating in lesson study, I am taking the role of facilitator and enabling the students to participate more in the teaching and learning process. (SAT2-G3)

Increased use of teaching learning resources

The results revealed that the teachers were not using teaching-learning resources as much as required due to factors such as shortage of resources and lack of proper storage space. During this investigation, the teachers used teaching-learning resources more frequently than before by improvising them themselves either requesting their students to bring them or use their environment as a source. They claimed that the frequent utilisation of resources provided their students with concrete hands-on activities ultimately result in increased learning and interest of their students.

In old days, we would not take extra pain to collect all these materials. We would simply continue our teaching by abandoning the demonstration altogether. (SAT1-H1: 00:22:12)

[...] we have started using teaching learning resources in our lessons. For example, when we were teaching about flower, we brought flowers from a flower garden located at the back of our school. We have never remembered this garden before. During this lesson, we also instructed our students to come to the lesson with flowers. This is one of the changes or impacts of lesson study observed in our teaching. (SBT1-H2-00:09:41)

Collaboration

Prior to their involvement in this research, the teachers planned and taught lessons alone with limited discussions on matters related to teaching and learning. Peer observation and collaboration were limited. Participating in lesson study had contributed positively in enhancing their collaboration and minimising their isolation as indicated in the following extract:

We worked as a team during planning, teaching, and observation. During these processes, we have benefited from and shared ideas with one another. (SCT2-H3-00:28:54)

Now, we have already started working together in preparing lesson plans and observing one another's lesson in order to share ideas with one another. (SBT3-H3-01:24:53)

The finding of this research corroborates with Puchner and Taylor (2006) that report on the positive long-term effect of lesson study on participating collaborative efforts of teachers, ultimately changing classroom practices of teachers. Similar finding is also reported from studies in South Africa where lesson study contributed positively in enhancing collaboration and reducing teacher isolation (Coe, 2010; Coe, Carl, & Frick, 2010; Posthuma, 2012).

Peer observation

The result revealed that peer observation was not common. Participation in the lesson study cycles provided them with new experience of observing one another's lessons, which also enhanced their observation skills. Peer observation promotes teachers to learn from one another and ultimately improves classroom practice as they participate in more and more lesson study cycles.

I have worked for several years, but we have never observed one another. (SBT1-H1-00:01:18)

[...] a unique experience that we have practiced during lesson study was peer observation, an experience that appeared to us like climbing a mountain. We got an opportunity to observe lessons of one another. (SCT2-H2-00:21:18)

CONCLUSION and RECOMMENDATIONS

The purpose of this research was to implement lesson study in three middle schools of Eritrea and then explore its effects on Eritrean middle school science teacher learning and classroom practice. A research framework that combined workshops with active classroom practice of lesson study was designed to bring such development in teachers. These workshops presented the theory on lesson study and demonstrated the skills of lesson study, an organisation which is believed to have contributed to the effectiveness of the workshops. Following the workshops, the teachers practiced lesson study in their classroom supported by

different role players (Joyce & Showers, 2002). The provision of these support also influenced positively the success and implementation of the teacher development initiative. As a result of such arrangements, teachers claimed that they have conceptually developed, improved their skills in lesson planning and delivering science lessons, changed their attitudes, ultimately resulting in increased learning and changes teachers in classroom practice. Participating in the lesson study cycles enabled the teachers to use student-centred teaching styles regularly, increased the frequency of using resources and enabled them to observe and learn from one another. The teachers developed their capacity to reflect on their own practice, critique the work of other teachers and provide and receive feedbacks from colleagues. This corroborates with Xu and Pedder's (2015) finding that lesson study is a powerful learning process that helps teachers develop professionally. Moreover, lesson study provided a structure for teachers to work together and share ideas, resulting in teacher learning from one another. The collaborative nature of lesson study also helped teachers to overcome sense of isolation that they often experienced.

In conclusion, the researchers propose that the adoption of lesson study in Eritrea need to be considered for teachers at all levels in order to benefit from the approach. Providing quality professional development opportunities for teachers is central for improving quality of education delivered to students. In addition to supporting teacher learning, lesson study is a viable and an effective strategy to bring teachers to collaborate and seek solutions for their pedagogical problems.

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