Summary Paper

JICA’s Support to Education in Africa: Focusing on Mathematics and Science Education

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1. Context

1.1 Major challenges in mathematics and science education in Africa

For the purpose of enhancing economic development, many African countries pay a particular attention to scientific and technological development. To that end, those countries attach an importance to developing scientific and technological human resources. For the development of human resources contributing to scientific and technological development, the quality of mathematics and science education (MSE) at the basic education level holds a key. Hence, many countries in Africa have been making efforts to improve the quality of MSE at primary and secondary levels.

On the other hand, many of those countries are faced with challenges in MSE including negative attitudes of students, teachers and parents towards MSE and low achievements of national examinations in MSE.

When it comes to lesson delivery in the classroom, typical lessons observed in the classroom in many countries in Africa are lecture-type lessons where a teacher just explains concepts, demanding students to memorize facts and formulas and to give “chorus” answers with minimal activities carried out by students. It seemed that these kinds of lessons would not allow students to acquire scientific and mathematical thinking skills.

1.2 JICA’s technical cooperation in education of Africa

JICA has provided technical cooperation (TC) in improving the quality of MSE in Africa for about a half century. The first TC in MSE started in 1960’s in the form of dispatching volunteer teachers for MSE.

In order to address the major challenges of MSE mentioned above, the Kenyan government requested the Japan International Cooperation Agency (JICA) to assist in implementing a TC project, which was aimed to improve a teaching and learning approach and to establish a sustainable in-service teacher education and training (INSET) system. Then, the first TC project aiming to strengthen MSE was launched in Kenya in 1998.

Based on the successful implementation of the project, TC projects aiming to strengthen MSE were also implemented in other countries in Africa.

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1.2.1. **Improving a teaching and learning approach**

Most of the JICA-supported projects to strengthen MSE in Africa include a component of improving a teaching and learning approach. Those projects aimed to introduce a learner-centered teaching and learning approach that transforms lesson delivery from teacher-centered to learner-centered. One of the notable approaches is called ‘ASEI-PDSI approach’ that was developed in Kenya.

‘ASEI’ is an abbreviation of ‘Activity’, ‘Students-centered’, ‘Experiments’, and ‘Improvisation’. In the process of developing the INSET curriculum in Kenya, a survey to understand the situation was conducted. During the survey, the survey team realized that, although many of the teachers interviewed had mentioned the importance of student’s participation and practical activities in the lessons, most of the lessons observed were teacher-centered. Then, they agreed that the following four perspectives would be helpful for teachers to deliver student-centered lessons:

- from content-based to activity-based lessons;
- from teacher-centered to student-centered lessons;
- from lecture/theory-based to practice/experience-based lessons; and
- from conventional materials to improvised materials.

These four perspectives were symbolized as Activity, Student, Experiment and Improvisation, and embraced in the INSET curriculum. Detail of the four perspectives is explained below (Takemura, 2008: 269-274).

a) **Activity**: As many teachers whom the survey team observed applied a lecture method in their lessons, the survey team felt that lessons should be activity-based. Lessons should have practical activities that allow students to be engaged in, to think, and to construct knowledge/concepts. Activities are not limited to hands-on activities. Activities must include minds-on activities that bridge practical activities with conceptual understanding. Minds-on activities include: to predict, to develop strategies for solving a problem, to identify commonalities and/or differences, to distinguish evidence from opinions, to identify the relationship between causes and effects, to explain phenomena scientifically, etc.

b) **Student-centered**: Students should construct knowledge by themselves with the guidance of teachers. Teachers should guide students to arrive at conclusions. The process should be owned by students themselves. Hence, students must be at the center of lessons.

c) **Experiment**: Scientific knowledge is generated and/or discovered through experiments and observations. An experiment is one of the most effective tools for scientific inquiry. Through experiments and observations, hypotheses are tested to find scientific truths. Thus, science lessons should include experiments where necessary.
d) **Improvisation:** One of the reasons for using improvised materials is based on the necessity. Even when conventional science apparatus and/or learning materials are not available, students can still carry out small scale experiments with improvised apparatus and materials that are developed from local materials collected in learners’ immediate environment. Another reason is to raise interest and curiosity of students by using materials that are familiar to students.

‘PDSI’ is an abbreviation of ‘Plan (planning a lesson)’, ‘Do (carrying out the planned activities)’, ‘See (assessing students’ understanding and evaluating the lesson)’, and ‘Improve (improving the lesson based on the evaluation)’. ‘PDSI’ is a continuous reflection process, which allows a teacher to improve the particular lesson, the subsequent lessons, and lesson delivery skills in general (CEMASTE A 2005). Kenya has made efforts to transform teacher-centered teaching and learning approaches into the learner-centered ones.

While the ‘ASEI-PDSI approach’ was developed to address challenges in teaching and learning in Kenya, this approach has been proved to be also effective in other African countries which are faced with similar challenges in MSE. In those countries that have introduced the ‘ASEI-PDSI approach’ or similar ones, some improvements in lesson delivery have been observed.

### 1.2.2. A sustainable system for continuous in-service teacher education and training

Most of the JICA-supported projects to strengthen MSE in Africa also have another component that is aimed to establish a sustainable system for continuous INSET. The system is expected to allow those countries to provide teachers with training continuously and regularly to improve the teaching and learning approach described above. As a development agency, JICA pays a particular attention to the sustainability of the system for INSET.

One of the major approaches of providing INSET for teachers is a “cascading approach” where National Trainers train District Trainers, and then the District Trainers train mathematics and science teachers. In many of the TC projects JICA has supported, this type of INSET system was established that can be sustained technically, financially, and institutionally by each country.

Another approach to conducting INSET is called school/cluster-based INSET where teachers of a particular school and/or teachers from schools nearby come together to have a meeting to discuss issues, to plan, observe and discuss a lesson together. As the two approaches can be complementary, many countries combine the two approaches to some extent.

In establishing the system for continuous INSET, for the purpose of ascertaining the sustainability of the INSET system, the following issues were carefully considered: (1) The system should cover the whole nation so that the established system will be part of the regular programmes of the partner country; (2) The system should be sustained by the resources of the partner country; and (3) A monitoring and evaluation mechanism was incorporated so that the partner country on their own can monitor and evaluate the training and other relevant activities to improve the quality of training.
2. Objectives

As shown above, JICA has supported more than 10 countries in Africa to strengthen MSE in the last 18 years. Hence, it is high time that JICA should reflect on the experience in supporting African countries in improving MSE so that JICA can discuss the future direction of TC in Africa.

The main theme of this summary paper is to discuss issues identified during/after those TC projects were implemented to address the challenges presented in 1.1 by improving teaching and learning methods and establishing a sustainable system for continuous INSET.

3. Methodology

First, positive outcomes of the TC projects supported by JICA are summarized. Second, further challenges identified after/during the implementation of the projects are summarized and discussed to come up with possible measures. Finally, five cases are presented which are being implemented to undertake some of the measures.

4. Presentation of the outcomes

4.1 Positive outcomes of the TC projects supported by JICA

Most of the TC projects for MSE supported by JICA to improve teaching and learning approaches and to establish a sustainable system for continuous INSET, have shown positive outcomes as shown below.

(1) Regarding institution/system development
(a) Established a sustainable INSET system

Most of the countries established a system for INSET. Some of them successfully established a system that covers nationwide and that is sustainable including Kenya, Uganda, Ghana, Senegal and Zambia. For instance, Kenya has been sustaining the INSET at secondary level with its own budget and personnel by changing the frequency of the training from annual-basis to experience-basis.

(2) Regarding teachers
(a) Changes observed in attitude (perception) of teachers towards MSE lessons
   i) Some teachers have come to pay more attention to thought processes and problems of learners (JICA & Ministry of Basic Education and Literacy Burkina Faso, 2010).
   ii) Some teachers have come to make sufficient explanations during lesson delivery. (JICA & Ministry of Education the Republic of Rwanda, 2011).
   iii) Some teachers have come to make more communications with students. (Federal Ministry of Education Federal Republic of Nigeria & JICA, 2009).
(b) Changes observed in lesson delivery
   i) Teachers conduct more group work and experiments. (Federal Ministry of Education Federal Republic of Nigeria & JICA, 2009; JICA, Ministry of Economic and Finance
Some teachers have come to use more teaching and learning materials (TLMs) during lesson. They improvised TLMs for students’ activities and/or experiments (Federal Ministry of Education Federal Republic of Nigeria & JICA, 2009).

(3) Regarding students


(b) Students came to think more independently (JICA & Ministry of Basic Education and Literacy Burkina Faso, 2010).

(c) Students came to ask questions more frequently (Federal Ministry of Education Federal Republic of Nigeria & JICA, 2009; JICA & Ministry of Education the Republic of Rwanda, 2011).

(d) Interests of students in MSE increased (JICA & Ministry of Basic Education and Literacy Burkina Faso, 2010; JICA, Ministry of Economic and Finance Republic of Senegal & Ministry of Education Republic of Senegal, 2010).

(e) More students came to choose Physics (JICA & Ministry of Education Republic of Kenya, 2008).

4.2 Further issues identified during/after the implementation of the projects

While TC projects implemented in the countries to address the issues in MSE in collaboration with JICA have produced positive outcomes as shown in 4.1, the following issues have also been identified:

**Issue 1**: Teaching and learning methods that teachers have learned at INSET are not implemented in the classroom as expected;

**Issue 2**: Although changes in lesson delivery are observed, many of them are not meaningful; and

**Issue 3**: Changes in lesson delivery do not necessarily lead to improving academic performance.

Possible causes of the issues identified above and measures to address the issues are discussed below.

(1) Possible causes and measures to be taken for Issue 1

The first major issue that “Teaching methods learned at INSET is not applied in the classroom as expected” is widely observed. During the interviews conducted to evaluate the projects, this type of comments is almost always made. Major possible causes and measures to be taken for this issue are summarized as shown in Table 4.2.1.
Table 4.2.1 Possible causes of Issue 1

<table>
<thead>
<tr>
<th>Cause</th>
<th>Area</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cannot finish the syllabus.</td>
<td>Policy</td>
<td>• To streamline the curriculum.</td>
</tr>
<tr>
<td>2. Requires more efforts and longer time to prepare a lesson.</td>
<td>Teacher</td>
<td>• To streamline the process of preparation for lessons.</td>
</tr>
<tr>
<td>3. Examinations focus still on lower order thinking skills such as factual knowledge.</td>
<td>Policy</td>
<td>• To revise examination items.</td>
</tr>
<tr>
<td>4. Support by Head teachers and Standards Officers is weak.</td>
<td>School leadership</td>
<td>• To strengthen the capacity of Head Teachers/administrators to do supervision at school level.</td>
</tr>
<tr>
<td>5. Insufficient skills and knowledge for improvisation</td>
<td>Teacher</td>
<td>• Not only to introduce improvised materials, but also to provide teachers with skills and knowledge of improvising TLMs for other topics.</td>
</tr>
<tr>
<td>6. Difficult to deal with a large class.</td>
<td>Teacher/Policy</td>
<td>• To analyze errors in diagnostic tests.</td>
</tr>
</tbody>
</table>

(2) Possible causes and measures to be taken for Issue 2

The second major issue, “Although changes in lesson delivery are observed, many of them are not meaningful” is also widely observed. Although lessons delivered by many of the teachers who have participated in the training seem to have changed, many of the changes observed are not meaningful, meaning that the changes will not necessarily enhance conceptual understanding nor skills acquisition of students. Major causes of this issue are summarized as shown below.

Table 4.2.2 Possible causes of Issue 2

<table>
<thead>
<tr>
<th>Cause</th>
<th>Area</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Training once a year is not enough for teachers to internalize skills and knowledge learned during the training.</td>
<td>Policy</td>
<td>• To provide teachers with opportunities to internalize the skills and knowledge by institutionalizing Continuous Professional Development (CPD).</td>
</tr>
<tr>
<td>2. Teachers’ understanding about teaching and learning methods is not deep enough.</td>
<td>Teacher/Learner</td>
<td>• To provide teachers with opportunities to deepen the understanding about learners’ thought process and the reasons behind the change of lesson delivery. • To deepen the understanding about leaners’ thought process by analyzing errors in diagnostic tests. • To strengthen PCK of teachers.</td>
</tr>
</tbody>
</table>

(3) Possible causes and measures to be taken for Issue 3

The third major issue is that “Changes in lesson delivery seems to be meaningful, but do not necessarily lead to improving academic performance”. Major causes and possible measures for this issue are summarized as shown in Table 4.2.3.

Table 4.2.3 Possible causes of Issue 3

<table>
<thead>
<tr>
<th>Cause</th>
<th>Area</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The level and arrangement of contents in syllabi are not appropriate to the level of</td>
<td>Policy</td>
<td>• To revise syllabi</td>
</tr>
</tbody>
</table>
2. The structure of textbooks is not organized effectively for students’ understanding. **Policy** • To revise textbooks.

3. Learners’ prerequisite knowledge as the foundation for understanding lessons is insufficient. **Learner** • To develop remedial workbooks for learners to strengthen numeracy skills.

4. Examinations focus still on lower order thinking skills such as factual knowledge. **Policy** • To revise examination items.

5. Teachers are not motivated to spend time and make efforts for thorough preparation for lessons. **Teacher/Learner** • To provide direct support for learners by developing remedial workbooks for study outside school

<table>
<thead>
<tr>
<th>4.3 Implementation of some of the measures and tentative outcomes so far</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five cases are presented below which have been implementing some of the measures discussed above.</td>
</tr>
</tbody>
</table>

- **Case 1. Ethiopia:** After having implemented a project that is aimed at improving a teaching and learning approach, the Ethiopian government decided to strengthen the capacity of examination item writers to develop test items that can appropriately test competences of students.

- **Case 2. Malawi:** After having implemented a project aiming to improve a teaching and learning approach, the Malawian government has been trying to develop a system that allows INSET providers and PRESET institutions to improve their curriculum based on the reality of the classroom by conducting Action research.

- **Case 3. Morocco:** In order to redress the disparity between regions, the Moroccan government has introduced diagnostic tests that are used to analyze misconceptions and common errors of students so that they develop remedial materials to address the weaknesses of students identified.

- **Case 4. Senegal:** In order to increase the study hours of students and to allow students to strengthen acquisition of basic mathematics skills, the Senegalese government has been introducing remedial workbooks for students with the support of the communities.

- **Case 5. Zambia:** The Zambian government introduced Lesson Study that allows teachers to work collaboratively with peers to improve lesson delivery. After successful propagation of the practice nationwide, the government is now trying to establish a system to strengthen pedagogical content knowledge of teachers and lecturers of colleges of education by conducting Kyozai-Kenkyu.
4.3.1 Case 1: ETHIOPIA - Project for Capacity Development for Improving Learning Achievement in Mathematics and Science Education in the Federal Democratic Republic of Ethiopia (LAMS)

(1) Background

Ethiopia has achieved a significant improvement in education over the past two decades. For instance, the gross enrollment rate for primary education increased from 32% in 1990 to 95% in 2012. At the same time, in order to accelerate the development of the industrial sector, the government of Ethiopia has adopted a national policy placing an emphasis on mathematics and science education from primary through higher education. However, a number of challenges and issues remain to be tackled concerning the quality of education.

The Ministry of Education (MoE) in cooperation with JICA implemented the National Pilot Project for Strengthening Mathematics and Science Education in Ethiopia (SMASEE) for three years (2011~2014) for the purpose of establishing a model of in-service teachers training (INSET) targeting primary school teachers of mathematics and science for Grades 7 and 8. SMASEE developed/achieved, among other things:

- 3-year INSET curriculum and INSET materials
- monitoring and evaluation tools
- establishment of one national INSET center and eight regional INSET centers
- training of 300 Regional Trainers (RTs) and 2,200 Key Teachers (KTs) from the target regions [under SMASEE]
- training of 22,500 RTs and KTs from non-target regions [with government’s own budget]

Because of the project’s remarkable achievements, the government of Ethiopia took a strong initiative to expand the SMASEE activities to cover the whole nation. It first established the Mathematics and Science Improvement Center (MSIC) to take charge of this nation-wide initiative. Through the extended activities by MSIC, 1,956 RTs and 14,369 KTs have been additionally trained so far. The INSET materials have been used in the training and, at the same time, improved and expanded to become five books. Monitoring and evaluation results show that the trainees’ attitude towards mathematics and science education is changed and that their capacity to implement INSET training is improved. MSIC is an indication of the Ethiopian government’s sustained commitment to the improvement of mathematics and science education.

While this project successfully built an effective INSET system and trained over 41,000 resource persons, a lesson has been learnt: Implementing SMASEE alone is not enough; it is necessary to address other institutional issues simultaneously such as curriculum, teaching and learning materials, teacher qualification, learning assessment and examination systems, educational administration and finance. It was against this backdrop that both Governments of Ethiopia and Japan agreed to implement a project particularly to reform the assessment and examination systems. It is called the Project for Capacity Development for Improving Learning Achievement in Mathematics and Science Education (LAMS).
For students to attain effective learning, it is necessary that the three components of the teaching/learning process, that is, “curriculum,” “classroom teaching” and “learning assessment,” should be consistent in their principles and contents. The students’ understanding should be correctly assessed by means of appropriately designed question items that are consistent with the curriculum and the textbooks. Only when these three components share the same set of principles and contents, the teaching/learning process as a whole can be effective and high-quality education can be achieved. LAMS therefore aims to pursue the consistency in the three components, particularly focusing on the third one, learning assessment.

Figure 4.3.1 Importance of consistency in the three components

(2) Practice introduced
LAMS is a three-year project being carried out from October 2014 to September 2017. Its project purpose is that “quality of curriculum strategy to improve students’ learning achievement in mathematics and science education at target grades is enhanced.” Following agencies are working for this Project as the Ethiopian executing agencies:
- Mathematics and Science Improvement Center (MSIC) (MoE)
- National Education Assessment and Examinations Agency (NEAEA) (MoE)
- Curriculum Development and Implementation Directorate (CDID), MoE
- Teachers and Education Leaders Development Directorate (TELDD), MoE
- 11 Regional Education Bureaus

(a) Question Item Development Workshop and Item Pools
The central activity of LAMS is the Question Item Development Workshop. The LAMS participants, around 90 experts (professional officers) invited from the executing agencies above, are organized into five Working Groups (Mathematics, Biology, Chemistry, Physics and Assessment/Evaluation). The Working Groups meet at the Workshops for their training and activities. A total of ten Workshops are scheduled in three years (once in three to four months). One Workshop lasts one week. In each Workshop, the members will:
- Develop items
- Mutually review items
- Rewrite items according to the comments
- Verify items through field tests conducted after the Workshop
- Analyze the results of the field tests in the next Workshop

The question items thus developed will be further selected and finally stored in the Item Pools, which are accessible to anyone concerned with educational assessment. LAMS participants have set their own targets as follows:

<table>
<thead>
<tr>
<th>Table 4.3.1 Targets for Item Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Group</td>
</tr>
<tr>
<td>Mathematics</td>
</tr>
<tr>
<td>Biology</td>
</tr>
<tr>
<td>Chemistry</td>
</tr>
<tr>
<td>Physics</td>
</tr>
<tr>
<td>Assessment &amp; Evaluation</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

As of the end of July 2016, LAMS has already conducted six Workshops out of ten and their achievements are summarized in Table 4.3.2.

<table>
<thead>
<tr>
<th>Table 4.3.2 Intermediate Achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Group</td>
</tr>
<tr>
<td>WS1</td>
</tr>
<tr>
<td>Mathematics</td>
</tr>
<tr>
<td>Biology</td>
</tr>
<tr>
<td>Chemistry</td>
</tr>
<tr>
<td>Physics</td>
</tr>
<tr>
<td>Assessment &amp; Evaluation</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

(b) Workbook Development

Another main output is workbooks on the four subjects for Grades 7 and 8. LAMS started working on this assignment at the fourth Workshop. The participants developed and adopted the respective tables of contents and every participant has been assigned a few specific topics to develop. LAMS has adopted three principles for this work: 1) The workbooks should cover all topics specified
in the curriculum; 2) the workbooks should be as slim as possible; and 3) the workbooks should facilitate the understanding of ordinary students.

(3) **Major outcomes**

To evaluate the impact of LAMS, six indicators have been specified:

1) The participants’ satisfaction with the project activities
2) Change in the participants’ perception on curriculum consistency
3) Quality of items: the number of items that violate the guidelines
4) Quality of items: the scores of overall quality assessment of individual items
5) Quality of items: the rate of items that have “difficulty,” “discrimination index” and “item-total correlation” in acceptable ranges
6) Quality of items: the rate of items of the Primary School Leaving Certificate Exam which are consistent with the minimum learning competencies

With respect to 1), 3) and 5) above, intermediate evaluation was conducted during February-May 2016 through a questionnaire survey of Workshop participants, by administering a specially arranged mathematics test and by analyzing the items developed and field-tested by LAMS. The evaluation has revealed following findings.

1) **Participants’ satisfaction:** More than 90% of the participants indicated that the LAMS training gave positive impact on their question item development skills. Over 88% of the participants also believed that they were able to develop better question items after the training (Etenesh & Ishii, 2016. The survey conducted in May 2016).

3) **Number of guideline violations:** Among the 100 items randomly selected from Workshop 2 and Workshop 5, respectively, 352 violations of the 13 guidelines were committed during the second Workshop while the number was reduced to 203 during the fifth Workshop (Etenesh & Ishii, 2016).

5) **Rate of items with acceptable “difficulty,” “discrimination index” and “item-total correlation”:** When items developed in Workshop 2 and Workshop 5 are compared, the rate of items in the acceptable range increased as shown in Table 4.3.3 (Etenesh & Ishii, 2016):

<table>
<thead>
<tr>
<th>Percentage of Items in the Acceptable Ranges</th>
<th>Percentage of items with difficulty value between 0.20 and 0.80</th>
<th>Percentage of items with discrimination index value of 0.20 and above</th>
<th>Percentage of items with I-T correlation value of 0.20 and above</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop 2</td>
<td>72.5</td>
<td>60.8</td>
<td>59.2</td>
</tr>
<tr>
<td>Workshop 5</td>
<td>85.6</td>
<td>70.6</td>
<td>73.5</td>
</tr>
</tbody>
</table>

When 30 mathematics items developed under LAMS and 30 conventional mathematics items (developed before LAMS intervention) are compared for the same competencies, higher quality of LAMS items is proved as seen in Tables 4.3.4 to 4.3.6 (Bimerew & Ishii, 2016):
(4) Current Focus

As is indicated by the intermediate evaluation, LAMS as a whole is on the right track accomplishing its assigned tasks. However, there seem to arise two issues that were not anticipated at the beginning of the project. They are:

1) How to deliver the LAMS training to all primary school teachers throughout the country; and
2) How to capacitate the MSIC experts to become the National Trainers on item development.

The first issue has been unanimously raised by the LAMS participants. To do it is outside of LAMS’ scope and should be pursued by a separate project. Closely related to the first issue, the second issue also requires serious attention. LAMS is currently taking gradual steps towards this goal. It is strongly hoped that MSIC would become able to deliver in-service training on classroom assessment and item development along with subject teaching skills. The Ethiopian government has recently requested a new technical cooperation project to the Japanese government to pursue this goal and materialize INSET on classroom assessment and practical item development skills.

4.3.2 Case 2: MALAWI - Improving Teachers’ Practice through Action Research: Strengthening of Mathematics and Science in Secondary Education (SMASSE)

(1) Background

The Malawi government has been implementing in-service teacher education (INSETs) through the project for Strengthening Mathematics and Science in Secondary Education (SMASSE) for mathematics and science teachers in secondary schools since 2004. SMASSE aims at improving teachers’ content knowledge and pedagogical skills with the emphasis on student-centred education. After more than a decade for such an intervention reports still indicate that teachers who attend these INSETs partially practice the skills they acquire during the training (Ministry of Education Science and Technology & JICA, 2012). These reports point out issues to be addressed for teachers, for instance, needs to substantially improve their teaching which included skills in preparing lesson plans and engaging all students in large class size. Teachers also attribute difficulty in implementing student-centred approaches to large class size, inadequate facilities and insufficient teaching and learning materials.
In Malawi research done so far lists up challenges but not much research has been done on what solutions could be effective in such conditions. For this reason, SMASSE INSET Malawi believes that the teachers need models on which they can base their own teaching in order to improve their practice. It is necessary for them to be given opportunities to develop an understanding about these pedagogies while participating in experiences that develop each of the teacher factors. SMASSE incorporated “action research” as one of the important components in its activities. Our expectation is that we can derive as many results as possible which benefit us in improvement of the content of SMASSE INSET. In conducting action research, we do not only observe the phenomena in the classroom but also intervene (take action) in teachers’ teaching based on the identified challenges teachers and learners confront and try to find the solutions.

Action research is defined as a ‘reflection-in-action mindset for teaching’ where the educator continuously considers the impact of his or her actions where they are being implemented, not afterwards” (Ary et al., 2014). Mertler (2009) cited in the mentioned literature characterized action research in three dimensions: 1) The research is situated in a local context and focused on a local issue, 2) The research is conducted by and for the practitioner, and 3) The research results in an action or a change implemented by the practitioner in the context. SMASSE adopted this Mertler’s model. Also in the same literature, Mills (2000) described action research as a systematic inquiry done by teachers (or other individuals in an educational setting) to gather information about, and subsequently improve, the ways their particular educational setting operates, how they teach, and how well their students learn.

In Malawi teachers attribute difficulty in implementing student-centred approaches to large class size, inadequate facilities and insufficient teaching and learning materials (Ministry of Education, Science and Technology & JICA, 2009). This study is taking an action research approach with an aim of improving their own instructional practice and consequently students’ learning outcomes specifically focusing on analysing the process of teaching and learning in the actual settings. SMASSE INSET has been conducting trainings for mathematics and science teachers since 2005 through a cascade model. These trainings have been conducted at National and Divisional levels for Divisional Trainers and all mathematics and science teachers respectively. Action research activity was best opted because of the necessity of intensive and close interaction with the teachers, necessity to observe closely what is happening in the classroom, especially from the aspect of what impedes teachers from practicing the skills they acquired through INSET.

(2) Practice introduced

The outcomes of action research are to provide feedback to INSET and pre-service teacher education (PRESET). The following objectives were set:
1) To identify problems in mathematics and science teaching and learning, together with the teachers
2) To identify and implement solutions based on ASEI/PDSI
3) To reflect good practices upon curricula of INSET and PRESET
Among three teams conducting action research with SMASSE, Department of Teacher Education and Development (DTED Team) uses the findings from the activity to provide feedback to INSET curriculum and improve subsequent interventions. In addition, the findings including good practice will be disseminated to all mathematics and science teachers through technical support to activities by school clusters. Domasi College of Education (DCE Team) and Chancellor College of the University of Malawi (Chanco Team) through the Faculty of Education utilise the results to inform their PRESET curriculum by incorporating the findings into their course outlines of mathematics and science education methodology.

These three teams selected different pilot schools (9 schools in total) for treatment based on different research designs for their own purposes. Each team considered some particular features such as 1) accessibility to schools (for intensive intervention), 2) typical challenges the teachers confront, 3) school category (conventional secondary school or Community Day Secondary School (CDSS)), 4) location (urban or rural) and 5) teachers’ willingness to participate in the research. Also teachers’ qualifications were considered in some cases. In each pilot school the research teams are working in collaboration with teachers in biology, mathematics and physical science (or physics and chemistry separately in accordance with the new secondary curriculum). The following describes the interventions done by a team of National Trainers from DTED Team at two of the pilot schools.

![P-D-S-I cycle](image)

**Figure 4.3.2 PDSI cycle**

The activities at each school follow the Plan–Do–See–Improve (PDSI) cycle. The team visits the schools throughout the term where the trainers and the teachers are involved in planning the lessons together (“P”), execute the lessons together (“D”) and evaluate the effect of the planned activities that direct subsequent planning (“S”), implementation of subsequent lessons in order to reflect the results of evaluation on practice (“T”). Specifically, each action involves: collaborative lesson planning (between teachers and researchers), giving technical advice to teachers on methodology, trial of teaching methods, lesson observation and post-lesson discussion and reflection by the teachers. This process provides opportunities for the teachers to enhance their assimilation of learner-centred education and to manipulate the ideas in the way they align the ideas with their
perceived challenges. At the same time, by sharing research questions between researchers and teachers and practicing above mentioned PDSI cycles in collaboration, the research teams try to build a teachers’ habit of continuous investigations for finding solution to overcome any pedagogical challenges.

A combination of quantitative and qualitative techniques is applied such as questionnaires and interviews on the perception of the subjects and the lessons administered both to teachers and students, interviews with the teachers before and after conducting the lessons, tests on students’ achievement to measure learning outcomes, etc. The influence of learner-centred approach is also measured by making records of what actually took place in the classroom: The lessons are videotaped and both the teachers and the researchers keep log books of lesson planning, lesson observation and post-lesson discussion. These materials are used to find the kind of improvements made in the implementation of planned lesson.

(3) **Major outcomes**

The questionnaire on students’ perception of mathematics and science subjects and lessons served for identifying the needs as well as for baseline study. The questionnaire was conducted in 2015 at the two pilot schools and two control schools in Central East Education Division. The data below show the results in mathematics at one of the pilot schools, which gives some general observations. The conclusion in terms of the impact the intervention will be derived from the comparison with the results of end line study planned in 2017 and other observations on specific topics determined by each researcher.

The results of this questionnaire show that the majority of students (81%) enjoy learning mathematics, like it, want a job that needs mathematics and want to become mathematics teachers in the future. However, according to the results, 72% of them find mathematics difficult. This situation may be explained by the results of lesson observation by the researchers in the first two lessons that the teachers planned and implemented before the commencement of our intervention. For example, in about first 25 minutes out of 40 minutes of a period there was silence among students in the both lessons. The students’ activities included: listening to the teachers attentively, copying the examples which the teacher wrote on the chalkboard with clear explanations and writing exercises similar to the examples given in groups. Even so, the teacher described such lessons as learner-centred and they specifically mentioned that there was active participation of the learners. The lesson, however, had characteristics of teacher-centred lessons from a point of view of researcher.

The study found that the teachers had some misunderstanding of learner-centred lessons and active participation. The response of the students reveals that they enjoyed and liked this teacher-centred lesson though it might not have been effective in terms of learning. It is possible that the students like and enjoy the traditional way of teaching in the classroom because they are accustomed to this type of lesson, and in addition, they might not have exposed to learner-centred ones. From such observation, questions rose whether the students will like the lessons during the intervention or we need interventions in different ways. This calls for more investigation which directs
the course of intervention in the future.

(4) Current focus

As we mentioned, one of the objectives of our action research activity is to give feedback to INSET curriculum. The challenges observed in the pilot schools have been used to direct the themes of subsequent INSET. For instance, the main theme of INSET in 2015, Assessment: A Tool for Teaching and Learning, and the one in 2016, Promoting Individual Thinking Skills through Mathematics and Science Lessons, were selected based on the findings in our action research. Some of the collected samples, among which are found incorrect answers students provided and actual question papers for end-term examinations with many flaws, have been utilized in INSET materials and shared to all the teachers in the country.

In future INSETs, good practices derived from the action research activities will be disseminated among mathematics and science teachers in all over the country for discussions in which teachers can reflect upon their own teaching.

With regard to PRESET, higher education institutions involved in the activity are in the process of reviewing their curriculum. Domasi College of Education has incorporated the ASEI/PDSI approach in their proposed curriculum, while Chancellor College is validating this approach so that it can be assimilated to their curriculum. Chancellor College is considering continuing action research on their own after this Phase 3 of SMASSE Project terminates in August 2017. In newly established Nalikule College of Education, an office for research centre is secured where action research is being planned to be administered.

In 2015 and 2016, JICA invited researchers from Mzuzu University and The Polytechnic, University of Malwi in addition to the above mentioned institutions to a training course in Japan in order that they recognise the effectiveness of action research and familiarize themselves with its methodology.

SMASSE Project thus have made efforts to sustain the activities especially in PRESET institutions.

4.3.3 Case 3: MOROCCO - Project for Promoting Education with Equity and Quality in Morocco Establishing a Quality Improvement Cycle Using the Educational Evaluation

(1) Background

In the Kingdom of Morocco, enormous efforts have been made, especially since the National Charter of Education and Training was declared in 1999, in order to provide quality education for the entire nation. Consequently, its net enrolment rate in primary education reached to 98.4% in 2014 so that the people’s full access to the most basic level of education is considered as generally achieved. Meanwhile, improvement of the quality of education to enhance students’ achievement is a current national issue. For instance, the result of the National Program of Learning Assessment carried out in 2008 shows that the overall achievement rate of the learning objectives according to the national
curriculum in mathematics at the fourth, sixth, eighth, and ninth grades are 34%, 44%, 25%, and 29% respectively (Conseil Supérieur de l'Enseignement, 2009). In addition to the general phenomenon of limited learning achievement in the whole country, there is an apparent disparity between urban and rural zones in which the students residing in the latter performs considerably lower than their counterparts in the former (Conseil Supérieur de l'Enseignement, 2009). To tackle these challenges, an educational reform is being carried out in accordance with the Strategic Vision of the Reform 2015-2030 prepared by the Higher Council of Education, Training and Scientific Research which takes the School as situated in the heart of the project of their national society (Conseil Supérieur de l'Education, de la Formation et de la Recherche Scientifique, 2015).

In that context, the Government of Morocco requested Japan to cooperate in implementing the Project for Promoting Education with Equity and Quality (PEEQ) and the project started in September 2014. It contains two main components, namely the equity component to address mainly the issue of equitable access to education and the quality component dealing with the improvement of quality of education in mathematics and science. This chapter discusses the quality component which is pertinent to the theme of the entire paper.

(2) Practice introduced

At the early stage of the project implementation, Moroccan pedagogical inspectors and Japanese experts in instruction undertook a general analysis on the current situation producing low level of student learning achievement, since it is important to identify the challenges to reduce the disparity. They observed math and science classes, discussed with teachers and administrators, and conducted a questionnaire survey at the target schools. Consequently, one of the major problems identified by the project team involved insufficient attention to the students learning at a slow pace and/or with difficulties.

Therefore, in order to improve the teaching and learning especially in challenging schools, PEEQ attributed great importance to the teacher’s deep understanding of students’ thinking ways, whether they are correct or incorrect, represented by their answers to the test items and to the questions asked in the classroom. Considering the students’ errors as important sources for the improvement of teaching and learning, what could be called “pedagogy of error” (e.g., Robert, 2008), a diagnostic test was carried out by the National Center for Assessment, Examinations and Streaming and the project team collaboratively. The test was given for the fifth and sixth graders in mathematics and scientific activities, and the questions were prepared in accordance with the educational objectives set in the national curriculum one-year lower than that for the test takers (i.e., fourth-grade-level questions for the fifth graders and fifth-grade-level questions for the sixth graders). Ten Moroccan pedagogical inspectors from different regions who were specialized in relevant subjects worked with Japanese experts to develop the test. First, on the basis of the national curriculum, reference frameworks were formulated to determine the objective of each item with due consideration for the appropriate ratio of each content domain and cognitive domain. Then, the test items were written by them to according to the framework. Between March 5 and 10, 2015, total 1,143 students (594 fifth
graders and 549 sixth graders) in 16 target schools took the test. The target schools were selected in the project areas having more difficulties in quality and equity of education than other areas do according to the relevant indicators including dropout rate, transition rate to secondary education, repetition rate, gender parity index for student number, average score in certificate examination, and percentage of students under pass-rate).

(3) **Major outcomes**

Its overall results are presented in the Table 4.3.7.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Domain</th>
<th>5th</th>
<th>6th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>Numbers and calculations</td>
<td>38.2</td>
<td>38.4</td>
</tr>
<tr>
<td></td>
<td>Geometry</td>
<td>38.9</td>
<td>52.0</td>
</tr>
<tr>
<td></td>
<td>Scales and measurements</td>
<td>26.3</td>
<td>22.6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35.4</td>
<td>36.2</td>
</tr>
<tr>
<td>Scientific Activities</td>
<td>Earth and life sciences</td>
<td>53.7</td>
<td>52.3</td>
</tr>
<tr>
<td></td>
<td>Chemistry and physics</td>
<td>33.4</td>
<td>27.6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>47.8</td>
<td>36.3</td>
</tr>
</tbody>
</table>

Not only the percentage rate of correct answers sorted by subject and domain but also that of each question was calculated so that the degrees of difficulty could be compared among items with different learning objectives. The comparison was presented in the form of graphic chart. Figure 4.3.3 gives an example of the analysis by question in the domain of numbers and calculations of the fifth grade. For instance, while 65.0% of the test takers answered correctly to the question of addition of two natural numbers (a five-digit number plus a four-digit number), only 36.7% gave a correct answer in the addition of two decimal numbers with two digits or less after the decimal separator. One can confirm that a considerable part of the students have difficulties in calculation of decimal numbers.

Moreover, error analysis was carried out for all the questions to reveal the sources of their errors. In case of the equation 58.74 + 853.6, four typical errors were identified and their frequencies and most probable reasons were presented (see Table 4.3.8).
The results of the diagnostic test revealed two important challenges for the students so that they were utilized to improve teaching and learning in the project target schools. First, since some
learning contents in which students commit an error were identified, training workshops for teachers were organized to improve their teaching practice in the classroom by revising their lesson plans with careful and specific consideration for the students’ actual difficulties. The other issue pointed out by the diagnostic test was the weak mastering of basic knowledge and skills of subject matters. Therefore, in mathematics particularly, a series of supplementary teaching-learning materials (i.e., exercise books) were developed and distributed.

(4) **Current Focus**

In September 2016, a diagnostic test will be carried out for a second time. For this second execution, certain improvements will be brought about. The capacity to point out the students’ achievement level will be enhanced by means of the simpler questions arranged in a systematic manner (see Figure 4.3.4).

<table>
<thead>
<tr>
<th>Question in 2015</th>
<th>75236 + 2681 =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions in 2016</td>
<td></td>
</tr>
<tr>
<td>(1) 7 – 8 =</td>
<td></td>
</tr>
<tr>
<td>(2) Chose the right operation to resolve the problem: 21 + 4 =</td>
<td></td>
</tr>
<tr>
<td>+ 4 1 + 2 1</td>
<td>+ 4 1</td>
</tr>
<tr>
<td>6 1 2 1</td>
<td>2 5</td>
</tr>
<tr>
<td>(3) + 5 9</td>
<td>7 6</td>
</tr>
<tr>
<td>(4) 236 + 81 =</td>
<td></td>
</tr>
<tr>
<td>(5) 75236 + 2681 =</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.3.4 Additional Questions to Enhance the Analytical Capacity**

The prompt production of analytical sheets should facilitate the individualized remedial action for the students. On the whole, by means of combing the diagnostic test and remedial actions, PEEQ aims at establishing a cycle of quality improvement of teaching and learning including a proper use of educational evaluation. Currently, the Ministry of National Education and Vocational Training is developing its strategy for disseminating the diagnostic test and subsequent improvement of teaching and learning to the entire nation. In order to put it into practice, the use of information and communication technology as a delivery tool, such as the Ministry’s web-site and database, is being considered.

4.3.4 **Case 4: SENEGAL – Improving Mathematics learning of primary school pupils with drill books**

**Background**

In 2013, the Government adopted the Program for Improving the Quality, Equity and
Transparency in the Education and Training Sector (PAQUET-EF), which provides the framework for operationalization of the Letter of General Sector Policy (2013-2025), which counts on the implementation of priority actions for governance based on accountability and a substantial improvement in student achievement.

To materialize this strategic option, the Government of Senegal has obligated the participation of local authorities and communities in the management of the education system as a strategic option as reflected the Decree N° 2014-904 of 23 July 2014 on the establishment, the organization and the functions of School Management Committees (CGE) and Unions of School Management Committees (UCGE) and its implementing order N° 01383 dated 30 January 2015. Despite the political will and many initiatives developed on the ground, the involvement and mobilization of local partners still remained timid in the schools management and governance. To meet the quality of education requirements, it is necessary to ensure that each learner has the Mathematics ability in general and the numeracy, including basic skills in numeration and the four operations in particular.

In this respect, the Ministry of National Education (MEN), in collaboration with the Japan International Cooperation Agency (JICA), implemented “The Project for Strengthening Mathematics, Science and Technology Education (PREMST)” and “Project for School Environment Improvement (PAES)” from 2007 to 2015. PREMST successfully strengthened primary teachers’ capabilities through in-service training with the “lesson study” approach.

Through the Project for School Environment Improvement (PAES), JICA provided technical assistance for the establishment and functionalization of CGE and UCGE, which are critical organizations to operationalize the policy of promoting the autonomy of primary schools in Senegal. Based on the results of these two projects, “The Project for Improving the Learning of Mathematics in Primary Education (PAAME)” has been implemented since September 2015 and will continue until August 2019. In articulating the objectives for the reinforcement of school-based management and quality improvement, particularly in mathematics, MEN and JICA have taken a new option aimed to ensure pupil-centered education through community involvement, capacity building of teachers in service and development of interventions in the classroom in order to improve learning outcomes in mathematics.

(2) Activity to improve mathematics learning with drill books

With greater involvement of communities and local authorities in the management of education quality, it is expected that the learners will be able to acquire the basic skills in numeration and four operations, while consolidating the achievements in the field of community mobilization and involvement in school governance. This is one of the most important reasons why MEN, in collaboration with JICA, has been implementing a pilot activity using mathematics drill books to improve pupils’ numeracy skills since the school year 2014-2015.

It is in the framework of Voluntary Action Plan (PAV), a planning tool developed and
implemented by CGEs using their own resources, CGEs organize remedial courses outside the official class hours in order to complement the learning time, which is considered to be insufficient only with the classroom activities. Until recently, the areas of intervention with JICA focused on the improvement of conditions for pupils’ learning, such as classroom construction, teacher training and school governance. On the other hand, the use of mathematics drill books aims to directly improve the quality of pupils’ learning. In this context, mathematics drill books on pre-math activities, numeration and the four operations have been utilized in the pilot activity to strengthen pupils’ basic numeracy skills. Inspired by the prototype of drill books developed by JICA, MEN adopted, revised and validated the drill books for the pilot activity in Senegal. These drill books are structured as follows:

<table>
<thead>
<tr>
<th>Table 4.3.9 Structure of the drill books (Version 2015-2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Book 1 (Section 1)</td>
</tr>
<tr>
<td>Book 2 (Section 2)</td>
</tr>
<tr>
<td>Book 3 (Section 3)</td>
</tr>
<tr>
<td>Book 4 (Section 4)</td>
</tr>
<tr>
<td>Book 5 (Section 5)</td>
</tr>
<tr>
<td>Book 6 (Section 6)</td>
</tr>
</tbody>
</table>

NB. The Books 6 and 7 of the version 2014-2015 were merged as the Book 6 of the version 2015-2016.

The remedial courses with drill books are organized outside official class hours and complement the official time credit. Pupils work individually on their personal drill books and move on to the following pages according to their own acquisition pace. The exercises of the drill books are arranged in ascending difficulty and systematically repeated in order to ensure learner’s acquisition. In principle, pupils do exercises independently, but with the help of “facilitators”, who monitor pupils’ attendance, check the progress and mark the exercises.

(3) Results of the pilot activity for the school year 2014-2015

During the school year 2014-2015, the MEN worked with sixteen schools for about 3,000 pupils from the first grade (CI) to the fourth grade (CE2) in the pilot activity with drill books. The preliminary selection of schools was done so that the selected schools might have a fairly functional CGE, which could organize remedial classes with their own resources, thus obtain results and draw lessons. Then, the schools that accepted financial support in the implementation of the pilot activity with drill books provided by JICA, were chosen. The financial contribution of JICA was limited to the provision of drill books for all target pupils and to the training of CGE representatives and facilitators, while the CGEs were responsible for the expenses related to facilitators, school equipment and supplies. In total, the sixteen CGEs recruited 141 facilitators, including 88 representatives from the community, who were junior high school graduates (BFEM) or above.

During the year, these sixteen schools organized remedial classes using drill books for 43.9 hours on average, within a range between 23.0 and 79.9 hours for the period from December 2014 to May 2015. For this achievement, the CGEs of these schools effectively mobilized 5,023,450 FCFA
(about 10,000 USD), that is, the average of 313,966 FCFA (about 630 USD) by CGE. It should be noted that ten schools of the sixteen continued to organize their remedial classes with the drill books even during the period of the teachers' general strike which lasted for over a month.

A series of placement tests were conducted to measure the effect of the use of drill books for the school year 2014-2015: (1) Pre-test at the end of October 2014; (2) Midterm test in the middle of February 2015, and; (3) Post-test at the beginning of June 2015. Each test consists of the sections that correspond to the drill book contents. For example, the level of understanding on the content of Book 3 is tested with Section 3. One of the indicators used to measure the effect of the use of drill books is the change of the pass rate for each section from the pre-test to the post-test. The pass rate for a section is defined as the percentage of pupils who gave the correct solutions to all the problems for the section.

Table 4.3.10 below shows the change of pass rate from the pre-test to post-test for Sections 3, 4 and 5, which is mainly related to the addition and subtraction. In Section 3, with ten problems on the addition of a one-digit number plus a one-digit number with or without carryover, a rate increase was observed for all the grades, between 9.7 and 35.0 points. Section 4, which has ten problems on the subtraction of a one- or two-digit number minus a one-digit number, registered an increase of over 20 points for all grades. As in Section 5 with five problems on the addition and subtraction of two or three figures, Grades 3 and 4 pupils gained 7.4 and 10.5 points respectively.

| Grade       | Number of pupils who took: | Pass rate (% of pupils who got full marks for the corresponding section) | | |
|-------------|----------------------------|------------------------------------------------------------------------|---|---|---|
|             | Pre-test | Post-test | Pre-test | Post-test | Change | Pre-test | Post-test | Change | Pre-test | Post-test | Change | Pre-test | Post-test | Change |
| Grade 1 (CI) | 753     | 717       | 0.5%     | 10.2%     | + 9.7   | 2.5%     | 25.7%     | + 23.2 | |
| Grade 2 (CP) | 717     | 690       | 6.6%     | 41.6%     |         | 2.5%     | 25.7%     | + 23.2 | |
| Grade 3 (CE1) | 742    | 697       | 34.1%    | 56.1%     | + 22.0  | 21.0%    | 41.8%     | + 20.8 | 1.9%    | 8.3%      | + 7.4 |
| Grade 4 (CE2) | 675     | 669       | 50.1%    | 75.2%     | + 25.1  | 35.0%    | 56.8%     | + 21.8 | 7.7%    | 18.2%     | + 10.5 |
| Total        | 2,887   | 2,773     | 22.2%    | 45.2%     | + 23.0  | 19.2%    | 41.2%     | + 22.0 | 4.7%    | 13.2%     | + 8.5 |

These results were quite encouraging for pupils and adults who made the effort to organize remedial classes for more than five months with their own resources. The contributing factors might be the successful gain of learning time with quality drill books, realized with the support of the community highly motivated and committed to improving their children’s learning. During the implementation of the pilot activity, some facilitators were too eager to obtain results and thus minimized the marking of the exercises in order to save time. In such a case, the pupils might have moved on to the following exercises without having sufficiently understood the content. In the course of the school year, a review session was held with the school principals and facilitators in order to make sure that they prioritize the pupils’ understanding and retention of their knowledge and skills instead of the hasty progress in the use of drill books.
(4) Way forward

In the course of the pilot activity with drill books, discussions are underway to ensure the sustainability of the organization of remedial classes with drill books. Thus, in the activities of strengthening community involvement, efforts are ongoing towards the local authorities and the educational community in order to ensure the budgeting in favor of drill books through the process of the budgetary debates and in the action plans of the CGEs. This strategy has been adopted through the community-based education forums organized with the JICA-funded project and in the process of updating the CGE action plans.

The sustainability of the model largely depends on the sustainability of its cost. This is why the current debate depends on Senegal’s institutional options where education is a devolved competence, which gives local authorities the responsibility to finance for a better education quality. The project assists them at this level to orient the resource allocation; this is an opportunity to take to fund the purchase of drill books. On the other hand, with the direct allocation of financial resources to schools by the government since 2014, CGEs also have an opportunity to contribute to the acquisition of drill books. Concrete recommendations will be made before the closing of the project in August 2019 to provide Senegal with a sustainable model aligned with its strategic options.

The PAAME aims to disseminate best practices to improve pupils’ mathematics learning. To realize this, an organizational system will be established by mobilizing both the teachers and the educational community. Although the implementation of drill books with community facilitators outside the official hours can be effective for pupils’ learning of numeracy, the drill books alone cannot guarantee the quality of learning. It is important to ensure effective intervention of the teachers in their classes possibly before introducing the drill books and a sufficient coordination and collaboration between the activities in the classroom and outside the classroom.

4.3.5 Case 5: ZAMBIA – Lesson Study Practice of Teachers in Zambia

(1) Background

In Zambia, teacher education starts from Pre-service Teacher Preparation where the would-be teacher undergo initial teacher training before they are posted to become actual teachers. This is followed by In-service Teacher Training which is practiced from two broad categories in Zambia which are INSET programmes and on-going Teacher Professional Development. Major INSET programmes for teachers in Zambia are run through such programmes as “Fast Track Teacher Education Programme (FTTEP)” which is done by the Ministry of General Education in collaboration with various universities and Teacher Training Colleges, the “Primary Teacher Diploma by Distance Learning Programme (PTDDL)”, where the Ministry aims at upgrading certificate holder teacher to Diploma level. Other programmes under INSET are “Primary Teachers Degree Programme” that the Ministry runs in conjunction with the universities. All of these programmes have been helping teachers at primary and secondary schools in upgrading their qualifications.

In 1998, Ministry of Education formalised and institutionalised the School Programme of
In-service for the Term (SPRINT) in order to provide guidance for a sustainable Teacher Continuing Professional Development (CPD) at the point of implementation, managed by the school Head teachers. The SPRINT framework was also put in place as a tool to interpret the implementation of policy on Teacher CPD in Zambia underlined in the national policy document, “educating our future” (Ministry of Education, 1996).

(2) Practice introduced

The lesson study practice was introduced into the Zambian Teacher CPD programmes in 2006 with technical cooperation of Japan International Cooperation Agency (JICA). The introduction was necessary and timely because while School based CPD was going on in schools, the Teacher Group as well as departmental meetings lacked the desired content that could stimulate and motivate the teachers into engaging in meaningful professional discussions. Lesson study is a continuing professional development approach used by teachers to solve their own problems. It is a form of “action research” used for teacher professional development and the field for this practice is the classroom as a “laboratory” for generating data-driven conclusions about content and pedagogy. Lesson study follows the “plan”, “do”, “see” principle and, in Zambia, lesson study cycle follows the eight stages described below: (i) Defining the Problem or Challenge, (ii) Collaboratively Planning the Lesson, (iii) Implementing planned Lesson, (iv) Discussing the Lesson and Reflecting on its Effects, (v) Revising the Lesson, (vi) Teaching the Revised Lesson, (vii) Discussing the Lesson and Reflecting on its Effect again, (viii) Compiling reflections (what has been learnt for teachers’ CPD).

Lesson study was introduced as a tool that teachers could use to enhance their peer–to–peer learning practice and fitted in very well into the existing SPRINT framework and its structures of Teacher Group Meetings (TGMs), Head Teachers In-service Meetings (HIM), School In-service Monitoring (SIMON), Grade Meetings at the Resource Centre (GRACE) and so on (Ministry of Education, 1998). It was introduced into the SPRINT framework over a period of 10 years (2006 – 2015) through a phased approach and, according to the master plan for School based CPD, it is projected that by the year 2023, all the primary and secondary schools in the country with total number of 9,500 schools will have been embraced under the practice of School based CPD through lesson study, which is supposed to include 100,000 teachers and affect 3,800,000 pupils.

Though the introduction and expansion of lesson study practice have been supported by JICA through technical cooperation projects, “ownership” of the program and “sustainability” of implementation has been carefully considered since the beginning. Firstly, lesson study was not introduced as a new program or new system for the teachers, but introduced as a practice adopted in the existing SPRINT framework, which teachers were doing at schools. This avoided confusion among the implementers and made them extend the practice easily. Secondary, since the SPRINT was a program run by the Ministry, existing framework and human resource as well as funds for SPRINT was used for introducing lesson study to the schools and implementing necessary workshops at national, provincial, district levels. Consequently, 93% of the costs for the program from 2006 to 2015 came from the Ministry (Nakai, 2016). Thirdly, lesson study practice can be done at any school with
low cost and flexible to fit school calendar. This characteristic of the practice contributed the practice to sustain at school level. Lastly, the practice put teachers at schools as main actors of the program, who plan, conduct, discuss and make decisions for improvement by themselves. This design of the practice empowered teachers to own the practice. In the program, teachers are not recipients of the training contents, but core agents to provide idea for the improvement of classroom lessons.

(3) **Major outcomes**

It was found that lesson study practice was cost-effective and flexible, because it can be implemented at schools without sending teachers outside of the station and fit into school calendar and its activity plan. The practice empowers teachers as main actors to improve lessons at classrooms, thus, changes of teachers in terms of commitment to their work was seen in the field. While lesson study has been introduced and implemented in the country, the followings have been found as effects of the practice in the researches to assess its implementation and impacts.

(a) **Quantitative Aspect**

As shown in Figure 4.3.5, more than 46,000 teachers at primary and secondary schools are conducting lesson study as of 2015. This means that almost half of teachers in the country are given opportunity to continuously study and improve their lessons without leaving schools.

![Figure 4.3.5 Scaling-up of lesson study in Zambia](Source: Ministry of General Education & JICA (2015))

(b) **Qualitative aspect**

Surveys on the teachers’ skills and learning of pupils were conducted in 2011 and 2015 to assess the improvements by observing lessons in mathematics and science at primary and secondary schools as well as administering questionnaire to pupils on their learning. Teachers’ skills were seen from the four areas that were looked at, that is 1) ability to planning a lesson, 2) ability to delivering a lesson, 3) learning of pupils in terms of attainment of objectives and also 4) learning of pupils in terms
of extent of subjective (active) learning. For example, in ability of planning a lesson, teachers’ skills on planning lesson based on pupils’ level of understanding and expected reactions were assessed. In ability of delivering, questioning techniques and organizing pupils’ process of thinking were checked. In the survey, an increase was observed in all the four areas under the study (Ministry of General Education & JICA, 2015). This conclusion was derived from the figures that were obtained from 500 teachers in the country before introducing lesson study (baseline time) and after four years of implementation (endline time).

Other surveys also revealed that national examination pass rates of grade 12 students in mathematics and science at schools where teachers are conducting lesson study was higher than that of the schools which have not introduced practice (Ministry of Education & JICA, 2010).

(c) Challenges

In the process of practicing the lesson study concept as a strategy or as a tool for teacher continuing professional development practice challenges also surfaced along the way. Some of the encountered setbacks are outlined below.

The introduction of lesson study also brought about the concept of facilitators. These were supposed to be selected ordinary teachers trained with necessary knowledge on lesson study implementation, so that they facilitate the implementation of lesson study at the school or at the zone level or at the cluster level. However some lesson study facilitators do not display the desired abilities that are needed. In addition, most of the facilitators are full time classroom teachers with a full teaching load. This compromises their work as lesson study facilitators because they must first attend to their classes before they can carry out duties of a facilitator.

The lesson study practice aims at fostering peer–to-peer learning of the teachers. Ultimately each individual teacher, having learnt something from the peers must deliver well in the classroom. However, lesson study is not a “quick fix” mechanism where immediate results are derived.

Figure 4.3.6 Sample result of assessing teachers skills

Source : Ministry of General Education & JICA (2015)
Unfortunately, it has been taken to be a quick fix mechanism whereby immediate results are expected by other stakeholders. When such is not the case, there are levels of discontent and dissatisfaction on the part of those that expected a lot. They tend to think that the lesson study practice is a sheer waste of time because it has not shown them the results that they expected in so short a time.

(4) Current Focus

In view of lessons that were learnt in the initial phases where focus was more on the quantitative aspect of lesson study implementation and practice the focus is current on the qualitative aspect (but not doing away with the quantitative aspect) because in the numbers of teachers meeting and numbers of schools that are meeting the quality aspect of lesson study practice finds its way.

The 3rd phase of the lesson study implementation which was more of scaling up to take the practice to all provinces meant that all school were now largely practicing lesson study in their school based continuing professional development practices. In some provinces, such as Central Province, the phase brought in a scenario where lesson study was being practiced by all teachers for all grades and for all the subjects. Such concern as to the kinds of content that characterizes these TGMs arises. In other words what determines the issues that teachers discuss in their TGMs? How are the issues to be tabled and discussed in TGMs or Departmental meetings generated? Do they benefit the individual teachers’ lesson delivery? What is the quality of discussions that go on in the groups? If it a post lesson demonstration discussion, what is the quality of the discussion? Are the teachers well equipped to carry out a qualitative discussion which will bring forth the desired results? The practice of lesson study has gone to full scale in the Zambian schools but due to the above concerns, the current focus is now on the quality aspect.

In an effort to improve on the content aspect of the teachers, an initiative to try and improve the pedagogical content knowledge (PCK) of the lecturers in mathematics and science is in underway in three of the 10 government–run colleges of education. The focus of this initiative is to assist the lecturers (teachers of teachers) to have comprehensive knowledge and skills connecting subject contents with pedagogical strategies, so that they can in turn produce better teachers at the pre-service training level. The key players in this whole arrangement are those officers who have undergone special training in Kyozai-Kenkyu (intensive study of teaching/learning materials) in mathematics and science, which enhances understanding subject contents deeply with considering pupils’ thinking process and way of understanding.

The classroom gives an opportunity for actualization and bearing in mind that actual teaching begins when the teacher sets foot into the real classroom, the project which seeks to improve the “teachers of teachers” pedagogical content knowledge also seeks to encourage a culture of collaboration between colleges of Education and the schools which in this case are known as “collaborating schools”. By engaging in various activities such as collaborative lesson observations, lesson planning, school visits and open-schools, it is envisaged that teachers undergoing pre-service training will have a real picture of that which really goes on in the school setting especially school based continuing professional development. Additionally the school setting will provide an
opportunity for colleges and schools to be “talking to each other” through theory informing practice or practice informing theory. This largely brings about the broader issue of collaboration between in-service (schools) and pre-service (colleges).

5. **Key lessons learnt from the analysis of the experience**

The following are the key lessons learnt from the analysis of the experience of JICA in having worked with some countries in Africa to strengthen MSE:

1. It is difficult to transform teaching approach by training solely. In order to transform teaching approach in the classroom, holistic approach is needed. For instance, it is necessary to change the nature of the national examination so that the examination can test the competences developed by learner-centered lessons. If the national examination tests only low-order thinking skills such as memorizing factual knowledge, teachers do not have incentives to change their teaching approaches to learner-centered ways. In addition, if the syllabus contains too many contents, it will be difficult for teachers to conduct learner-centered lessons considering that teachers must teach the contents prescribed in the syllabus. Therefore, it is necessary that the three levels of curriculum, namely, intended curriculum, implemented curriculum, and attained curriculum, should be consistent. Ethiopia’s case study is an example to deal with this issue;

2. Even if changes are observed in teaching (lesson delivery), in many cases, the changes are superficial, for instance, just following a particular procedure. In order to make the change profound, a teacher needs to understand the value of the change. It is also necessary for teachers to have pedagogical content knowledge in order to implement the change required to actualize the value. Zambia’s case study is to deal with this issue of strengthening PCK;

3. It is essential for teachers to observe changes taking place in students including the changes in thought processes and behaviours of students. Lessons must be assessed primarily based on the changes observed in students. Changes observed in teachers are referred to as the means of bringing change in students. Morocco’s case study tries to follow thought processes of students by analyzing errors in diagnostic tests. Malawi’s case study attempts to identify student’s perceptions through Action research; and

4. Although teachers are the most important target group to improve the learning taking place in students, direct interventions to students are also necessary to complement efforts made by teachers. One of the approaches to intervening students directly is to develop and distribute remedial workbooks for self-study of students. Senegal’s case study shows an example of efforts to address this issue.
Based on the findings presented above, it was learned that, in order to enhance learning taking place in students, a holistic approach — not only improving the teaching skills of teachers, but also improving syllabi, examinations, teaching and learning materials, etc.— is needed.

Hence, JICA will continue dialogues with partner countries to identify areas to support. Based on such dialogues, JICA, as a development partner, will prioritize areas to support which becomes an integral part of a holistic approach of the partner countries.

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Committee.

¹ In this strategic vision, the term “School” means the entire education system including primary education, lower and upper secondary education, higher education, scientific research, training of managers, vocational training, and traditional teaching.