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Factors that Impact Sustainability of Lesson Study in Teaching and Learning Mathematics

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Abstract: Lesson Study is a repeated over time process based on the feedback from teachers who conduct it although the process can either be successful or unsuccessful due to certain factors that can either support or hinder its effectiveness. The study will explore factors that impact sustainability of lesson study in teaching and learning mathematics. The purpose of the study would be to understand the key elements that either support or hinder the long-term success of the lesson study approach and also to explore ways to overcome potential barriers to its sustainability through offering recommendations for schools on how to effectively sustain lesson study practices in mathematics education. The study utilized a qualitative case study and was based on social constructivism. Six purposively selected teachers of mathematics at two secondary schools were involved in lesson study cycles. Data were collected through questionnaires, semi structured-interviews and lesson observation. Thematic analysis was employed to analyse the data from the three sources. The results revealed that teachers portrayed both positive and negative attitudes towards lesson study in teaching and learning mathematics. On the negative attitudes, it was revealed that lesson study is time-consuming and challenging while on the positive attitudes, it was found that lesson study is a way to improve teaching practices in class. It was discovered that some negative attitudes towards lesson study by some teachers were as a result of some factors that impacted the sustainability of lesson study in teaching and learning Mathematics. For example, lack of resources such as materials used in lesson study activities, perceived benefits of lesson study, appropriate implementation of lesson study activities, time constraints and lack of continuous support from some organizations such as Non-governmental organizations and the government itself.

Based on the negative attitudes, it was suggested that headteachers should continuously orient and remind teachers that lesson study is not time-consuming and challenging but beneficial to them and the learners. It was also recommended that the government should continuously provide resources and advise headteachers to ensure that they include lesson study program on the time table for it to be a success. It was also recommended that the government should continuously support teachers through providing incentives such as allowances for their transport and lunch to encourage them to be participating in lesson study activities in order to boost teacher confidence in delivering lessons to the learners. School leaders must also be organizing trainings and workshops to equip teachers with the skills and knowledge needed to sustain lesson study. They must also ensure that adequate teaching materials and resources are provided to enhance the effectiveness of lesson study. There is also need for sufficient time for planning, observation and reflection to avoid compromising the study.

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I. INTRODUCTION

Teachers of mathematics have been doing everything possible to improve the standard of performance for pupils in mathematics. They hold teacher group and departmental meetings such as Continuing Professional Development and lesson study just to discuss the best approaches to utilize in teaching mathematics to ensure that learners understand the subject and appreciate it. Lesson Study involves groups of teachers meeting regularly over a period of time, ranging from several months to a year, to collaborate on the design, implementation, testing, and improvement of one or several "research lessons" (Stigler & Hiebert, 1999). According to National Council of Teachers of Mathematics (2013), lesson study cycle consists of several key steps including the selection of a specific learning goal, the design of a lesson plan to address the goal, the implementation of the lesson in a classroom setting, and analysis of student responses. This process enables educators to identify effective teaching methods, share best teaching practices and continuously improve their instructional techniques. One of the main benefits of the cycle is to focus on collaboration and the ongoing Mathematics professional development. Tukombe, Banda, and Nakai (2017) reported that Lesson Study, known as a practice by teachers to improve their knowledge and skills in teaching and learning, was introduced in Zambia in 2006 with the technical assistance from the Japanese government. It has proven to be a very user-friendly and long-term effective tool that enables widespread teacher inclusion, as teachers progress through cycles within their schools either during Teacher Group Meetings or other Professional Departmental Meetings. The impact of the lesson study on teachers' attitudes towards Mathematics, students, and teaching methods has been generally positive (Nakai, 2011). Lesson study practice resulted into observable benefits, such as enhanced teaching skills among instructors and improved mathematics pass rates for students. The study has also demonstrated to be a sustainable approach to enhancing teacher professional development although learner performance in mathematics has been unsatisfactory for years (ECZ, 2016). Zambia is now one of the worst-performing countries in Southern Africa (Baba, 2015) and it is believed that it is because the study has been declining or inconsistently practiced despite its proven effectiveness in improving instructional practices in various educational settings. There are challenges to its sustainability such as lack of time, lack of institutional support, financial resources, lack of professional development opportunities, resistance to change by some teachers and in-depth understanding of the study by some teachers These challenges have a negative impact on both teaching and student learning mathematics which needs answers through a thorough investigation into the study aimed to report the factors that impact sustainability of lesson study in teaching and learning mathematics in selected Zambian schools. To understand the study, the methodology has more details.

II. METHODOLOGY

The methodology that was utilized in the study included research paradigm, research design and approach, study site, target population, sample size, sampling technique, data collection instruments and data analysis. The research paradigm adopted in the study was constructivism which holds that "truth and meaning do not exist in some external world but are created by the subject's interactions with the world. The study employed a qualitative method approach using a Case Study design and it was guided by the research objectives and questions. Six purposively selected teachers of mathematics at two different junior secondary schools in Lusaka province of Zambia were involved in the lesson study cycles. Data were collected through open-ended questionnaires, semi structured-interviews and lesson observation then analyzed thematically and using descriptive statistics where appropriate from the three sources.

III. FINDINGS

In this section, I will present the findings based on the collected data through the instruments such as questionnaires, interviews and lesson study observations. Themes emerged from the data through the instruments that were administered to the participants. Data analysis, however, was specifically guided by the information that provided answers to the impacts of sustainability of lesson study in teaching and learning mathematics. From the data that was collected, it was revealed that there are both negative and positive attitudes that impact sustainability of lesson study. It was revealed that some participants felt the need to engage in lesson study due to the poor performance of learners. Some participants expressed uncertainty and stated that they had no idea of what lesson study is and how it is conducted. Other factors revealed were the availability of materials for lesson study activities, provision of materials required to conduct lesson study, benefits of Lesson study, appropriate implementation of Lesson study activities, time constraints, Attitudes, lack of support and lastly mitigation of lesson study challenges.

- *Availability of Materials for Lesson Study Activities*

It was found that the availability of materials can be a positive and negative factor that can impact sustainability of lesson study in teaching and learning mathematics. Participants clearly stated the specific materials required for a successful lesson study cycle. For instance, one participant said that:

As teachers, we need Stationary such as Lesson study guide, curriculum, and observation tools for collecting data and furniture to conduct lesson study although each time we need them the school rarely provides.

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This suggests that for the lesson study activities to be ongoing and successful in the mathematics education, there are materials that should be put in place. The availability of materials for lesson study activities can vary depending on several factors, including location, the educational institution and the specific subject area you're focusing on. Without the necessary materials for lesson study, it is not easy to complete the cycle of the study.

- *Provision of Materials Required to Conduct Lesson Study.*

Another factor that was revealed by participants was the provision of lesson study materials. This became evident as the participants shared details about how they obtained their materials they used during lesson study. When they were asked about who provides materials, their responses were that:

The school provides the materials and sometimes it's just teachers' resourcefulness. The institution, teachers and organization like Japan International Corporation Agency provides materials. Japan International Cooperation Agency (JICA) is one of the organizations which provides materials like Markers, Manilla papers, text books and other materials which we normally use for lesson study.

This explains it that if there are no materials, it is not easy to conduct a lesson study within and outside the school. Lack of materials and who should provide them therefore may impact sustainability of the study negatively because the cycle may either fail to be completed or may not be implemented due to lack of materials and also a teacher may end up not growing professionally which may affect the performance of learners negatively. Therefore, there is need for continuation of provision of materials by the school, the government and other stakeholders.

- *Benefits of Lesson study*

Lesson study as it has been mentioned is very beneficial. In the questionnaires and during interviews, participants indicated that the perceived benefits of lesson study are among the factors that positively impact and sustain lesson study activities. If the benefits are not known there will be negative attitudes towards the study by some teachers because they do not know or rather understand the importance of practicing lesson study. When participants were asked about the benefits of lesson study for teachers who conduct it, a response was given as:

Research based teaching sir deepens content and pedagogical knowledge which leads to improved instructional practices. Some further explained that on the side of pupils, due to lesson studies, there is improved learning outcomes, confidence, self-efficacy and enhanced problem solving skills. Some further said that learners tend to concentrate more when there are a number of teachers during a lesson. This is because during the implementation of lesson study, teachers enhance their teaching skills, within or among themselves without being away from class, the practice happens in the real class so it is more effective and teachers tend to look forward to more lesson studies.

Lesson study is a collaborative and an effective way to develop teaching skills, improve student learning and also create a collaborative school culture. Its focus on collaborative practices, reflection and continuous improvement ensures that it benefits both teachers and students over the long term. This implies that beyond teachers, lesson study can benefit students, schools and the community at large. When teachers improve in their professional practice, student learning outcomes typically improve, which can bring about the positive effect on the overall school performance. The study fosters a culture of continuous improvement mathematics, which is crucial for schools looking to stay responsive to the evolving needs of students.

- *Appropriate Implementation of Lesson Study Activities*

Lesson Study implementation requires careful collaborative planning and a structured approach. The study need to be designed in a way that promotes active participation, reflection and improvement. It was revealed that implementing lesson study effectively can have a significant impact on sustainability, particularly when lesson study cycles are completed. When participants were asked about their completion of the lesson study cycles, it was revealed that some participants never complete the cycle. Generally, the study cycle in mathematics involves planning, lesson discussion, lesson implementation, post lesson discussion, analysis or reflection and revision and iteration. Teachers collaboratively identify a problem, lesson plan, then a volunteer demonstrates a collaborative planned lesson, then they discuss, re-teach and compile conclusion. At almost every stage of the study cycle, it was found out that each teacher was very busy trying to finish the syllabus, making it very difficult to finish the cycle. It was further said that practicing lesson study in a correct way is one of the factors which impacts sustainability of lesson study effectively. Teacher creativeness and innovativeness is also vital. But above all, Policy consistency is key. Some education policies may not be consistent, hence affecting the implementation of lesson study.

- *Time Constraints*

Challenges faced during lesson study generally have a negative impact on its sustainability and time constraint can be a negative factor that can impact sustainability of lesson study in a mathematics education. Participants often mentioned that time constraint is a crucial factor that hinders the implementation of lesson study. According to them, time constraints is one of the factors affecting the lesson study cycle. It was revealed that time to gather resources and plan a lesson collaboratively is not enough. Therefore, time constraint is one of the factors that impacts sustainability of lesson study in teaching and learning mathematics negatively.

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➢ *Attitudes*

Attitudes of teachers were found to be factors that impacted the sustainability of lesson study. The study observed both positive and negative attitudes. It was revealed that sustainability depended on attitudes. For example, poor attitude from the teachers, lack of coordinated action plans and weak supervision determines the implementation of lesson study. The idea that there is no certification or immediate external reward, makes some teachers develop negative attitudes because they feel like it is a shire waste of time and this affect the lesson study cycle negatively.

➢ *Mitigation of Lesson Study Challenges*

It was found that, among other factors mentioned, mitigation of pedagogical challenges can either impact sustainability of lesson study negatively or positively in teaching and learning mathematics. We need to involve ourselves in Peer teaching so that we can address the instructional challenges. Sometimes even just sharing information on challenging or new topics, new trends such as Information Communication Technology in mathematics, Examinations Council of Zambia marking trends, poor performance at National Examinations in mathematics and sciences and poor support system to teachers of mathematics in schools. Like one participant mentioned, for us to overcome learners' poor performance during examinations, we need to share ideas on challenging topics and need to avail each other with new teaching techniques. This can happen in a group where there is need to create enough time required to complete all the stages of the lesson study and motivate some teachers to be willing to cooperate with fellow teachers.

IV. DISCUSSION

This section reports the discussion which was provided based on the themes that emerged from the title of the article.The study revealed that the availability of materials for lesson study activities, provision of materials required for conducting lesson study, perceived benefits of lesson study, appropriate implementation of lesson study activities, as well as attitudes, time constraints and lack of support are some of the factors that impact sustainability of the lesson study initiative.

➢ *Availability of Materials for Lesson Study Activities*

The availability of materials can either impact sustainability of lesson study negatively or positively in the mathematics education. Participants indicated the materials needed for lesson study activities such as Lesson study guide, school curriculum, observation tools for collecting data, lesson plan, flip charts or Manila papers, markers, pens, textbooks, syllabus, laptops and projectors. Without a variety of teaching materials, educators may rely on traditional methods such as lectures or rote memorization. This limitation can raise a child who ends up forgetting things easily because rote learning mainly accommodates short-term memory. So the lack of appropriate teaching materials can also create barriers in promoting student learning. It was further revealed that the availability of lesson study materials and teachers' positive attitude towards pedagogical change are key factors that determine the effectiveness of lesson study activities. Access to resources was also highlighted as significantly important. This means that if necessary materials and resources are not accessible, it becomes difficult for teachers to implement lesson study. For example, if one has access to teaching resources, it is much easier to conduct effective lesson study activities. Kihwele (2023) conducted a study, and the findings revealed that the availability of learning materials influenced pre-service teachers in sustaining lesson study practices. The findings showed that course instructors assisted teachers in obtaining relevant materials to facilitate their discussions and personal reading. In cases where obtaining materials was challenging, the instructors encouraged them to be innovative and creative in improvising materials or teaching aids from available resources although this was not for every lesson as some materials may not be easy to improvise. Teachers admitted that their interest in effectively engaging in lesson study was heightened as they improvised learning materials.

Ensuring the availability of necessary teaching resources is significant because it helps in fostering an effective learning environment, promoting teacher well-being, and achieving positive educational outcomes.

➢ *Provision of Materials Required to Conduct Lesson Study.*

The provision of lesson study materials is another factor that impacts the sustainability of lesson study in teaching and learning mathematics. Participants explained how they sourced their materials, stating that the school and individual teachers provided the lesson study materials. Others mentioned that Japan International Cooperation Agency (JICA) provided some materials through the Ministry of Education, such as writing markers, manila papers, textbooks, and other materials commonly used for lesson study. These materials are crucial due to the nature of lesson study. Hunter and Back (2011) highlight that lesson study involves a group of teachers collaboratively planning a lesson known as the 'study lesson' over a series of meetings. The study can be video-recorded or observed by the entire team, focusing especially on student responses and weaknesses of the lesson. This process is iterative which means that it is repeated.

➢ *Perceived Benefits of Lesson Study*

Another factor that may either be negatively or positively impact the sustainability of lesson study in the mathematics education is perceived benefits of the lesson study itself. Participants explained that research-based teaching, deepens content and pedagogical knowledge leading to improved instructional practices. Banda (2007) appears to support these findings, as he notes that the Lesson Study approach, as a form of Continuing Professional Development (CPD), is proving to be a beneficial model for in-service teachers. This approach

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allows for the simultaneous development of teachers' and managers' capacities, ultimately enhancing the quality of teaching and learning. Schools also benefit from improved managerial skills as this is a positive impact in teaching and learning mathematics.

It was further revealed that students also benefit from lesson study activities which motivates teachers to continue with it. Through lesson study, there are improved learning outcomes, confidence, self-efficacy, and enhanced problem-solving skills for students. Some participants emphasized that lesson study does not only enhance teaching materials but also improves teachers' capacity to plan and deliver lessons, resulting into better learning outcomes. As a result, pass rates and learners' conceptual understanding improve.

Collaboration among teachers leads to knowledge-sharing and provides a platform for correcting ineffective methods. Teachers understand that lesson study aims to help students improve their performance, fostering unity among teachers. Additional perceived benefits include improved teaching skills and enhanced learner performance in National Examinations. Pass rates influence changes in learners' behavior and attitudes. Hunter and Back (2011) found in their study that collegiality and reflection are among the perceived benefits reported by teachers from various groups. They noted that lesson study provided opportunities for teachers to collaborate, enhancing their understanding of the topic, teaching methods, and students' learning processes. Collaborative work allows teachers to exchange information on topics, students' attitudes, and the preparation of assessments. Teachers work together using common schemes of work and lesson plans, taking ownership of challenges in teaching mathematics. Lesson study helps teachers address areas where they face difficulties, ultimately benefiting learners who experience improved pass rates when lesson study is fully integrated.

Lesson study promotes collaborative research on classroom activities, facilitating the exchange of experiences between teachers, collaborative planning, participatory learning, improved professional dialogue, and teachers' reflection. Active learner participation and performance are encouraged, as teachers observe each other's classes, motivating students to engage actively in class activities. Learners demonstrate increased focus when multiple teachers are present during lessons. Lesson study enhances teachers' skills through real classroom practice, making it more effective, and teachers eagerly anticipate further lesson studies.

- *Appropriate Implementation of Lesson Study Activities*

Implementing lesson study in a correct way is very important and beneficial to both teachers and students as appropriate implementation of lesson study can significantly impact sustainability of the lesson study, especially when the study's cycles are completed. However, to assess if lesson study were implemented correctly, the researchers inquired about the completion of the cycles. Upon asking if the cycles were finished, some participants disclosed that they had not completed the cycle due to time constraints and lack of necessary materials. This suggests that maintaining higher quality in the implementation of lesson study by teachers in schools leads to improved performance by students in science.

Enhancing factors for the quality implementation of lesson study, such as providing trained facilitators and upgrading the study environment, should be considered to enhance the practice. On the other hand, hindering factors identified in the research, like heavy workloads for teachers and high pupil-teacher ratios, could serve as topics for discussion in management boards to enhance teachers' lesson studies and students' learning in science.

Furthermore, some participants stated that they consistently complete the cycle, outlining the different stages involved in a mathematics lesson study cycle. Others mentioned that they only occasionally complete the cycle, attributing this to factors such as time constraints and curriculum pressures. Kihwele (2023) observed that lesson study is essential for teachers' professional development, with some countries emphasizing its implementation for pre-service teachers. Despite its benefits, lesson study faces various constraints in implementation, which may hinder expected learning outcomes.

To ensure proper implementation of lesson study, teachers should establish a well-structured activity schedule, including a timetable for the cycle's activities, support from supervisors, and a spirit of collaboration among colleagues and administrators.

- *Time Constraints*

Coe, Carl, and Frick (2010) embracing lesson study practices offers a sustainable opportunity for teachers to continue with the professional development through collegial collaboration. However, every educational initiative tend to face some challenges even when there are perceived benefits. However, it was found that challenges faced during the implementation of lesson study by teachers normally impact the sustainability of lesson study negatively. Among other challenging factors, participants mentioned time constraints as one of the factors which impact the sustainability of lesson study activity, resistance to change and limited resources. They explained that there is no enough time to gather and conduct lesson study collaboratively, and some environments are hard to conduct lesson study in a large class. Others said that lack of time affects the implementation of lesson study negatively. Indeed without or with less time it is not easy to implement lesson study and this may impact the sustainability of the study in teaching and learning mathematics negatively. Therefore, time for lesson study activities has to be created.

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- *Attitudes*

It was revealed that the idea that there is no certification or immediate external reward, some teachers feel it is a sheer waste of time. Negative attitude by some teachers not wanting to see the need to continue learning affects the effective implementation of lesson study. In their study, Tukombe, Banda, and Nakai (2017) recorded a participant who stated that:

"My major turning point in the negative attitude I had towards Continuing Professional Development (CPD) was last year in 2016 with the coming of third continuing professional development training."

I began to see the difference and the reason why as teachers we needed this program as compared to our learners. My mindset was changing gradually, my feeling and sense of responsibility increased in the support of School-Based CPD." It can be deduced that new programs always tend to be received with mixed feelings. In the long run, when the majority have seen the benefit, everyone gets to accept it. Furthermore, Kihwele (2023) reported that the teachers who were implementing lesson study for the first time found that it was not as smooth as planned. When the lesson study is not smoothly planned, it enables teachers to develop a negative attitude towards it as a result it brings a negative impact in the sustainability of lesson study in teaching and learning mathematics.

- *Lack of Support*

The other factor that may impact the sustainability of lesson study in mathematics education is lack of administrative support and knowledge of lesson study. The other support could be peer support. Without the peer support, it becomes a challenge to implement lesson study and it may impacts the sustainability of the study in teaching and learning mathematics. The lack of this support can impact the sustainability in mathematics education negatively. Its sustainability depends heavily on consistent and adequate support at multiple levels.

- *Mitigation of Lesson Study Challenges*

Among other factors, it was revealed that mitigating pedagogical challenges can positively impact the sustainability of lesson study. This indicates the need for a collective or individual effort to overcome perceived lesson study challenges. Participants explained that to improve the situation, they needed to engage in peer teaching to address instructional challenges. Sometimes, just sharing information on challenging or new topics, such as Information Communication Technology in mathematics, can be beneficial. Baba and Nakai (2015) noted that ensuring quality education throughout the country is the ultimate goal for all countries. It was further emphasized that creating enough time to complete all stages of lesson study, motivating teachers to cooperate with one another, and having school managers ensure adherence to correct practices are important. Additionally, teachers need clear explanations of the concept of lesson study to understand what is to be achieved. Kihwele (2023) further highlighted that lesson study offers a platform for internalizing pedagogical skills through collaboration and teamwork. It provides constructive feedback to teachers for self-reflection and improvement. Through this approach, teachers develop essential skills such as project-based learning, new technologies, collaboration, innovative pedagogy, social networking, critical thinking, and integrating social artifacts in the learning process.

V. CONCLUSION

For teachers showing negative attitudes towards lesson study activities, the government, through the Ministry of Education, should continuously be providing incentives such as snacks, drinks, and transport just to motivate them to be participating in lesson study. The ministry must also be awarding certificates at the end of each term upon completion of the lesson study cycle. School leaders should also be continuously orienting teachers about how to conduct lesson study. The orientation will also enable teachers to understand the benefits of lesson study, as indicated by Stutchbury, Gallastegi, and Woodward (2019), who argue that lesson study is designed to support the pedagogic change required to implement the new curriculum. It aims to encourage teachers to explore possibilities within their own classrooms, develop practices that challenge and support learners, and cultivate new attitudes in line with the revised school curriculum and practices within their context.

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