

**Methodology Article**

Reflection on Lesson Study and Implementation for Enhancing Mathematics and Science Teaching and Learning in Rwandan Schools

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Abstract: The impact survey of report on teaching and learning mathematics and science in Rwandan schools indicated different challenges featuring teachers in implementation of curriculum. Some of the challenges in mathematics and science topics for teachers and students are; inadequate skills for conducting science practical works and lack of permanent friendly professional development programme. This paper reflects on how these challenges could be addressed through lesson study approach in Rwandan context. The interpretivism approach will be used in this study and some of the related model about the lesson study description and implementation. Data were collected from the existing literature pertaining to lesson study and the accessed writings from countries which have embraced and implemented the lesson study in mathematics and science were considered. The analyzed data confirm positive impacts of lesson study towards the quality of teaching and learning of mathematics and science by improving teachers' teaching competences as well as students' academic achievement in the countries that have implemented it. Based on the findings, a lesson study is urged to be implemented and spread in Rwandan primary and secondary schools and also being initiated in teacher preparation programmes as one of school community of practice to nurture teachers' competences for implementing the curriculum.

Keywords: Implementation, Lesson Study, Teaching and Learning, Reflection

1. Introduction

The quality of education is very critical to any nation's education, particularly in the developing countries as those countries are aiming to achieve Sustainable Development Goals (SDGs), in which one of them is to "ensure inclusive and equitable quality of education and promote life-long learning opportunities for all" [23].

Achieving those goals largely depends on qualified teachers, since qualified teachers are said to be the most important persons in the process of curriculum implementation [2]. Inspired of that, both teacher training programmes and institutions in developing countries do not adequately provide

teachers particularly, mathematics and science ones with worthwhile knowledge and skills necessary for implementing curriculum reforms [31]. In addition, teachers face a number of challenges such as large number of trainees, shortage of trained teachers, recruiting none motivated and competent students, insufficient of teaching facilities, teachers' job satisfaction and motivation, and inadequate of teacher professional development programmes.

As result, there is no significant classroom change in aspect of teaching and learning after the completion of in-service trainings, workshops, seminars, and conferences [8, 13, 5], among other researchers have criticized such traditional approaches of teacher professional development programmes because of being too brief, fragmented, incoherent and not

considering realities of schools as well as classrooms.

Acknowledging the role played by in-service professional development face to face the quality of teaching and learning through traditional cascade training approaches of top-down, there should be a ‘lesson study’ approach of training as school-based training facilitated by teachers themselves and focuses on teachers’ knowledge and skills as well as schools and classrooms realities as highlighted by Leu [13].

Different authors have almost similarly described what a lesson study is. Reference [32] argued that lesson study is a new way of professional development practiced by Japanese teachers for decades that resulted to high scores in mathematics. It is a thorough and well-articulated process for examining teachers’ classroom practice [7]. According to Doig, B. & Groves [4], a lesson study got a special attention by educators of the West and throughout South-East Asia because of its contribution to students’ achievements as well as to positive attitudes in mathematics and science.

As it is intended as well as described above, the question is what lessons the countries including Rwanda that may plan to institutionalize the lesson study can learn from those which have already enacted such particular kind of teacher professional development? And how can they do in order to mitigate challenges faced by those which have implemented the lesson study practices?

This paper examines how the lesson study was implemented in different countries including the ones of sub-Saharan Africa and explores common challenges associated with its practicability. Authors then carefully reflect and discuss for appropriate practices that might be common to developing countries, particularly sub-Saharan African ones owing to the shared common challenges pertained to teacher education as well as schools diversity that could be addressed by practicing the process of the lesson study. They finally suggest possible ways through which the new ideas could be introduced in the context of this study for contributing to the achievement of their socio- economic development goals.

2. Methodology

As this study is a critical review, while reflecting on the existing findings, it is guided by interpretivism perspective. According to [1], interpretivism is an approach to research used in social science as the case of this study that opposes to positivism used in natural science. It is founded on the belief that the knowledge and understanding of reality is socially constructed by human actors in natural setting.

The interpretivism approach used in this study is guided by Onion Ring Model described in [16] which was employed in examining the lesson study in Zambia. The model contains five rings of any education system which affect the enactment of new ideas, a lesson study in this case. From outermost to the innermost, the model comprises national policy about the lesson study description and its implementation, school culture for supporting the innovation and assisting in its implementation, classroom environment for pedagogic and

physical aspects, teachers’ personal characteristics and school level of lesson study implementation as established by teachers with its critical attention on specific aspects of it. Data were collected from existing literature related to ‘lesson study’ particularly its implementation and associated challenges.

The revisited literature was purposefully selected from Japan and United States of America as countries that are pioneers in lesson study practice. Also the accessed writings from countries which have embraced and implemented the lesson study as their situated-fit kind of mathematics and science teachers’ professional development such as Australia, Malaysia, Hong Kong, Indonesia, and Zambia were considered. A report on the workshop in which a lesson study was practiced in Rwanda was also used.

Following the model and approach guides this study as described above and the gathered data were thematically examined. Their outcomes are reported based on lesson study theoretical underpinning, significance of lesson study implementation, and challenges related to its implementation.

3. Findings from Revisited Literature

3.1. Theoretical Perspectives

Reference [28] coined the idea of a “teacher as a researcher” on the lesson. Based on the plan of his/her research, teacher is involved in a careful organized self-study in which works of other teachers that are pertained to classroom practice are thoroughly analyzed. Such analysis is done with the aim of identifying strengths and areas for improvement and such improvement as believed by [28] is brought by a combined effort of classroom teachers together with independent researchers’ teams who are capable to get the main ideas or facts from what is about teaching and learning. From the practice, pedagogic tips as well as new subject content are shared and then constructed for improving the classroom realities.

The teacher as researcher named a lesson study in Japan [11], described as a contextualized learning theory as it is focusing on a specific situation, activity and culture. The lesson study approach is also a variation or phenomenographic theory which involves a qualitative change in the way people experience something in the world around them as it was initially developed in Sweden and then in Hong Kong [18-21].

The lesson study is characterized by a group of two to six teachers or more depending to the situation [21] whereby; teachers, preferably those of the same department or the same subject, collaboratively plan lessons and carefully evaluate classroom practices for the purpose of improving their teaching and then better learning of students [14]. According to [15], highlight that a lesson study largely improves instructional strategies through collegial planning and teaching, observed live classroom practices, and collaborative as well as collegial discussions and lesson improvement; and makes learners to get a clear understanding of what learnt and use a particular skills [21].

Japanese lesson study approach was rapidly and extensively spread in other countries particularly United States and others of Asia where it is used as a systematic process for producing professional knowledge about teaching by teachers. Japanese lesson study cycle like it, other forms applied in different countries is done into different steps including choosing the topic which is generally the problem of study for example fostering students' interest in learning or how to solve quadratic equations, planning a lesson in which teachers use relevant resources and their own teaching experience to plan the lesson collaboratively, teaching the lesson where one of the teachers is chosen to implement the lesson plan, evaluating the lesson and reflecting on its effect, revising the lesson, teaching the revised lesson, evaluating and reflecting, and finally sharing the results [32].

In the countries that have adopted such way of professional development, the emphasis in lesson cycle implementation depends on the individual country's choice where for example, in Japan the focus is on learners' conceptual understanding as well as teaching and learning material preparation [28, 32]. Reference [27] view the lesson study programme as one of the models of professional development designed to assist teachers in order to produce quality lesson plans and gain a better understanding of student learning in mathematics across Years seven to twelve. Considering different ideas on the lesson study described above, different countries have used them to implement the lesson study as one of professional development programme. In the next paragraphs, the worthwhile roles of lesson study implementation are presented.

3.2. Significance of Lesson Study Implementation in Mathematics and Science

The reviewed writings give picture on the relevance of lesson study that has been conducted in different countries of the world.

In Hong Kong, 'Variation Theory' as form of Japanese lesson study was used and had impacted teachers on both conceptual and practical understanding of assessment as reported by Elliott [6]. With lesson study approach, as it has been the case among the three schools in United States, typical lessons can be produced and published as models of instruction [12]. Additionally, teachers' intellectual engagement and collaborative work was benefitted. Teachers' teaching skills in science and students' pass rates particularly in biology were improved [3]. It is also reputed to be a monitoring strategy for teacher candidates since it helped them to be familiar with lesson study practices and benefits whereby they found for example the lesson study format easy to navigate and they were found to be more focused on their own instruction than they were.

A lesson study is important for teachers because it enables them to understand easily new concepts and how to provide effective support to learners. In light of this, one of the Australian teachers attributed the greater understanding of how the steps involved in learning a new concept and adequate scaffolding to learners as some of results of participating in the

lesson study [27]. Moreover, all the teachers and team leaders agreed that lesson study was valuable to co-teach, because it showed them how other teachers dealt with the topic as well as disruptions to tasks as 84% of the participants reported that they had learnt the better way to teach the topic and deepened the content understanding; and 81% reported their deep understanding of how students learn the mathematics in the lesson. The benefits of the lesson study were also reported by the teachers of the second cohort whereby 87% and 86% expressed to have learnt from co-teaching which shows how other teachers deal with topics in addition to other things that may prevent the progress of teaching and learning and also better ways of teaching particular topics. However, a number of those who deepen their understanding were decreased comparing to the report of the first cohort which means that participants benefit differently based on their needs.

Apart from teachers, Japanese teacher professional development contributed in students' academic achievements in mathematics and science [30]. It is also attributed to constant best performance in Mathematics and science of Japanese students in Trends in International Mathematics and Science Study (TIMSS) and in the Programme for International Student Assessment (PISA) comparing to their Western counterparts. By the lesson study, teachers can set experimental activities conducted by learners and then discuss their findings. With such practices, Indonesian students' enthusiasm, motivation, activities and performances were pointed out [17]. Additionally, as a result of being actively engaged in effective learning process and in addition to being self-directed in learning even beyond the class, as students claimed to enjoy the learning process and deepen both knowledge and understanding [6].

Apart from western and Asian countries, lesson study has been introduced in some of sub-Saharan countries through educational project that was or is supported by Japan International Cooperation Agency (JICA). In Zambia, lesson study approach was institutionalized in 2005. By the lesson study, this was confirmed by students pass rates in science, since before 2005 the results are different from those of 2006 and upward and also the results from the provinces where lesson study was implemented greatly differ from those where lesson study was not implemented. In Rwanda, in 2009-2010 lesson study activities were initiated and introduced through Strengthening Mathematics and Science in Secondary Education (SMASSE) project which was a jointly project between Japan International Cooperation Agency (JICA) and Ministry of Education (MINEDUC). Since the lesson study is for both teacher and learners, the one conducted in one secondary school in Rwanda was positively affect students' learning as well as improves teachers' teaching skills and pedagogic content knowledge since many of the participants particularly teachers and learners wished more lesson involving students' activities or experiments as some of their voices obtained from the completed evaluation sheets revealed: "I was interested, so keep it up." "It was very interesting and lovely lesson and come back again." "This is a nice idea to do these activities with my classmates and you as

visitors. It was really amazing; we were as if we were creating. This was one of the nicest things in my life I saw. I will never forget. I wish you do such lessons to other schools in the country”, “I wish that we could do experiments in every lesson of biology”, “Thanks for giving us new lesson. I really had fun doing activities. Keep it up”. Also, teachers being observers and those who taught learnt and appreciate the process [26]. The similar appreciations were also mentioned by different education bodies which had seen its practice or involved in one way or another during the workshop as they highlighted that lesson study is a new methodology of putting the learner at the centre of the learning process so that it puts an end to the traditional way of unidirectional teaching and that it will obviously improve the quality of education in Rwanda [26]. Despite of the identified roles brought by that practice, it didn’t however persist due to not being institutionalized in any of the in-service and pre-service teacher programmes.

3.3. Challenges Associated with Lesson Study Practices

Although, the lesson study contributed particularly to the quality of teaching and learning of mathematics and science; different constraints of it were also identified in Malaysia [22]. Those include time, teachers’ workload and perception of teaching. On a micro level, there is lack of teachers’ awareness of professional development while the examination-oriented culture rooted in the education system is at macro level. According [17], some other constraints reported as the shortcomings of the lesson study through Video Tape Recorder (VTR) of good lesson as a product of the lesson study to use for teacher education include teachers’ competencies in making lesson plans and students’ worksheets, teaching methodologies, students’ readiness and their number in class, educational facilities and equipment. Other problems were furthermore pointed out by Isoda [10], are nature of lessons which are always in the same “form” that is focused on using charts, concrete objects, group activities, and limited accessibility of teaching materials and colleagues’ abilities. Some other hindrances of the lesson study practices identified in Zambia include high pupil-teacher ratio, heavy teachers’ workload [3]. The failure to bring changes in classroom situation is attributed to the lack of clear understanding of the concept of learner-centered as well as teachers’ culture due to the fact that the lesson study requires openness and will be criticized.

Therefore, if there are enough supporting factors like; positive support from the school administrators, committed, dedicated group leader and strong collegiality among the lesson study team; then lesson study will be successfully implemented as an effective and innovative mode of teacher professional learning. Whereas allocating of well-trained facilitators at school and sufficient environment provided by grant-aided schools were reported as lesson study promoting factors [3]. Even though the lesson study has been introduced, the reference [9] argued that lesson practice has not changed into student-centered yet where for example in mathematics lessons, checking solution and doing exercises as well as group activities are common in the development of the lesson.

Based on its significance on the quality of education and in particular for both teachers and learners as reported earlier; lesson study practice is suggested to spread out and continue in Rwandan schools. The question here is how it will be re-established since the one initiated couldn’t persist.

3.4. Reflection on the ‘Lesson Study’ Institutionalization in Rwanda

We fully acknowledge that ‘one size does not fit all’ but we believe that countries can learn from each other particularly when it comes to good practices with the aim of filling the gaps. Since the lesson study has positively affected teachers quality and students’ learning, it resulted in academic achievement as well as positive attitudes in the countries that have implemented the professional development approach, particularly for mathematics and science teachers from Eastern to the Western countries [4, 15, 21, 27, 29, 32], a country like Rwanda and others that are contemplating to adopt that marvelous practice could not be left behind. Thus, the government of Rwanda should have a policy in place that a lesson study guide is included for smoothing the implementation of teacher professional development as well as the curriculum implementation.

Once the lesson study is officially accepted as a leading professional development particularly in mathematics and science where it has yield positive results, its institutionalization and sustainability requires all education stakeholders particularly those of the school community of practice at first understand it and then own it. Here, those who were national trainers, some educators from former Kigali Institute of Education (KIE) currently University of Rwanda-College of Education (UR-CE) and secondary school inspectors or other authorities from Rwanda Education Board (REB) who have experienced the lesson study approach from different countries namely Japan, Malaysia and Zambia [26], with other resource persons particularly educationists could have continue to support the spread and implementation of the lesson study in teacher training programmes and secondary schools instead of giving up.

At school level, all school community members including parents, teachers and students; are advised to change their culture of either being observed while teaching or providing constructive feedback as well as supports. With such change, there will be an agenda of collaborative planning and also the lesson study activities will be in school timetable either once a week or month or even a term as it will be stipulated by the policy. With that, school culture and classroom environment will be affected as a result of a good learning climate that will be created and promoted by lesson study practice. Additionally, reference [6] emphasized the relevance of the lesson study as the affordable strategy since it can be applied on small scale rather than on large scale.

As teachers are the most important people in the implementation of the curriculum [2], Rwandan teachers particularly mathematics and science ones should have personal and professional characteristics of the 21st century including that not limited to the ability to develop

relationships with their students, patience, caring, kind personality, knowledge of learners, dedication to teaching and engaging students in learning. With these attributes, they can be researchers, being knowledgeable and skillful and then implement the competence based curriculum effectively. This has also stressed by Fernandez and her colleagues [7] who argued that teachers must adopt three critical lenses which are 'research lens', 'curriculum lens', and 'student lens' for examining the practice if they want their lessons to succeed.

Lesson study as it has been attributed to be a potential to transform teaching and learning, when its policy will be in place in the context of Rwanda, school culture and classroom practices will be changed as a result of that new idea together with teachers' personal characteristics. Although, it has some challenges which might led to unsuccessful implementation particularly those of the school as well as teachers, school authorities should at first understand and own it; and some misconceptions Rwandan teachers may have face to face the more time that will spend in the lesson study cycle; we are advising them not to teach more time without improving the practice, since the best way is at first to be skillful and knowledgeable in the concepts and or content which are difficult for teachers and then provide what is relevant to students who need to be competent from competent teachers.

4. Suggestions for Lesson Study Institutionalization

Considering roles played by the lesson study practices, we are suggesting countries to embed this practice in their educational system. Therefore, there is need to kick start for effective establishment and implementation of the lesson study. This should be done by skillful and if possible, experienced staff from Rwanda Education Board (REB) together with other international or local experts in lesson study practices. For its successful implementation, regular support from experts and other experienced teachers is very important. Also, small but manageable steps of what implementers of the lesson study are able to do that are to be identified following the theory of Zone of Feasible Innovation suggested by Rogan [25] and Rogan and Grayson [24]. This way of the lesson study implementation is suggested based on the ideas of the aforementioned authors who argued that a new curriculum in this case a lesson study as the programme of professional development cannot be implemented in one big leap but needs to be done in series of smaller steps that are manageable. Due to the fact that the implementation of the lesson study is not looking only teachers, sufficient supports from school administrators and other dedicated group leaders among others are highly needed. Additionally, in the context of Rwanda, joining teachers from neighboring schools for experiences sharing and also when the number of the teachers per school and subject is not enough. Also, external catalysts particularly consultants could be invited. All of them will help in different stages of the lesson cycle

depending to the role that will be assigned to them prior to the lesson cycle. However, lesson study alone is not enough as it is regarding mostly teachers. A stimulating atmosphere for its practice is very much needed. In this regards, the concerned stakeholders particularly school head teachers must create it; otherwise what is expected from lesson study practice will not be achieved. This may also led to non-sustainability of what was a good idea.

Due to the fact that, some schools may only have one teacher of mathematics and science subjects respectively and therefore think that lesson study is impossible for them; neighboring subject school teachers and other resource persons particularly external consultants are advised to be invited for the effective professional development.

5. Conclusions and Recommendations

Today, Rwanda like many other countries acknowledges the important role of Mathematics and science since they are at the heart of educational system. Moreover, a Competence Based Curriculum (CBC) is being implemented with emphasis of competence-based and learner-centered principles among others for effectively achieving national goals. Achieving those goals depends largely on strong education caliber including the most cornerstones in teaching and learning who is a teacher as an agent of classroom change as well as of Rwandan society. Teachers solely are not sufficient for bringing change in classroom. Reason why a good school leader with leadership skills particularly listening, discussing and leading is needed for kicking and sustaining school based professional development particularly the lesson study as it is only the one to significantly satisfy teachers' needs in terms of teaching practice.

Therefore, a friendly, collaborative and school-based approach of the training known as 'lesson study' is recommended to be institutionalized as a model of teacher professional development. In this respect, Rwandan schools have to eagerly accept the idea of the lesson study and then, in particular, mathematics and science teachers embrace it as it is reputable to improve the quality of education in various aspects of the teachers as well as students; and it has been appreciated by Rwandan educators from different institutions as well as students.

If the 'lesson study' approach is well welcomed and practiced in one lesson study group, as it has contributed to the improvement of mathematics and science teaching and learning where Japan is the best example; similar achievements like those identified in good practicing countries will be also found in Rwanda like in other developing countries.

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