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Implementing the Japanese Mathematics Education System in Fiji

DEEPAK Datt and ISHII Hiroshi

Department of Mathematics Education, Hakodate Campus, Hokkaido University of Education

フィジーで日本の数学教育システムを導入するために

ディーパック ダット・石井　洋

北海道教育大学函館校数学教育研究室

ABSTRACT

This study considers aspects of the Japanese mathematics education system that can be implemented in Fiji and addresses strategies and pedagogies that could be used to improve standards of mathematics in Fiji. There are many concerns in Fiji about the standards of mathematics achievement. Statistics have shown that in both elementary and secondary schools, poor mathematics results have been prevalent for more than a decade (Chand et al., 2021; Joweli, 2018). It is imperative that reforms and initiatives that can bring about a paradigm shift from the traditional teaching and learning practice, one which is still too teacher focused to one that has more learner-centered approaches, are introduced sooner. To bring about the desired results in mathematics in the near future, Fiji should model its strategies and pedagogies after Japan as Japan ranked in the top 10 countries from 2012–2018 in mathematics achievements by the Programme for International Student Assessment.

1. Introduction

1. 1. Background

The Ministry of Education, Heritage and Arts is the Ministry in Fiji responsible for overseeing Fiji's education system. The Ministry is tasked with conducting and delivering education services to all Fijian students. The Ministry has numerous responsibilities: advising the government, providing administrative and management support, enacting policies and acts, and providing learning resources such as textbooks. The Ministry is also tasked with making and distributing external exams to schools all over the country. In Fiji, one year of early childhood education/kindergarten is compulsory, and primary and high school/secondary education is compulsory for eight and five years, respectively. The government provides free education to the early childhood,

primary and secondary school students by making school fee-free and by providing free textbooks and bus fare. In Fiji, multicultural and multiracial schools are under the guidance and administration of numerous religious organizations. There are 900 early childhood, 737 primary, 173 high, and 17 specialized schools and 4 universities in Fiji.

The four universities are: Fiji National University, Fulton College, The University of the South Pacific, and University of Fiji. Fiji National University comprises of various colleges, namely the colleges of medicine, business, agriculture, humanities, engineering, Fiji's National Productivity Organization and the Fiji Maritime Academy. Fulton College is a Seventh-Day Adventist church institute based in Nadi. The University of the South Pacific is a regional Pacific university, with headquarters in Suva and a number of campuses in the Pacific islands. The University of Fiji based in the Lautoka was established by a Hindu religious group.

Education in Japan is governed by the Ministry of Education, Culture, Sports, Science, and Technology, and it began as a 6-3-3-4 system (six years of primary school, three years of junior secondary, three years of senior secondary, and four years of higher education) after World War 2 (Nuffic, 2020). In the Programme for International Student Assessment aimed at fifteen year olds Japanese students recorded high levels of achievement, particularly in mathematics- and science-related areas. Educational activities outside of school also flourish, and programs leading to advanced education are implemented.

Enrollment in high schools, the second half of secondary education, reaches over 90% of school-aged students in Fiji, and the enrollments in college are also high, reaching over 50%. Admission to high schools and colleges is mainly through entrance exams, held from January to March. The level of Japanese education is high even by world standards (Cave, 2001).

1．2．Research Questions

What Japanese education strategies and pedagogies can be implemented in Fiji to improve standards of mathematics performance in Fiji?

2．Methodology

Methods of data collection are closely associated with the research methodology (Denscombe, 2014). There were three methods used to collected data and interpret and analyze data for this research. The methods are as follows:

2．1　Reading materials, collect/interpret/analyze data from internet, books and journals, which is reflected in the literature review.

2．2　A questionnaire comprised of open-ended questions (Johnson & Christensen, 2012) designed to gather data was distributed to teachers in Hakodate Elementary and Junior High school and Fijian teachers who are currently teaching in Japan.

2．3　Observing lessons in Hakodate Elementary and Junior High schools affiliated with the Hokkaido University of Education in person and watching videos about the Japanese teaching and made lesson observation analysis.

3．Literature Review

3．1．Reforms in Fiji

Studies have revealed that, although Fijian teachers claim to value learner-centeredness,

evidence of this is lacking in widespread practice (Joweli, 2018). The participants of the study (teachers, student teachers, and teacher educators) raised strong concerns about the increase in teacher accountability and performance-based culture rapidly engulfing Fiji's education system (Lingam, 2007).

The authors suggest that, for successful educational reforms, it is necessary to gain an in-depth understanding of the practical realities of the contexts in which teachers operate (Crossley et al., 2017; Joweli, 2019; Isoda, 2010).

From the beginning of formal education, formal global programs of development have contributed to the growth of the educational contexts of Pacific Island countries (PICs). Small PICs like Fiji "continue to reconcile and recover identities that were challenged, even erased, during the colonial rule" (McCormick, 2014).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Bank are policy makers in education, and through their financial aid, personnel, and advisory commissions, they continue to influence education policies (Crossley et al., 2017). Global social policy programs such as Education for All, Millennium Development Goals, and now the Sustainable Development Goals have all been part of UNESCO's influence in molding the education system of most PICs.

Many researchers are skeptical about the nature of aid in PICs and the influence on the development shift from basic education to current contemporary education. There is an agreement among authors that, in terms of education, so-called international "best-practice" informs and shapes decisions on both what aid is to be allocated and the mechanisms for how it should be delivered, with little attention to the particular needs of the region.

In Fiji, improving the quality of mathematics education has progressively become a major concern. Fiji's quest to develop its own identity has gained importance, and awareness that education can significantly influence these aspirations (Begg et al., 2018) has created a flux-like state whereby solutions are desperately sought.

In the past, the focus of educational dialogues and debates has been profoundly impacted by the colonial mindsets prevalent in the Fijian education system. In the past two decades, however, much attention has been focused on changing teaching and learning to align with the development of "quality education for peace, change and progress" (MOE, 2015).

Most recently, Fiji's National 20-Year Development Plan 2017-2036 has provided a vision for revolutionizing Fiji and states that "The curriculum will continually be reviewed and strengthened to achieve national objectives ... Incorporating contemporary thematic areas in educational curriculum such as cultural diversity, gender, nutrition, respectful relationships, drugs and alcohol, climate change and the environment that will enrich students' understanding of wider social issues" (Ministry of Economy, 2017).

3．2．Manners before Knowledge

In Japanese schools, the students do not take any comprehensive exams until they reach the age of 10. It is believed that the goal for the first three years of school is not to judge the child's knowledge or learning but to establish good manners and to develop their character. Children are taught to respect other people and to be gentle to animals and nature. They also learn how to be generous, compassionate, and

empathetic and practice qualities like grit, self-control, and justice. In Japanese schools, students have to clean the classrooms, cafeterias and even toilets all by themselves. When cleaning, students are divided into small groups and assigned tasks that rotate throughout the year. The Japanese education system believes that requiring students to clean up after themselves teaches them to work in a team and help each other. Besides, spending their own time and effort sweeping, mopping, and wiping makes pupils respect their own work and the work of others. Clearly, respect for our learning environment is essential, and vibrant classroom displays and well-ordered classrooms all play their part. Children in Japanese schools during these three years are also taught literacy and numeracy skills. Since we also teach values education in Fiji every day from Year 1 to 13, the main focus in these three years is for students to master literacy and numeracy skills rather than take exams.

3．3．Problem-Solving (Neriage Approach)

Mason et al. (1982) wrote that "mathematical thinking is provoked by contradiction, tension and surprise." *Neriage,* the whole-class discussion technique in a teaching-through-problem-solving lesson, is for students to develop each new mathematical concept by solving a problem that illuminates as it strives to give students this kind of exciting and collaborative experience. The structure of Neriage can be flexible depending upon the topic of the lesson, the nature of the problem, and the objective of the lesson. There are four main types of Neriage: introducing solutions in order of their sophistication to highlight the progression of thought, comparing solutions to help students understand how they relate to each other, contrasting solutions to discuss misunderstandings, and comparing solutions to an open-ended problem to identify general rules or characteristics.

The Japanese problem-solving lesson structure for mathematics has evolved over four decades, originating in a desire to introduce open-ended problems to not only to enhance students' higher-order thinking but also to enable students to use their previous knowledge and skills to learn something new through the process of solving a problem (Becker et al., 1990). The major characteristics of these problem-solving lessons include: *hatsumon*—the (single) thought-provoking question or problem that is the key to students' mathematical development and mathematical connections; *kikan-shido*—sometimes referred to as the "purposeful scanning" that takes place while students are working individually or in groups, which allows teachers not only to monitor students' strategies but also to orchestrate their reports on their solutions in the neriage phase of the lesson (Fig. 1); *neriag*e—the "kneading" stage of a lesson that allows students to compare, polish, and refine solutions through the teacher's orchestration and probing of student

Fig. 1 Teacher acts as facilitator while students do their activity

solutions; and *matome*—the summing up and careful review of students' discussion to guide them to higher levels of mathematical sophistication (Shimizu, 1999).

The neriage phase of a lesson—the "heart" of the lesson—begins after students struggle with the problem and come up with their own solutions. "During the process, a teacher highlights important mathematical ideas and concepts for students to reach the goals of the lesson" (Fig. 2) (Takahashi, 2006). Typically, this stage takes upwards of half the time of a lesson.

Students learn more through teaching others.

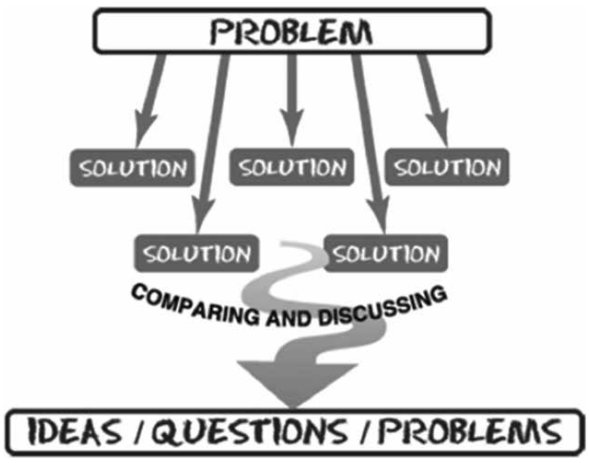

Fig. 2 Problem-Solving Approach (Takahashi, 2006)

This is the same in our country as we have students in groups teaching each other in their group. More learning is taking place by peer teaching (Prakash, 2019).

3．4．Lesson Study

While there has been worldwide interest in Japanese Lesson Study as a model for teacher professional learning, there has been less research into authentic implementation of the problem-solving lesson structure underpinning research lessons in Japan, in particular the ways that teachers can conduct in-depth, orchestrated discussions of student solutions that lead to mathematical learning (Inoue, 2011).

Lewis, Perry, and Friedkin (2009) describe the Japanese Lesson Study Cycle as having four phases (Fig. 3): goal-setting and planning, including developing the Lesson Plan; teaching the "research lesson" with its associated lesson observation; the post-lesson discussion; and the resulting consolidation of learning.

According to Stigler and Hiebert (1999), the main focus for lesson study is for the same or another teacher to present the same lesson and improve on the weaknesses noted previously.

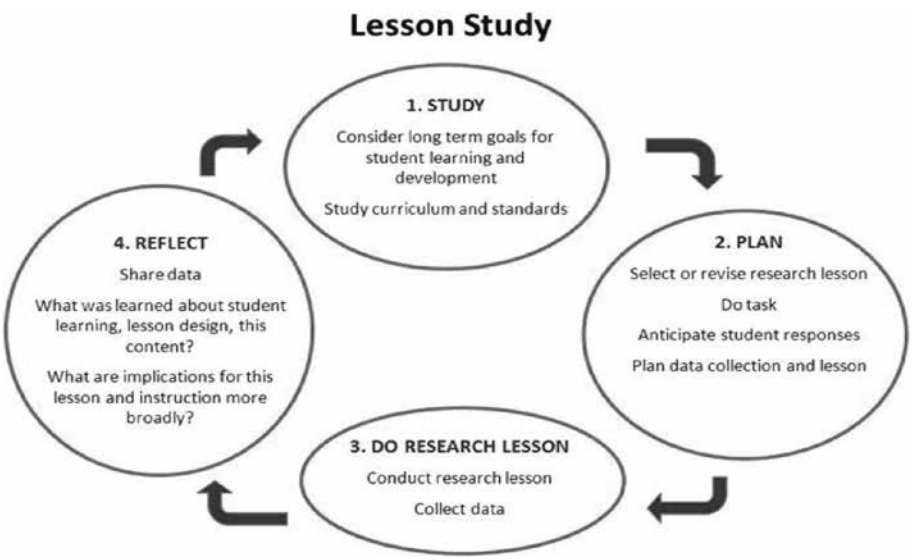

Fig. 3 Lesson Study procedure used in Japan (Lewis et al., 2009)

3．5．Use of ICT to Improve Mathematics

Integration of ICT in teaching and learning mathematics is a great challenge for students and teachers in Fiji. Technology plays an important role in the school sector in the process of empowering the technology into the educational activities (Fig. 4). Technology can be considered the most effective way to increase the knowledge of the students. ICT, which can engage the students on a number of levels, is an essential tool in the modern classroom. Classroom teaching and learning process is generally considered a tri-polar process where teacher, learner, and learning environment possess three major poles. Teachers should become technologically sound and responsible not only for their learning but also for their students' learning.

3．5．1．Innovation of Mathematics Teaching with ICT

Geometric Constructor is one of the dynamic geometry software programs used in Japan (Iijima, 2006). There are three versions (DOS, Windows, Java), with the web applications using Geometric Constructor/Java. One of the features of Geometric This software was developed through collaboration with teachers, especially regarding lesson study; Geometric Constructor is particularly effective when used during whole-class discussion.

Geometric Constructor is one of several dynamic geometry software programs, along with cabri and Geometer's Sketch Pad, that has been developed by the author. Since 1990, it has been used in many schools (mainly junior high schools) in Japan. It has also helped with lesson study for many teachers. In Iijima's paper, he gave an overview of the outline of the innovation with Geometric Constructor, focusing on the software features and lesson examples.

One of the cores aspects of discussion in this community is lesson study, which is the theme of this conference. In many cases, about 10 teachers attend to classroom observation and observe and discuss the lesson. But many other teachers cannot attend, because of their own job at own schools, so we send them copies of video tape or a video file in CD/DVD.

3．6．Resources

Resources in teaching and learning is a term describing something that can be used to support the teaching and learning process, such as a primary source, graphic organizer, audio-visual aids, e-learning/technology, objects, events, and people. Resources are recognized as helping in the processing of information by creating interest in learners, attracting and maintaining attention, helping understanding, and aiding memory so that knowledge acquisition and retention is improved (Fig. 4). Wilson (2014) further mentioned that resources promote learning. For learning to take place, a connection has to be made with the brain; therefore resources have to be fit for purpose (active, inclusive, and student centered). To buttress the "brain connection" and "fit for purpose" statement, Wilson (2014) further mentioned that "the most effective resources

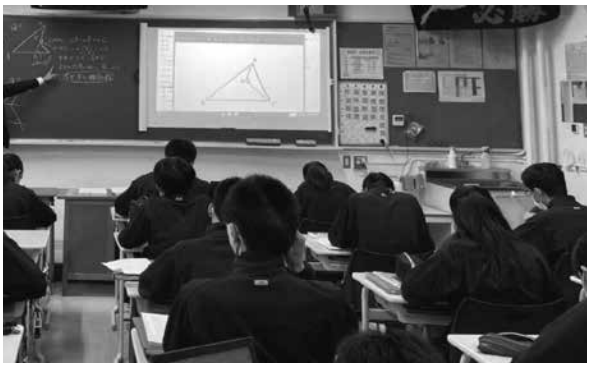

Fig. 4 Use of technology to project shapes

stimulate a number of senses (e.g., sight, hearing and touch, etc.), are versatile and easy to use, achieve what they are set out to achieve, and simple."

4. Data, Analysis, and Consideration

4. 1. Questionnaires

Questionnaires were distributed to 11 teachers in the Hakodate elementary school affiliated to Hokkaido University of Education. Four questionnaires were sent to Fijian teachers who are currently teaching in Japan, but none replied. The years of experience for the teachers who participated in the research are displayed in Table 1.

Table 1 Teachers' experience

Years of experience	1-5	6-10	11-15	16-20	21-25
Number of teachers	1	2	5	2	1

This showed that most teachers who participated in the research had a good number of years of experience, and the feedback they provided was mostly from experience rather than training, which is a factor that determined the effectiveness of the data received for this research.

More than 50% of the participants believed that teacher input influences student achievement (Fig. 5). Therefore, to improve the standard of education, teachers should participate in reforms such as manners before knowledge, problem-solving pedagogies, lesson study, using ICT, and resource-based classrooms, which can be implemented with approval from the Ministry of Education in Fiji.

4. 2. Lesson Observation

Seventeen lessons at a Hakodate elementary and junior high schools affiliated to Hokkaido University of Education (hereafter Hakodate schools) were observed over two semesters. Prerecorded mathematics class videos with translation were also watched, and after every lesson, the class was analyzed and observations recorded. A designated lesson observation format was designed to look at aspects of this research in semester 2. Eight lessons were observed (Table 2).

The perspective of lesson study in Fiji is different from Japan. The Fijian lesson study is

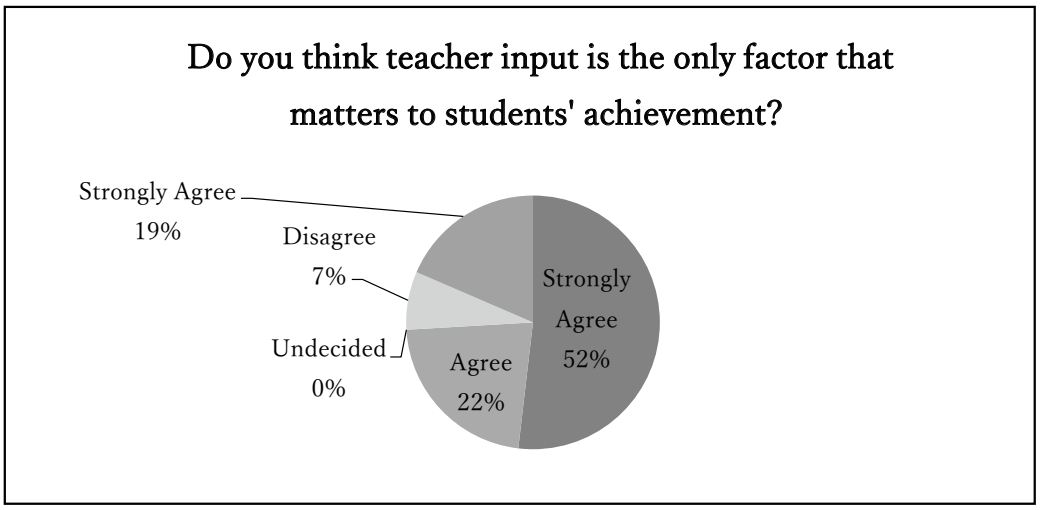

Fig. 5 Teachers' perspectives on student achievement

Table 2 Outline of Lesson Observation

Date	Grade	Topic	Lesson Study	Neriage	ICT	Resources
10/13	1	Addition of one-digit numbers	✓	✓	x	✓
10/20	6	Proportion and inverse proportion	✓	✓	✓	✓
10/27	6	Ordering scenario	✓	✓	✓	✓
11/10	6	Angles	✓	✓	✓	✓
11/25	8	Proof and proof setup	✓	✓	✓	✓
12/ 3	8	Investigating shapes	✓	✓	✓	✓
12/ 7	2	Multiplication	✓	✓	✓	✓
12/14	5	Area of quadrilaterals and triangles	✓	✓	✓	✓

mostly done by individuals, e.g., Head of Schools, Assistant Heads, or education officers. This is basically to judge the teachers' pedagogy and give feedback for improvement. During the Japanese Lesson Study, there are many observers who give their ideas about improving the lesson for the future.

4. 2. 1. Problem-Solving Approach (Neriage)

As observed, Japanese teachers use problem-solving as a powerful approach for teaching mathematics. There are several notable characteristics of the Japanese approach to problem-solving. One of the characteristics is that Japanese problem-solving lessons usually do not finish after each student finds a solution to the problem. I observed from the lessons that teachers believe that the heart of the lesson begins after students come up with different strategies to get a solution (Fig. 6). The teacher acts as a facilitator for extensive discussion with students by comparing and highlighting the similarities and differences among students' solutions. It was also noted that different types of neriage were implemented in all the lessons that were observed at different levels depending on the topic.

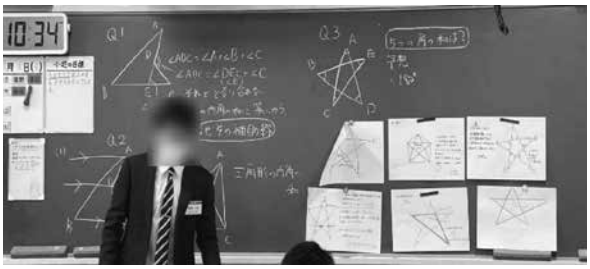

Fig. 6 Neriage Approach: Various solutions to a question are presented by students

Lesson Plan and Observation for a Problem-Solving Approach Lesson

The Japanese problem-solving approach (detailed in Table 3) is more qualitative, where one question has various strategies to solve a problem. One question will be given, and students have to brainstorm to get different strategies to solve it, whereas in Fiji, in a quantitative lesson, there will be more than 5-6 questions in a lesson for students to solve. The teachers usually give examples, notes, and ideas how to solve problems, whereas in Japan students are encouraged to think and brainstorm for themselves where the teacher is only a facilitator. The teacher moves around to help where students are stuck and need help. The strategy used in Fiji is basically "spoon feeding," whereas the Japanese teachers make students think on their own.

Table 3 Lesson observation record

Lesson Plan (Flow of the lesson)	Observation Details
Step 1: Greeting, discussing the previous lesson, and posing a problem	The teacher bows and greets students and vice versa. Class discussion on the previous lesson/elicit prior knowledge through class discussion. The teacher sets tasks that can be solved in a variety of different ways by applying previously learned knowledge and presents the content to be learned. Problem given by teacher by projecting it on the board using laptop, projector, television, Google classroom, written on blackboard or printed chart/ worksheets.
Step 2: Individual Thinking	Students are given time to think of different strategies and ideas to solve the problem. Teacher sets a time and displays on a stop timer. Usually 5-15 minutes is assigned for a problem depending on the lesson and class level. The teacher walks around, observes, and helps children to solve the problem.
Step 3: Comparison and Extensive Discussion	The ideas are then presented on the board. Students explain their ideas to the class, children are also encouraged to listen to and question others' ideas. When ideas are brought together (generalized), it is important to experience them by themselves. The reorganization or integration of ideas proceeds smoothly from the presentation and communication of children.
Step 4: Summarize and posting of tasks	More activities are incorporated that let children experience the ideas and procedures. It is important that both correct and incorrect responses are discussed. Children are later given few more tasks to solve.

4. 2. 2. ICT

The data on the impact of ICT in education suggest that most teachers agree that ICT can be used as a tool to improve student achievement and reduce teacher workload. As per the analysis of classes observed, 87% of the lessons made use of ICT to foster children's competencies for living in the digitally centered future. Elementary and junior high schools in Japan provide every student with a computing device, letting them effectively make headway in ICT-based learning. On the questionnaire, teachers responded that it also saves them time to use computers to project shapes rather than recreating notes and shapes on the chalkboard. It was also evident that the computers can be used as tools in the classroom lessons and later as a study aid or even when schools pivot to online learning for various reasons. Students in Hakodate schools use tablets from years 1 to 3 and Chromebooks for grades 4 and up (Fig. 7).

Fig. 7 Students give their feedback about the lesson using Google Classroom

4．2．3．Resources

Japanese classrooms are filled with an abundance of resources; this is another reason for good academic achievement for students in Japan. Most of the resources are bought by the schools from resource developers, with different resources for different lessons. Resources such as laptops, tablets, projectors, televisions, blackboards, printed charts, textbooks, assistant teachers, etc. were seen in the Hakodate schools (Fig. 8). Japanese educators have been using textbooks as a resource for teaching mathematics and often emphasize that they can distinguish between "teaching the textbook" and "using the textbook to teach mathematics." To provide a better learning experience for their students, all the teachers should be able to use the textbook to teach mathematics effectively using their knowledge and expertise. This statement is still widely accepted in Japan; however, textbook publishers have responded to demographic shifts and are designing the textbooks with new supports to help less-experienced teachers teach mathematics through problem-solving.

There are assistant teachers in Hakodate schools I have observed. These teachers are present in almost all classes to aid students with learning differences. These assistant teachers can be regarded as human resources and help both teachers and students. The Ministry of Education in Fiji can implement this but not on large scale like Japan because of financial difficulties. They can have one assistant teacher per school in a small school, two in a medium school, and 3 in a large school to teach only slow learners .

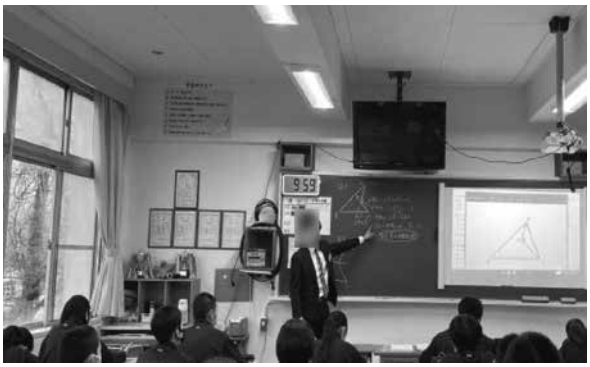

Fig. 8 Classroom Resources

4．2．4．Manners before Knowledge

The importance of manners, discipline, and clean classrooms was clear from the observations we did throughout the year. According to my reading, most Japanese students do not get any exams until they reach grade six (the age of 12). The goal for the first six years of schools is not to judge the child's knowledge or learning but to establish good manners and develop their character. More focus on values education, literacy, and numeracy for the implementation of this concept should be done in Fiji. Values education in the Japanese people was evident when, during the World Cup soccer tournament, the Japanese spectators cleaned up the stadium after the match. These lifelong lessons are taught at elementary school stage of life.

5．Recommendations

This study will provide insights to the Ministry of Education, Heritage and Arts in Fiji and to the teachers in implementing the Japanese education system as a reform for the future. The findings provide a basis for further empirical research to highlight experiences and empower teachers for a more supportive and collaborative professional and personal network.

The Fijian education system can easily address issues through implementing some of the strategies of the Japanese education system. This study showed that moving away from

exams in the first six year of education can help teachers and students focus on lifelong learning, literacy, and numeracy skills. The implementation of ICT can help in lesson study; reduce teacher workload; enhance learning even during a pandemic or natural disaster, to which Fiji is very prone; and make Fijian students digitally advanced, as is the vision of the government.

Implementing the problem-solving approach will also build Fijian students' critical thinking skills and resilience and grit. Also, if there are a lot of resources in the Fijian classrooms that can help broaden students' knowledge and reduce the time for teacher preparation, teaching and learning will be fun. Children learn more from exploring.

These strategies and pedagogies can be implemented using the "top to bottom" approach where the Ministry will approve implementation and schools will implement the best option for their community. If this approach cannot be implemented then the "bottom to top" approach can be implemented with the Head of School and teachers incorporating some of the strategies that can fit in the Fijian education system.

6. Conclusion

The Fijian education system is robust and rapidly developing with teachers who are far better trained, qualified, and knowledgeable than ever before. The aspects of the Japanese education system such as knowledge before education, problem-solving, lesson study, ICT, and resources as discussed in this research can be implemented in Fiji.

This research has identified the strengths of implementing the Japanese education system in the Fijian education system to improve the quality of education, which, if addressed, has the potential to mark an era of enhanced student performance.

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（ディーパック ダット　教員研修留学生）
（石井　　洋　函館校准教授）