

Ensuring Quality Education in Ghana: Experiences of Basic School Mathematics and Science Teachers

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Abstract

The study investigated benefits which Basic school teachers in the Akuapem North District perceived to have derived from the Lesson Study Model. The study was a descriptive survey that used the mixed method approach. A 33-item semi-structured questionnaire rated using 5-points Likert scale, and focus group interviews were used to collect data. A combination of purposive and convenient sampling procedures was used to select 46 basic school teachers. Data obtained from questionnaire were analysed using means, standard deviation, and percentage while analysis of verbatim quotations from focus group interviews was used for triangulation. The results revealed that teachers felt their competences in the four thematic areas (knowledge in subject matter, lesson planning, lesson preparation and teaching material preparation and usage) which were the focus of the Lesson Study Model, had improved and in some areas much tremendously.

Keywords: Lesson study, In-service training, Professional development, JICA, STM

1. Introduction

The relationship between improved education and national development is very strong. Many studies point to the fact that education has the potential to improve the social and economic development of nations of which China, Finland, United States of America, to mention but a few are great examples (Solman, 2005; Romanowski, MacCarthy and Mitchell, 2007; Addo, 2010). It is impossible for any nation to benefit from education if there are no good and qualified teachers who are willing to carry it out. Teachers are the key agents and crucial when it comes to education (Akyeampong, 2003; Cherian and Daniel, 2008; Mensah & Acquah, 2011). Keeping teachers in top shape for holistic education delivery is vital, and in-service training is one way of improving teacher competence and quality.

The education system in Ghana needs an in-service training strategy that is functional and sustainable. The state of in-service training in Ghana today may not be that different from what Zimmerman (2011) described as lacking the 3Ms namely money, material and manpower. Money, material and manpower are imperatives for running any functional and sustainable in-service training programme that will equip teachers with current and best practices in teaching in the Ghanaian education system especially at the basic level. However, because of the insufficient or non-availability of money, materials, or manpower, in-service training of teachers is often not carried out as expected (Ameyaw-Akumfi, n.d; Akyeampong, 2003; Riske, 2007). Lesson Study was therefore introduced as an alternative way of providing cost effective and sustainable in-service training strategy for Mathematics and Science teaching. According to Lewis and Tsuchida (1997), Lesson Study is an in-service strategy that is reflective and inquiry based, and has the potential of qualitative improvement in the teaching and learning of Mathematics and Science. The introduction of Lesson Study into the Ghanaian educational system was based on the collaboration between the Ghana Education Service (GES) and Japan International Cooperation Agency (JICA) under the GES/JICA Science Technology and Mathematics (STM) In-service training (INSET) project. This study is based on the GES/JICA STM INSET project which was implemented from 2001 to 2011 in the Akuapem North District of Ghana.

The study was carried out to determine, from the perspective of teachers, what benefits in terms of competencies in the areas of Mathematics and Science teaching they had derived after a decade of implementation of the project. The research question for this study therefore was: What benefits in terms of Mathematics and Science teaching competences do teachers perceive to have derived from the Lesson Study model of in-service training adopted by the GES/JICA STM project in the Akuapem North District?

This study will add to knowledge and challenge the traditionally held views of in-service training in Ghana. It will bring to the fore the need to explore and adopt an institutionalised, sustained and functional in-service training programme to maximize the acquisition of professional competencies for effective teaching and learning at the Basic Education level in Ghana. To educational authorities and other stake holders who are concerned about the lingering problem of supervision, it presents a way of removing supervision bottle-necks since by its nature lesson study is acknowledged to be a self motivating means of teachers improving upon their own professionalism in which schools engage even though it is not obligated by law (Fernandez and Yoshida: 2004). Also, it makes a case for an in-service training model in which the competences acquired by teachers find translation into real classroom practices and has a mechanism for follow-ups to assess its success or failure and

for continuity (Hatorri & Adzifome, 2008).

2. The Lesson Study Model of In-service Training

Lesson Study originated from Japan (Lewis, et. al, 2009) and forms an integral part of the teacher professional development system in that country. Like any other professional development strategy, Lesson Study evolved over time to become what it is in the Japanese educational system (Yoshida, 1999). It has been viewed as a pragmatic means of improving teachers' professional competences that quickly find implementation in actual classroom situations and translates into improvement of quality of teaching and its consequent improvement in students' understanding of lessons (Stigglar, 1999; Lewis, et. al, 2009; Saito & Sato, 2012). Stigglar in comparing instruction in the United States of America, Germany and Japan inferred that Lesson Study could be a contributory factor to the quality of teaching and learning in Japan.

Hatorri & Adzifome (2008) attribute the outstanding performance of Japan in Trends Mathematics and Science Study (TIMSS) and the similar approaches to the teaching of Mathematics and Science across the nation to Lesson Study. Lewis and Tsuchida (1997) posit that Lesson Study was critical for supporting educational change and innovation in Japan. Though Lesson Study has a cultural underpinning which is largely peculiar to the Japanese educational system, similar outcomes have been reported across continents testifying to the gains that it has brought about in teaching and learning in real classroom situations (MacDowell, 2010; Ono & Ferreira, 2010; Burghes & Robinson, 2010; Pongsanon, et. al, 2011). Evidence exists on several international cooperation projects centred on the use of the Lesson Study model to improve teachers' professional competences and classroom teaching and learning (Lee, 2007; Burghes & Robinson, 2010).

While Lesson Study is used in Japan for all subject areas, it has rather gained popularity as a professional development strategy in Mathematics and Science outside Japan (Odani, 2007; Marsight, 2007; Lewis, et. al, 2009; Burghes & Robinson, 2010). In Japan, Lesson Study is principally used at the elementary school level. However, its replication outside of Japan has extended to include the secondary level or high school level (Allen, et. al, 2004).

2.1 Lesson Study as Praxis

Lesson Study begins with a group of teachers who identify a common area of concern in actual classroom practice. Largely, it has to do with challenges in the teaching of some topic areas/ themes. Together, the group of teachers with this common interest plan a lesson on an agreed topic, obtain expert input if necessary, and one of them selected to teach this lesson to an audience in a real classroom situation, usually at the elementary school level. This audience act as critical participants whose observations are used for the later refinement of the lesson. After refinement, the lesson is taught again in the same or similar class to observe what gains have been made. Finally, a reflection session is held where views and ideas from the study are shared. Fernandez (2004) outlines six the stages of lesson study as 1. Collaboratively planning the study lesson; 2. Seeing the study in action; 3. Discussing the study lesson; 4. Revising the lesson (optional); 5. Teaching the new version of the lesson (optional), and 6. Sharing reflections about the new version of the lesson. Thus in practice, Lesson Study is a collaborative, enquiry-based, cyclical and reflective professional development strategy.

Lesson Study is different from lesson planning in that while Lesson Study is a professional development strategy engaged by a group of teachers who want to reflect and improve upon their own teaching (Fernandez & Yoshida, 2004), lesson planning is just a blue print of what teachers want to teach. According to Richardson (2004), what differentiates them is that Lesson Study focuses on what teachers want students to learn rather than on what teachers plan to teach.

2.2 Implementation of Lesson Study in Ghana

According to Koroda (2005), until the 1990's, Japanese involvement in education in developing countries was described as 'hardware type' where they provided only school infrastructure and equipment. The change of strategy resulted in technical cooperation which culminated in the now defunct GES/JICA STM project which aimed at providing in-service training for teachers who taught Mathematics and Science at the basic education level and the now Colleges of Education. Though an attempt has been made to explain Lesson Study as practised in Japan, what was practised in GES/JICA STM project was a modification of what pertains in Japan, since the project aimed at exposing the model to the Ghanaian educational system for possible adaptation and institutionalisation.

A survey was first carried out in 2000 to find out the challenging topics in Mathematics and Science to pupils. The outcome of this survey revealed those topics which teachers were presumed to have difficulty teaching. To address this challenge the intervention was to tackle four areas of subject matter knowledge, Teaching Learning Material (TLM) preparation and usage, lesson planning and lesson presentation.

During the intervention, consulting experts from the Colleges of Education and JICA STM team in Mathematics and Science gave expositions on areas of focus to deepen participants' understanding. After these the participants were made to prepare lessons, make TLMs and do peer teaching. During the peer teaching sessions,

participants observed lessons critically and made inputs during post lesson conferences.

In most cases the same lesson was re-taught by the same person to find out if inputs made had been incorporated. Another reflection section, in the form of post lesson conference was done to fine-tune the lesson for delivery in an actual classroom. This lesson was further reflected upon and final inputs were made setting the tone for implementation of the best practices by individual teachers in their various schools. Initially, the Lesson Study model began with junior high school teachers and later, primary school teachers were rolled on.

The GES/JICA STM project, especially in the field of education in Ghana, introduced Lesson Study (though in a modified form) as part of their intervention to improve teacher professional competences and consequently to improve the teaching and learning of Mathematics and Science at the basic school level in Ghana. Though literature suggests positive gains in other countries where Lesson Study has been experimented (Lee, 2007; Marsight, 2007; Lewis, et. al, 2009; Burghes & Robinson, 2010), no study has attempted to assess how it impacts teachers' teaching competences in Mathematics and Science in Ghana. Thus, this study was carried out to investigate the benefits basic school teachers perceive to have derived from Lesson Study though according Lewis, et. al, 2009, benefits may not necessarily translate into future practice.

3. Methodology

This was a survey involving the collection of data using a combination of a 33-item structured questionnaire and focus group discussion. The descriptive survey method was selected because the researchers wanted to find respondents' perception of the benefits derived from being exposed to the Lesson Study model. According to Fraenkel and Wallen (2009), the descriptive survey method provides greater confidence with regards to specific questions which are of special interest and value to researchers. The sample consisted of 50 teachers.

The questionnaire was organised under four sections covering knowledge of subject matter, lesson plan preparation, lesson presentation, and teaching/learning materials preparation and usage. The item rating was done using a five point Likert scale ranging from strongly agree through not sure to strongly disagree. The questionnaire was scrutinized by experts to ensure its validity. This was done by two project coordinators to ensure that the descriptors captured were consistent with the scope and objective of the GES/JICA STM INSET project. Suggestions from these experts were incorporated to refine and improve the questionnaire. The questionnaire was pre-tested on eight teachers who had participated in the project and were currently pursuing further studies in a public university in Ghana before its administration. The Cronbach Alpha reliability coefficient of the questionnaire yielded a value of 0.8. Thus the instrument was considered to be highly reliable (Cohen, et. al, 2007). The focus group interview was unstructured and involved 5 respondents.

To avoid biased responses/opinion, respondents were categorically informed about the aim of the study as to identify challenges the project faced in order to disabuse their minds that they were being assessed. This was also to take care of ethical issues involved in an important exercise such as this.

The procedures used to obtain the sample were a combination of purposive and convenient sampling. The purposive sampling was used to select teachers who had previously been participants in the GES/JICA STM INSET project in the Akuapem North district. From these groups of teachers 50 participants were selected. Having informed the teachers of the purpose of the study and given assurance of confidentiality, the questionnaires were distributed to them and collected within a week. Out of the 50 questionnaires distributed 46 were completed and returned yielding a response rate of 92%. The high response rate attained is attributable to the involvement of the training officer of the Akuapem North Municipality. The focus group interview was scheduled and held on the day of retrieval of the questionnaires. This was done to find out if teachers' verbal responses would corroborate the questionnaire responses.

Responses to statements in the questionnaire from completed surveys were coded and analyzed using SPSS version 17 computer software. The items in the questionnaire were analyzed using statistical tools such as percentages, mean and standard deviation. Interview data were analyzed through the use of INVIVO 8 software. This helped us to carry out in-depth analysis of issues raised. Indeed, this software created the opportunity to query data whenever things were not clear. In addition, some verbatim quotations from participants were also inserted into the text to support emerging issues (Mensah & Acquah, 2011).

4. Results and Discussion

The respondents for the study were 46 basic school teachers in the Akuapem North District who had previously participated in the GES/JICA STM project. Respondents were made up of 12 (26.1%) males and 34 (73.9%) females. In terms of teaching experience 12 (26.1%) of the respondents had one to four years' experience; 20 (43.5%) had four to eight years experience and 14 (40.8%) had taught for nine years and above. Thirty four (73.9%) respondents taught all subjects and one (2.2%) respondent each taught Mathematics only and Science only. Five (5.5%) respondents taught both Mathematics and Science and five (5.5%) taught other subjects.

It is clear from the results that the female to male ratio is approximately 3:1 indicating that females outnumber

the males in terms of participation in the project. Also, considering the teaching experience of the teachers it was noted that newly trained teachers had the opportunity to participate in the programme and if the confidence which the respondents had displayed was anything to go by then we can confidently conclude that lesson study would be very effective as a means of inducting beginning teachers to teach Mathematics and Science effectively at the basic school level. The same goes for the background of respondents as generalist teachers and subject specialists. Majority of the respondents were generalist teachers and this goes to affirm the effectiveness of lesson study in improving teachers' content and pedagogical competences (Takashi and Yoshida, 2004; Lewis, 2005). This is against the perception that most basic school teachers find it difficult to teach Mathematics and Science because they lacked requisite training (Osei-Kwabena, 2011).

4. 1 Main Issues

The means and standard deviations for each section were computed to give a general idea of sectional issues surveyed. For each item and section, mean values of below three indicate agreement and above three indicate disagreement while three represents neutrality /uncertainty. In discussing the results, only teachers' agreement to statements made was reported. For the purposes of easy analysis, strongly agree and agree were combined to represent agreement and, strongly disagree and disagree to mean disagreement.

The sectional mean for table 1, which addressed teacher knowledge of subject was 1.92 (SD: 0.55). This shows agreement among respondents of their mastery of the various subjects they teach showing the impact of the GES/JICA STM INSET project. For instance 41 (89.1%) indicated that their understanding of previously challenging topics had greatly improved and 39 (91%) of them said they could now teach those previously challenging concepts with ease. Also, 37 (80.4%) of respondents indicated that they prepared lesson notes to fully cover the scope of content outlined in the syllabus and 39 (84.8%) of them indicated that they engaged students in challenging activities that promoted conceptual understanding of topics. However, 23 (about 50%) respondents pointed out that there were still some challenging areas they felt uncomfortable teaching.

The results from table 1 clearly show that respondents were confident that they had gained mastery of the subject matter in terms of Mathematics and Science required for teaching at the basic level of Education in Ghana. Teachers' responses in this survey is in sharp contrast to their initial response during the base line survey in which they freely expressed their uncertainty as to whether they had the knowledge base for teaching Mathematics and Science. During focus group interview, respondents expressed confidence that they have acquired Mathematics and Science knowledge that had made them capable of teaching these subjects at the basic school. A respondent opined:

“ The way we were taught during the project made it difficult for us to forget the concepts we learned about and how to teach them because it was full of hand-on-activities and experiments “.

Another agreed:

“Even after many years, I still remember some of the things we learnt and I can still teach those concepts when the need arises. So, when it comes to the knowledge acquired we had so much because we were exposed to many things that broadened our minds. I can therefore teach these concepts with confidence”

Table 1: Teachers' knowledge of subject matter

B.	SA	A	NS	D	SDA	Mean	SD
1. My understanding of previously challenging topics has improved	18 39.1%	23 50%	5 10.9%	-	-	1.72	0.66
2. I am now able to teach previously challenging concepts with ease	11 23.9%	28 60.9%	6 13%	-	1 2.2%	1.96	0.76
3. There are still areas I do not find comfortable teaching	13 28.3%	10 21.7%	10 21.7%	10 21.7%	3 6.5%	2.57	1.29
4. My lessons fully cover the scope of content outlined in the syllabus	27 58.7%	10 21.7%	6 13%	3 6.5%	-	1.67	0.94
5. I engage students in challenging activities that promote conceptual understanding of the topics	23 50%	16 34.8%	5 10.9%	2 4.3%	-	1.70	0.84

SA=Strongly Agree, A= Agree, NS= Not Sure, D= Disagree, SDA= Strongly- Disagree Agree, SD= Standard Deviation
 Clearly, this is an allusion to how Lesson Study broadens the content as well as the pedagogical content

knowledge of teachers. This is consistent with Lewis, Perry and Hurd (2009) observations that Lesson Study promotes both pedagogical and content knowledge of teachers.

In terms of teacher competence in lesson planning and preparation, the sectional mean was 2.2 (SD: 0.55). This indicated an agreement amongst respondents. For instance results from table 2 show that 42 (91.3%) of respondents indicated that GES/JICA STM project had improved their lesson planning and preparation and 41 (89.1%) further indicated that they effectively employed curriculum materials in the preparation of lesson notes. Thirty seven respondents (80.5%) indicated that they shared ideas with their colleagues to deepen their understanding of some grey areas and 34 (73.9%) indicated they were able to write specific measurable, achievable, realistic objectives. On their ability to conjecture students' entry behaviour, 31 of them (67.4%) indicated their agreement and 34 (74%) indicated they were able to capture all the features of a lesson plan, while 41 (88.9%) indicated they were able to write constructively aligned lesson plan. Further, 36 (78.3%) indicated they were able to write systematic and orderly lesson plan while 43 (93.5%) of them said they were able to prepare detailed and self explanatory lesson plan. As to when teachers wrote their lesson plan, 24 (52.1%) indicated they wrote their lesson notes during vacation or prior to the reopening of school, 18 (39.1%) indicated they sometimes did so a fortnight before delivery of lesson and 12 (26.1%) indicated that they prepared their lesson just a day before the lesson.

The findings also show that teachers who participated in the project acquired and furthered their skill in planning lessons cooperatively and have seen the importance of preparing adequately for Mathematics and Science lessons.

A respondent indicated:

'Considering the hand-on-activities and experiments we have to prepare long before lessons because these are not things you can do on the spot so I have to do effective preparation ahead of time'.

Also another participant expressed his opinion on the kind of cooperation engendered by the project.

'Formerly, I found it difficult to contact my friends for help but through the project I freely go to everybody for help, including those who are not in my school but are in the cluster'.

Table 2: Mathematics and Science lesson planning by teachers

C.	SA	A	NS	D	SDA	Mean	SD
1. My participation in Lesson Study / INSET has improved my lesson planning and preparation	23 50%	19 41.3%	4 8.7%	-	-	1.59	0.65
2. I effectively employ curriculum materials in the preparation of my lesson notes	25 54.3%	16 34.8%	4 8.7%	1 2.2	-	1.59	0.75
3. In the planning of my lesson in Mathematics and Science, I share ideas with my colleagues to deepen my understanding of some gray area	16 34.8%	21 45.7%	5 10.9%	1 2.2%	3 6.5%	2.00	1.08
4. I am now able to write lesson objectives accurately (Specific, Measurable, Achievable, Realistic)	19 41.3%	15 32.6%	6 13.0%	1 2.2%	5 10.9%	2.09	1.28
5. I am now able to connect subject matter with accurately conjectured students' entry behaviour	9 19.6%	22 47.8%	8 17.4%	2 4.3%	5 10.9%	2.39	1.18
6. I am now able to capture all salient features (core points, application, closure) of a lesson plan	17 37%	17 37%	5 10.9%	2 4.3%	5 10.9%	2.15	1.28
7. I am able to write a constructively aligned lesson plan	19 41.3%	22 47.8%	5 10.9%	-	-	1.70	0.66
8. I am now able write a systematic and orderly lesson plan	19 41.3%	17 37.0%	4 8.7%	1 2.2%	5 10.9%	2.04	1.26
9. I am able to prepare detailed and self-explanatory lesson plan	30 65.2%	13 28.3%	3 6.5%	-	-	1.41	0.62
10. I now plan my lesson during vacations prior to reopening of school	15 32.6%	9 19.6%	11 23.9%	8 17.4%	3 6.5%	2.46	1.30
11. I plan my lesson a fortnight before lesson delivery	5 10.9%	13 28.3%	7 15.2%	8 17.4%	13 28.3%	3.24	1.42
12. I sometimes prepare my lesson just a day before the lesson	4 8.7%	8 17.4%	4 8.7%	9 19.6%	21 45.7%	3.76	1.42

It is clear that through the project, teachers have gained the niche to consult their colleagues for explanations and guidance when they experience difficulties. This confirms Lewis' (2005) findings that lesson study promotes

collegiality amongst teachers. Many also indicated that they prepared lesson notes prior to re-opening and did advance preparation for their lessons for each term. This is also another healthy development since lack of effective preparation of lessons is one of the challenges to effective teaching and learning of Mathematics and Science.

Table 3: Teachers' competence in Mathematics and Science lesson presentation

D	SA	A	NS	D	SDA	Mean	SD
1. I use a combination of verbal and non verbal cues to enhance effective communication during my lessons.	29 63.0%	14 30.4%	3 6.5%	-	-	1.43	0.62
2. I consciously employ the questioning technique (question –pause-answer-feedback) during my lesson.	28 60.9%	13 28.3%	5 10.9%	-	-	1.50	0.69
3. I consciously distribute questions evenly taking into consideration the gender, spatial or geographical positions, differing abilities and other diversities.	29 63.0%	13 28.3%	4 8.7%	-	-	1.46	0.66
4. I use age appropriate language in asking questions and throughout my lesson presentation	17 37.0%	21 45.7%	4 8.7%	2 4.3%	2 4.3%	1.93	1.02
5. I use appropriate mathematics and science terminologies during my lesson presentation	18 39.1%	20 43.5%	6 13.0%	2 4.3%	-	1.83	0.83
6. I am able to confidently handle students.	27 58.7%	13 28.3%	4 8.7%	2 4.3%	-	1.59	0.83

In reference to teachers' competence in lesson presentation, the sectional mean of 1.62 (SD: 0.56) was obtained. This showed a strong agreement by respondents. For instance in table 3, 43 (93.4%) indicated they consciously used verbal and non-verbal cues to enhance communication during lessons and 41 (89.2%) indicated that they consciously used the questioning technique (question-pause-answer-feedback). Of the respondents, 42 (91.3 %) of them indicated they consciously distributed questions evenly, taking into consideration the gender, spatial, deferring abilities and other diversities. In terms of the appropriate use of language in questioning during lessons, 38 (82.7%) of respondents agreed they did so and 38 (82.6%) indicated they used appropriate Mathematics and Science terminologies during lesson. Of the respondents, 40 (86%) also indicated that they confidently taught students.

Respondents showed strong confidence in their ability to present lessons with pedagogical integrity. They indicated that at the College of Education, they were not exposed to the pedagogy of teaching some challenging topics. However through the project they had been equipped with such pedagogical skills. A respondent noted during the focus group interview:

“Previously we were not introduced to ways of teaching certain topics. For instance a topic like natural disaster, its teaching was very difficult for me. I was teaching it abstractly to the pupils all the time so they found it difficult to understand...but through the project we were given materials and taught ways of teaching it.”

Another corroborated:

“There was a topic in Science, that is, the balancing of chemical equations. At first I didn't know anything about it but during the project we were taught to use beads as models to teach the topic.”

It is obvious that lesson study provides impetus for teaching and equips teachers with various strategies of presenting Mathematics and Science lessons in a manner that enhances students' understanding of topics. This is consistent with the finding by Lewis (2005) and Burghes & Robinson (2010).

Table 4: Teachers' ability to prepare and use teaching /learning materials

E.	SA	A	NS	D	SDA	Mean	SD
1. I have developed the ability to identify appropriate and relevant TLM for my lessons	21 45.7%	18 39.1%	7 15.2%	-	-	1.70	0.73
2. I purchase most of TLMs	7 15.2%	13 28.3%	11 23.9%	9 19.6%	6 13.0%	2.87	1.28
3. I collect most of my TLMs from the environment and use them with some modifications	16 34.8%	21 45.7%	6 13.0%	3 6.5%	-	1.91	0.87
4. If need be I construct TLMs for my lessons	15 32.6%	19 41.1%	8 17.4%	4 8.7%	-	2.02	0.93
5. I deploy TLMs timely during my lessons	15 32.6%	21 45.7%	8 17.4%	2 4.3%	-	1.92	0.83
6. I employ the services of artisans for the preparation of my TLMs	7 15.2%	10 21.75	14 30.4%	11 23.9%	4 8.7%	2.89	1.20
7. I make room for adequate students interaction with TLMs	17 37.0%	20 43.5%	9 19.9%	-	-	1.85	0.74
8. I provide adequate and appropriate TLMs for my lessons	23 50.0%	11 23.9%	8 17.0%	4 8.7%	-	1.85	1.01
9. Most my TLMs used for my lessons are provided by my school	9 19.6%	11 2.9%	10 21.7%	11 23.9%	5 10.9%	2.83	1.31
10. I have acquired certain technical skills in the preparation of TLMs	11 23.9%	19 41.3%	12 26.1%	4 8.7%	-	2.20	0.91

The sectional mean for teachers' ability to prepare and use teaching/ learning materials was 2.26 (SD: 0.56) showing agreement. For instance in table 4, 39 (84.8%) respondents indicated they had developed the ability to identify appropriate and relevant TLMs for teaching Mathematics and Science lessons. Also, 37 (80.5%) respondents said they collected most of their TLMs from the environment and used them with some modifications while 34 (73.7 %) said they constructed their own TLMs if need be. Again, 36 (78.3%) respondents said they deployed their TLMs timely during lessons. Thirty seven respondents (80.5 %) said they made room for adequate student interaction with TLMs during lessons. Thirty four respondents (73.9%) indicated that they provided adequate and appropriate TLMs for their Mathematics and Science lessons and 30 (65.2%) respondents indicated that they had acquired some technical skills for the preparation of TLMs. Of the total number of respondents, only 20 (43.5%) of them indicated they purchased most of the needed TLMs and again only 17 (37%) respondents employed the services of artisans in preparation of their TLMs. Finally, 20 (22.5%) respondents indicated that most of the TLMs they used were provided by their school.

The response of participants to the questionnaire and which was corroborated in the focus group interview show that teachers who participated had a high degree of confidence that the project had equipped them with the relevant skills to prepare and use teaching and learning materials in their lessons. A respondent stated during the focus group interview:

“At first I found it difficult to prepare TLMs for my lessons but the project allowed us the opportunity to prepare and use teaching and learning materials. Unlike the training college [Colleges of Education] where the focus was on how to learn and pass your examination so we came out not having those skills”

In addition another respondent intimated:

“Apart from the preparation of TLMs we were forced by the Project to use them because previously I was teaching without teaching and learning materials. I have come to understand that their use makes teaching easier and helps students to understand concepts better”

We can emphatically say that these findings suggest that teachers' participation in lesson study has equipped them with relevant skills for preparing teaching and learning materials. This can be attributed to the material developments aspect of the project where participants were guided to use locally available materials to produce teaching and learning materials for teaching the various topics covered. This is a positive development since according to Yara and Otieno (2010), the use of TLM results in good academic performance of student.

5. Conclusion and Recommendations

The introduction of the Lesson study model in Ghana was aimed at exposing basic school teachers to current and best practises in the teaching of Mathematics and Science. The study surveyed teachers' competences based on the objectives of the GES/JICA project in four thematic areas of teachers' knowledge in subject matter, lesson planning, lesson preparation and teaching material preparation and usage. The study revealed that teachers who took part in the lesson study project implemented by the GES/JICA STM project in the Akuapem North District, in the Eastern Region of Ghana are now able to teach concepts in Mathematics and Science that they hitherto found challenging. The teachers claim they can now teach these concepts because they felt their understanding of these previously challenging topics in Mathematics and Science have greatly improved. Teachers also acknowledged that their participation in the GES/JICA STM project has improved the way they plan and prepare for their Mathematics and Science lessons. The findings of the study also revealed that teachers have acquired certain technical skills needed in preparing Teaching Learning Materials (TLMs) and have also developed the ability to identify appropriate and relevant (TLMs) for their lessons. The results also showed that collegiality and cooperativeness amongst teachers have improved tremendously. The finding shows, teachers competences had improved in all four thematic areas and in some areas much tremendously. After a decade of implementation, the teachers strongly felt they still possessed competences acquired through the project. It attests to the long term/lasting effect of the Lesson Study model adopted by the project.

The structure of Ghana's in-service training for teachers is top-down, sporadic, lacks enquiry, and has funding problems (Akyeampong, 2003; Riske, 2007; Zimmerman, 2011). It is largely organized and funded directly by non-governmental organs or development partners with different objectives and there seem to be no mechanism to coordinate their activities (Bukari, 2007). To address this situation, it is recommended that the Lesson Study model of providing in-service for teachers should be institutionalized. This is because aside the pedagogical benefits that would improve teacher quality and students learning, Lesson Study is enquiry based, bottom-up and requires comparatively minimum amount of money thus easily sustainable. It can easily be incorporated into the current teacher capacity building programmes of the Ghana Education Service without re-organization except for provision of budget. This recommendation is made because Ghana has critical mass of personnel with Mathematics and Science background and experience (Koroda, 2005) who will be able to roll out Lesson Study countrywide. Also, according to Osei- Kwabena (2011) most basic school teachers in Ghana who are generalist teachers find the teaching of Mathematics and Science difficult. Therefore, the institutionalisation of Lesson Study would provide a means of improving the content and pedagogical competencies of basic school teachers in the teaching Mathematics and Science (Takashi and Yoshida, 2004; Lewis, 2005). This can be extended to include other subject areas by exposing teachers of the different subjects to the Lesson Study model through subject association workshops, conferences, or seminars. Lesson Study is a professional development strategy used for all subject areas in Japan except that it has gained international reputation in respect of Mathematics and Science. Thus, extending it to other subject areas will be a step in the right direction. And considering its low financial cost, one would suggest its adaptation and expansion in Ghana more practically and in order to ensure greater effect. Indeed, such a practice has the potential of improving teaching in particular, and education delivery in general.

It recommended that Lesson Study be introduced at the Colleges of Education so that with time all teachers who go through these initial teacher training institutions would become acquainted with the Lesson Study model and subsequently apply it as practising teachers. It would predispose students to collaborative activity and building collegiality in the teaching profession.

Further, appropriate policies should be formulated to encourage maximum teacher participation in Lesson Study programmes by making it a requirement for promotion for teachers and head teachers in the Ghana Education Service and gradually integrating it into the overall teacher professional development programmes in the Ghana Education Service nationwide.

Finally, it is recommended that the technical cooperation in education, between Ghana and Japan be sustained so that more teachers could be trained and also learn from the Japanese expertise until we are well grounded to effectively implement the Lesson Study model. To ensure a more lasting and realistic effect, school heads, directors of education of the Ghana Education Service, and policy makers in education should be trained to appreciate the benefits of the programme so that they can ensure its existence.

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