Study Note

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Analysis of Developing 21st Century Competencies Through Problem Solving in Fiji Primary Mathematics Education

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Abstract: The Education system of Fiji has gone through multiple phases of reform since 2010 in the bid to improve its commitment to quality education delivery. In the wake of these reforms, the development of students' 21st century competencies in the learning process remains a major pressing concern despite the government's commitment to incorporate some international and regional competencies framework into its national curriculum framework as a reference point for teaching practices in Fiji. A prominent contributing factor to this competency development issue is the dominant use of traditional teacher-centered methods by teachers in the classrooms to meet the demands of its exam-oriented education system. However, the teaching of rectangle area through problem solving for this study using the new teaching strategy, which comprised of the integration of the Japanese structured problem solving model, Neuns' Problem Posing Model and Polya's Problem Solving Model, has produced promising results not only in the competencies development domain but in the area of improving students' conceptual understanding, problem solving skills and the addressing of misconceptions associated with rectangle area as well. Hence, this study provides empirical evidence that teaching through problem solving which supports student-centered learning is a way forward for the Fiji Education system in meeting the students' competency demand needed for life and work in the 21st century and even beyond. Yet, if Fiji teachers are unable to fully apply the new teaching through problem solving model in their daily teachings under its current context, a more transitional approach is recommended where both the traditional and the new model are accommodated in the learning environment.

1. Introduction

Fiji is a developing nation with 330 islands covering about 1.3 million square kilometers of the South Pacific Ocean. Its education system is highly centralized with the Ministry of Education solely responsible for the administration and management of education policy and delivery of services including the provision of curriculum frameworks, policy guidelines and directions (Lingam, Lingam & Sharma, 2017). In its commitment to make students become more competent both in the local and international community, multiple phases of strategic reforms were made in its entire system since 2010. One of the major initiatives taken by the Ministry, saw the incorporation of international and regional competency frameworks such as the UNESCO Delor's Framework which includes the four pillar of education (Learning to know, Learning to do, Learning to be and Learning to live together) and The Assessment and Teaching of 21st Century Skills (ATC21S) in its national curriculum framework to guide the teaching process in the classroom (MoE, 2013, & MoE, 2015-2018).

However, despite the establishment of a comprehensive national curriculum framework, studies have shown that teaching in Fiji is usually not done in the way it should be done (Wise, 2017; & Final Report, 2016). It has been noted as well that the teaching approaches currently used by Fijian teachers in the classroom is predominately teacher-centered in nature where the transmission of knowledge to the students take precedence over competencies development and deep understanding of concepts (Final Report,2016).

Therefore, in this article, the experimental study of the integration of the new teaching through problem solving model, which is comprised of three profound models namely the Japanese structured problem-solving model, Nune's Problem Posing model and the basic Polya's problem-solving model in some grade 5 mathematics lessons is discussed in greater details.

In this regard, findings have shown that the new teaching model proved to yield far better results than the traditional teacher-centered method not only in terms of competencies development, but in area of improving conceptual understanding, problem-solving skills and addressing misconceptions as well. Based on this empirical evidence, teaching through problem solving could be seen as an alternative teaching approach that Fiji primary school teachers need to incorporate in their practice as a means of developing students' competencies that are highly needed for their successful living in the 21st century.

2. Conceptual Framework

The study is primarily focused on the formulation of a new teaching pedagogy that can practically incorporate in the Fijian primary school mathematics lessons certain elements of the Assessment and Teaching of 21st Century Skills Framework (ATC21S). This framework covers four broad categories of skills which are deemed important for successful living in the 21st century. These are (i) ways of thinking (including creativity, critical thinking, problem-solving, decision-making and learning). (ii) ways of working (including communication and collaboration). (iii) tools for working (including information and communications technology and information literacy), and (iv) skills for living in the world (including citizenship, life and career, and personal and social responsibility) (Griffin, McGaw and Care, 2012. & MOE, 2015-2018).

Considering the importance of identifying an effective strategy that advocates such key skills development in school, this study has brought special attention to the following three key models which are integral parts of the conceptual framework of the new teaching through problem solving approach. These are:

(i) Japanese structured problem-solving model:

This Japanese teaching model, according to Asami-Johansson (2015) consists of four basic structural components, namely:

- Hatsumon: Where the teacher poses a key challenging question that provokes students' thinking at the beginning of the lesson.
- Kikan-shido: Students' are to work on the problem individually first and then in groups. The teacher scans students' individual problem solving process.
- Neriage: Whole class discussions is entertained to polish and develop students' integrated mathematical ideas.
- Matome: This is a summing up stage where the teacher reviews what students have discussed in the whole-class discussion and summarizes with them what they have learned during the lesson.

This model is commonly used in Japan to promote the development of conceptual understanding and key 21st century competencies such as problem solving, communication, creativity, collaboration and critical thinking (Takahashi, 2006). It has also contributed immensely to their students' excellent performance in international comparative assessment known as TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment) according to (Stols & Ono, 2016). However, the different kind of competencies that are developed by each component of the Japanese structured problem-solving model is shown in Table 1 of the Results and Discussion section.

(ii) Nune's Problem Posing Model:

This model is incorporated to support the 'Hatsumon' component of the Japanese problem solving model. It is designed to assist the teacher in posing different level of questions ranging from the least difficult to the most difficult ones based on three key distinctions as stated below:

- Problem involves quantities or direct relations between quantities. Problems of this sort can be exemplified as such: A rectangular paper is 4cm long and 3cm wide. What is its area? or The length of a rectangular board is 2times longer than its width. If the width of the board is 4cm. What is the area of the board?

- Problem involves inverse relation between quantities.

  Problems of this sort can be represented as such: A rectangular blackboard whose length is 6m has an area of $30m^2$. What is its width?

- Problem involves contextual relation between quantities.

  A problem of this sort can be demonstrated as such: John has made a triangular rose garden whose length is 6m and its width is 2m. If 1 bag of soil covers an area of $2m^2$, how many bags of soil will be needed to cover the whole garden?

However, this particular model presents a "framework for choosing appropriate problems to be used in teaching in order to initiate the children in problem solving. Evidently, research has shown that a teaching programme based on this framework has led to impressive improvements in primary school children's ability to solve a set of interesting, and quite difficult, quantitative problems", (Nunes, et al. 2015).

(iii) Polya's Problem Solving Model:

The Polya's problem solving model has been incorporated in the Kikan-shido stage of the Japanese problem solving model to further enhance students' problem solving skills. The original version of Polya's model (Polya, 2004), which described in behavioural terms the steps of solving a problem, including: understand the problem, make a plan, carry out the plan, and review (Singer & Voica, 2012), has been modified in this study to incorporate cognitive steps like the representation of mental model, which a solver has to take in order to reach the final solution of the problem as shown in figure. 1 below.

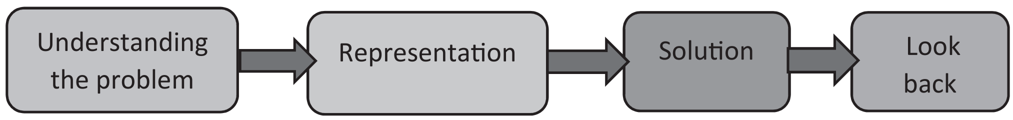


Figure. 1 Polya's Problem Solving Model (source: Polya, 2004)

The first step in Polya's model requires students to identify the unknown, the data, and the condition in the problem, while in the second steps, by using their individual understanding of the problem they should create a mental model and represent it through images, drawings, graphs, configurations, etc., with or without visual support. However, the third steps, commands the transformation of the mental model into a mathematical model such as an equation and computing algorithms as part of the actual solution. Hence, once the solution is obtained, the final step requires the solver to reflect and look back at what he/she has done, what worked, and what did not. Through such review students will enable to correct errors and also predict what strategy to use to solve future problems.

As envisaged, the inclusion of this model is meant to enhance students' problem solving skills. Such model has been strategically included in Singapore Mathematics Syllabus since 1990 which led to the introduction of the Model Method concept to further enhance students' knowledge and skills. The unceasing application of this model method in problem solving has put Singapore at the top of ranking list as far as achievements in TIMSS (Trends in Mathematics and Science Studies) is concerned (MoE, 2009).

In summary, the integration of these three key models is precisely illustrated in figure. 2 below.

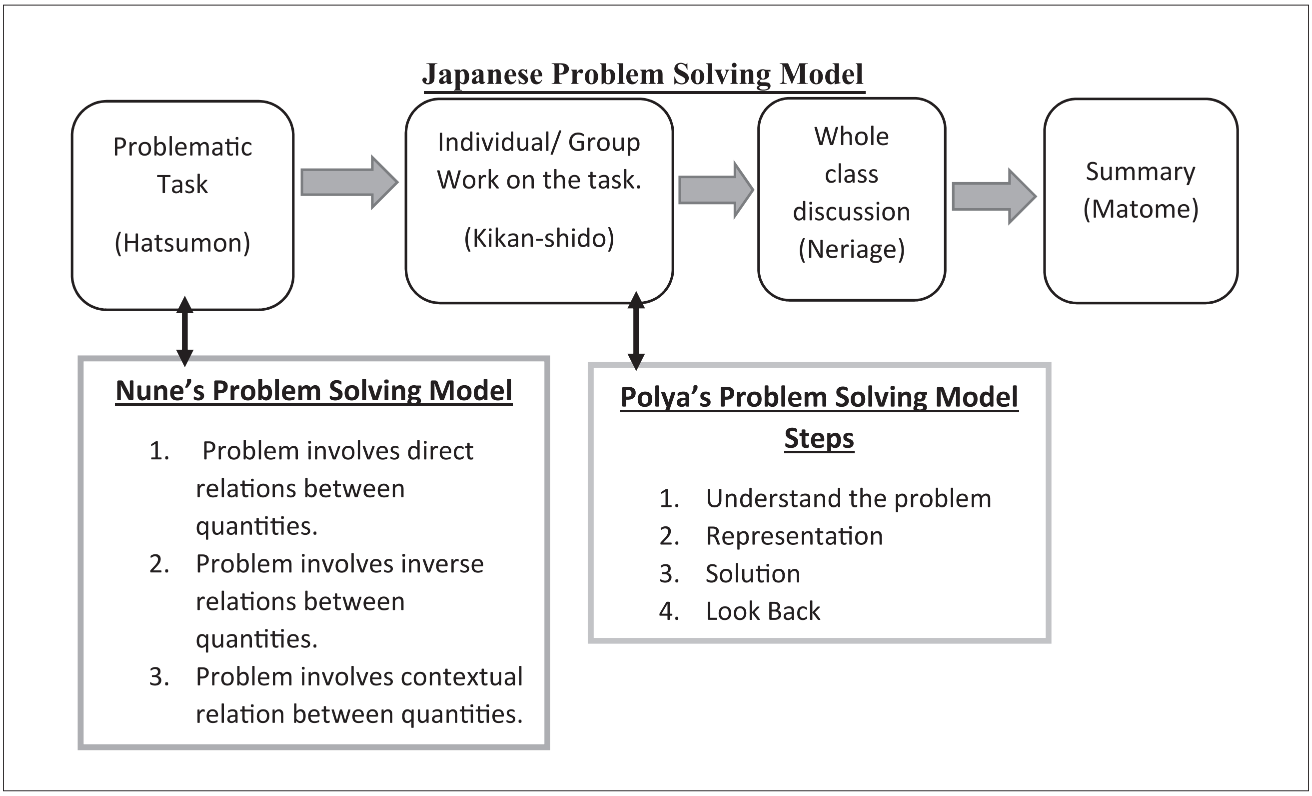


Figure. 2 The new teaching through problem solving model (source: author)

3. Study Rationale

The purpose of the study is to find out if the new teaching through problem solving model is capable of addressing the development of students' competencies better than the traditional teaching method in Fiji primary school mathematics education context. It is also envisaged that possible contextual challenges that have affected the proper development of key 21st century competencies might also be identified in this study.

4. Methodology

4.1 Research Design:

The research is both qualitative and quantitative in nature. In the qualitative research, methods like interviews, questionnaires, lesson observations were employed. Whereas, for the quantitative research, interview, observations and experimental lessons were the tools used for collecting quantitative data.

4.2 Instruments:

Data were collected from audiotaping 12 semi-structured interviews, distributing 37 questionnaires, taking field notes during 22 classroom observations, and the conduction of 2 sets of experimental lessons and 2 sets of control lessons between the assigned pre-tests and post-tests both in the rural and urban school settings. The experimental lessons were taught using the new integrated teaching model as shown in figure.2, which supports the concept of teaching through problem solving. However, the control lessons structure supports the traditional teacher-centered method of teaching for problem solving.

4.3 Sampling:

A combination of cluster sampling, convenience and simple random sampling were applied to accommodate all challenging factors encountered during the study, and also to maintain the representativeness of the study. Schools representing both rural and urban schools in Fiji were clustered according to their national academic performance and settings, in which four average performing schools, were then selected through convenience sampling based on accessibility. After sampling, the selected schools were randomly allocated to the experimental or control groups. Precisely, for the experimental groups, 31 students in (5A) urban school and 20 students in (5C) rural school took part, while in the control groups, 26 students in (5B) urban school and 20 students in (5D) rural school participated. Additionally, 43 fijian teachers representing both settings were also selected in the study. As part of the triangulation process, 12 teachers took part in either two or three of the following events, interviews, lesson demonstration and questionnaires. However, 1 teacher did only the interview, while an additional 30 teachers only did the questionnaires respectively. In the case of Japan, 10 teachers' mathematics lessons were observed meticulously as a complementary measure.

4.4 Data Analysis:

The thematic qualitative data analysis and the statistical quantitative data analysis were used in the study. For the qualitative data analysis, all interviews, questionnaires and classroom observation data were transcribed and coded, while the Microsoft Excel Statistical Software (XSTAT) were employed to facilitate the quantitative data analysis.

5. Results and Discussion

5.1 Comparative Analysis of Japanese and Fijian Observed Mathematics Lesson Structures and Competency Features

According to the first set of findings as depicted in Table 1., the Japanese problem solving model which encourages teaching through problem solving incorporated more 21st century related competencies in the learning process than the Fijian traditional teacher-centered teaching for problem solving model. As observed in the Japanese mathematics lesson structure, the problem solving process began with Hatsumon, where a challenging question was proposed to stimulate students' thinking. Then, in the kikan-shido, the second developmental stage of the lesson, students were encouraged to develop their 21st century skills like critical thinking and creativity while seeking the solution by themselves. At the same time applying metacognition skills which consist of reflecting and analyzing their own thinking in the problem solving process. It was also noted that students were encouraged to develop their own collaborative and communication skills through discussing their ideas openly in groups while the teacher acted as a facilitator. At the Neriage stage, students' presentation, communication and analytical skills were enhanced through group presentations, open discussion and analysis of each group's ideas before the lesson was ended at the Matome stage where the students' reflection skills are nurtured through the review and summary of what was learnt during the lessons with the teacher. Such approach was experimented in this study on the two experimental groups (5A and 5C) in Fiji primary schools as illustrated in figure. 3.

Table 1. Lesson Structures and Competencies Features (source: author)

	Japanese Problem Solving approach			**Fiji Traditional Teaching Methods**		
Pedagogy	Student-centered (Teaching through Problem Solving)			Teacher-centered (Teaching for Problem solving)		
Lesson Structure	**Time**	**Lesson Activities**	**Competency**	**Time**	**Lesson Activities**	**Competency**
Introduction	**5min**	Review	reflection	**5min**	Review	reflection
Development	**40min**	Practice: (a) Hatsumon – a task is selected. (b) Kikan-shido- individual and group work. (c) Neriage- class discussion	problem solving critical thinking, creativity, metacognition, communication, collaboration with peers and teamwork presentation, communication, analytical thinking.	**15min**	Teaching of new contents and demonstration of new skills to solve a problem by the teacher.	listening, collaboration with the teachers, One-way communication
				25min	Exercise: Teachers gave related problems for students to solve. Teacher led Class discussion of the solution.	Problem solving One-way communication
Conclusion	**5min**	(d) Matome – summary of learning	reflection	**5min**	Marking of the Exercise books.	

Figure. 3 Fijian students engaged in the new problem solving approach (source: author)

However, in the Fijian traditional mathematics lesson structure, students' 21st century skills development was rarely encouraged as new knowledge was initially transmitted by the teachers themselves and students had to listen and receive them passively. Also students' communication and collaboration skills were stifled by the one way-communication channel as teachers were the main communicator and students' only responded if questions were asked. It was also noted that, Fijian students spent a lot of time solving problems as a means of reinforcing the mathematical knowledge or skills that had already learnt during the lesson from the teacher before the lesson ended with the discussion of the solution led by the teacher and marking of exercise books. This was in stark contrast to the Japanese lessons, where students spent a great deal of time seeking the solution of the problems either individually or in groups right from the beginning of the lesson which in turn led to the higher development rate of 21st century skills among its students.

5.2 Contextual Factors That Drive Fijian Teachers' Classroom Practice

In the second set of findings, it was revealed during the interviews with the Fiji primary school teachers that their teaching methods have been influenced by various factors such as their own perceptions of teaching styles based on their experiences and past achievements; limited time available to cover the entire overloaded curriculum; top-down culture mentality that embraces the custom of subjects receiving information from authorities passively; political influence which pushes competition through examination, Teachers' Annual Performance Assessment (APA) based on students' examination results; and the enormous pressure exerted on them by the demanding education exam-oriented system. These factors drove teachers to dominantly embrace lecture teaching as a quick-fix strategy to meet the short term academic goals of the school and the government although, it disadvantageously gave less consideration to the development of students' competencies and conceptual understanding. However, a distinguishable impact of both the new and traditional teaching methods on students' conceptual understanding can be seen in the third set of findings as presented in figure.4 and figure.5 respectively below.

5.3 Comparative Achievement Rate of Experimental and Control Groups in Pre and Post Tests:

According to the test results in figure. 4, the two experimental groups (5A and 5C) gained a much better results in the post-tests after receiving intervention through the new teaching model. This is clearly shown with the average scores rising from 36% in the pre-test to 85% achievement rate in the post-test for group 5A and also a remarkable increase from 19% to 74% for group 5C. On the contrary, a much lower scores were obtained by the two control groups (5B and 5D) who were taught with the traditional problem solving model, with only a tiny increase from 13% in the pre-test to 23% achievement rate in the post-test for group 5B and a slight improvement from 38% to 44% for group 5D.

Such vast improvement in post-test scores of both experimental groups after receiving interventions is correspondingly indicated by the higher average score difference between their pre-test scores and the post-test scores as shown in figure. 5. In the urban school, the average score difference of the experimental group was 3.9, while its control group only managed to obtain a difference of 0.6. Likewise, in the rural setting, the experimental group gained a higher test

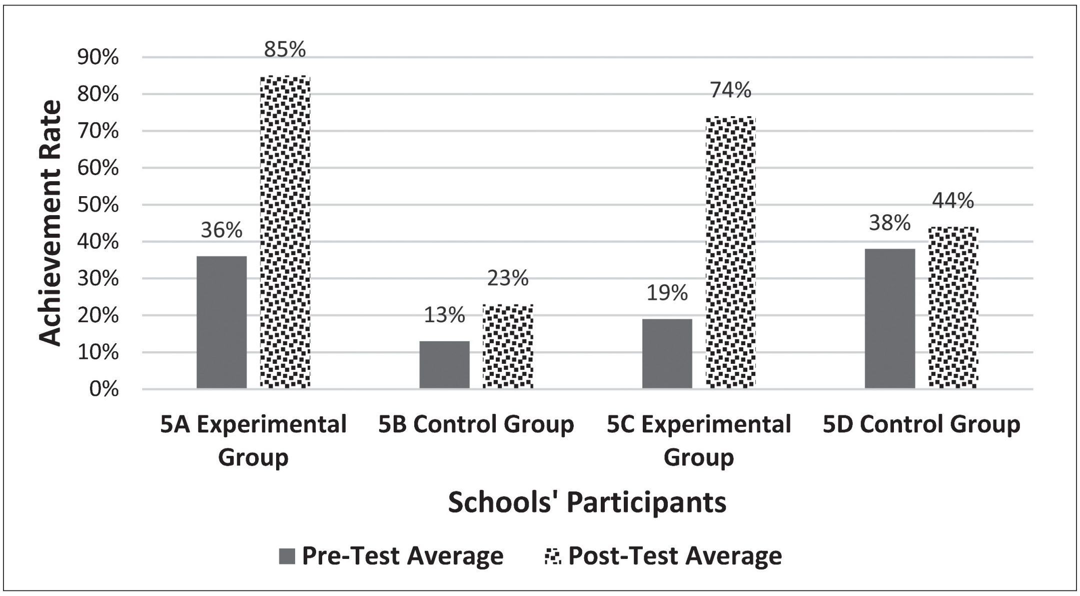


Figure. 4 Achievement Rate of experimental and control groups (source: author)

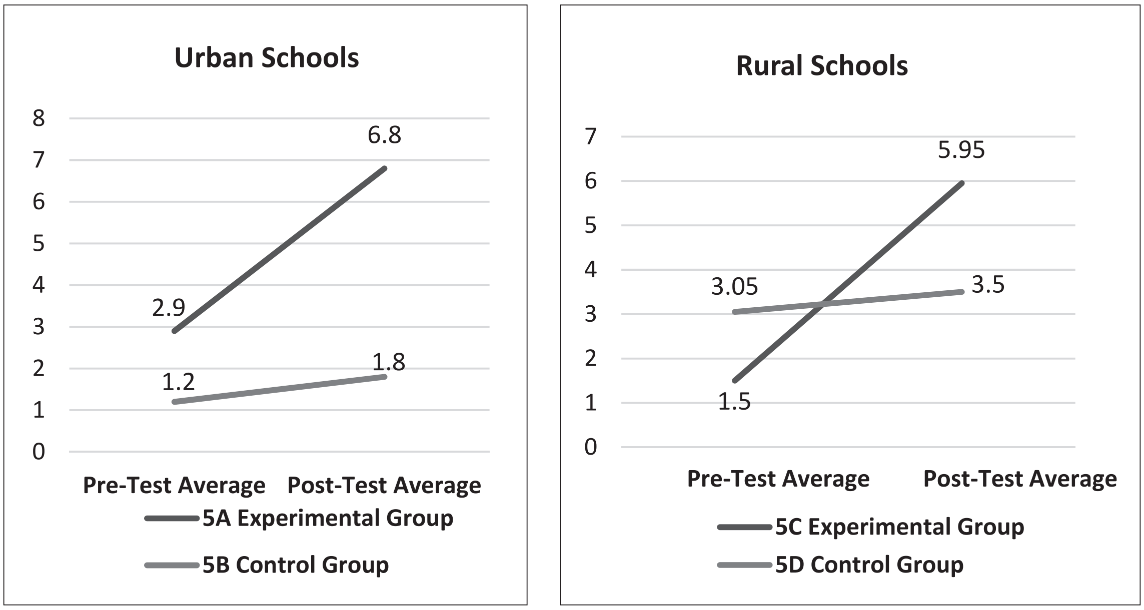


Figure. 5 Average scores of Experimental and Control Groups in pre and post-test (source: author)

score difference of 4.45, outperforming its control group, which only obtained a difference of 0.45, thus, indicate a weak improvement in the students' conceptual understanding. However, using the two-tailed tests, it was discovered that the results of the two groups are statistically significant as each gained a p-value of 0.00, which is less than the significant level, $\alpha = 0.05$ as shown in figure. 6 below.

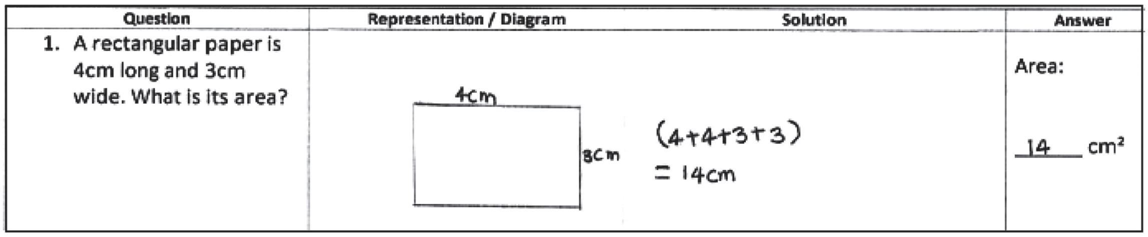
5A Experimental Group	5B Control Group	5C Experimental Group	5D Control Group
P(T<=t) two-tail 1.02E-11	P(T<=t) two-tail 0.007664	P(T<=t) two-tail 9.47E-08	P(T<=t) two-tail 0.0007274
(ρ-value = 0.00)	(ρ-value = 0.00)	(ρ-value = 0.00)	(ρ-value = 0.00)

Figure. 6 p-value of experimental and control groups (source: XSTAT Software)

5.4 Misconceptions Found in Pre-Tests and Post-Tests

The fourth set of findings is associated with the discovery of the following students' misconceptions (M1, M2, M3) on basic knowledge of area of rectangle and its contextual relationship with the area of triangle as shown in figure. 7, 8 and 9 below.

(a) Misconception 1: (M1)

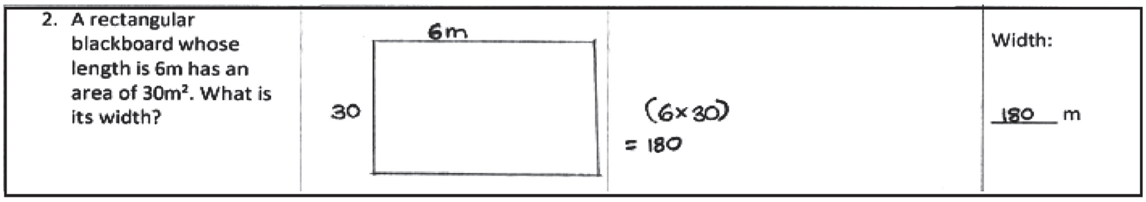


Question	Representation / Diagram	Solution	Answer
1. A rectangular paper is 4cm long and 3cm wide. What is its area?	4cm, 3cm	(4+4+3+3) = 14cm	Area: 14 cm²

Figure. 7　M1: Treating area as perimeter　　(source: author)

In question 1, students mistakenly calculating the perimeter of the rectangle, thinking that area is the total distance around the shape. So instead of doing (4cm x 3cm) to get the area, they added the lengths of all the four sides of the rectangle as (4+4+3+3 = 14cm) which simply denoted the length of its perimeter as shown in figure.7.

(b) Misconceptions2:(M2)

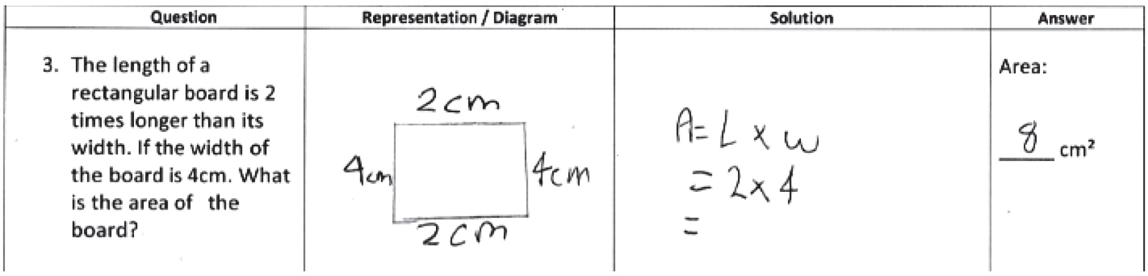


2. A rectangular blackboard whose length is 6m has an area of 30m². What is its width?	6m, 30	(6×30) = 180	Width: 180 m

Figure. 8　M2: Misrepresenting the width of rectangle as area in the inverse relation context　　(source: author)

For question 2, students seemed to find difficulty in understanding the inverse relations specified in the word problems. Thus, misrepresenting the dimension of the given area ($30m^2$) as width in the formula (Area = L x W). So, instead of writing (30 = 6 x W) according to the problem statement, they wrote (6x30) = 180 as shown in figure. 8.

(c) Misconception 3: (M3)



Question	Representation / Diagram	Solution	Answer
3. The length of a rectangular board is 2 times longer than its width. If the width of the board is 4cm. What is the area of the board?	2cm, 4cm, 4cm, 2cm	A= L x w = 2x4 =	Area: 8 cm²

Figure. 9　M3: Misrepresenting relations between quantities as a quantity in itself　　(source: author)

In question 3, students' misinterpreting the (2times) expression in the problem statement not as a relations of the length to the width but as a quantity of length in itself. As the results, they mistakenly wrote (A = L x W, 2 x 4), instead of (A = L x W, (2x4) x 4) to find the area as shown in figure. 9.

5.5 Polya's Model Influence on Problem Solving.

The final key set of findings of this study rested on the influence of the Polya's problem solving model on students' problem solving ability. According to the responses of the experimental groups' in the post-test, the use of the Polya's model in the problem solving situations has improved students' problem-solving skills outstandingly despite the different level of difficulty each problem entails. Such improvement is clearly demonstrated in figure. 11, where the generation of the solution for the problem initially began with the understanding of the problem through identifying the known and unknown data, and the condition of the problem first as shown in the first column of the worksheet in a circle, however, this was not done by the same student in the pre-test as seen in figure. 10. In the next step of problem solving, the students created a mental model of the data and have it represented in a picture form to make understanding more simple as depicted in the second column in a circle, before the solutions using known formulas or previous related mathematical model is applied as encircled in the third column. The last part of Polya's model, which requires looking back or checking all generated ideas and calculations done is evident in the post-test which has been highlighted in a circle at a far bottom of the third column in figure. 11. Evidently the use of the model has caused the experimental groups to gain deeper conceptual understanding, eliminate potential misconceptions and attain higher accuracy rate compared to what was displayed by the same student in each column of their corresponding pre-test worksheet as shown in figure. 10.

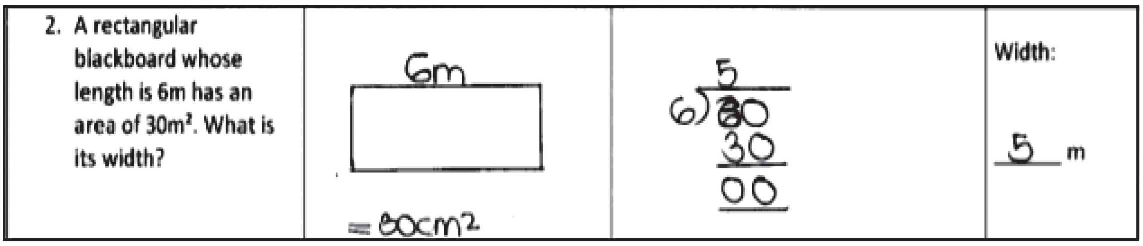


Figure. 10 (Pre-Test Worksheet) (source: author)

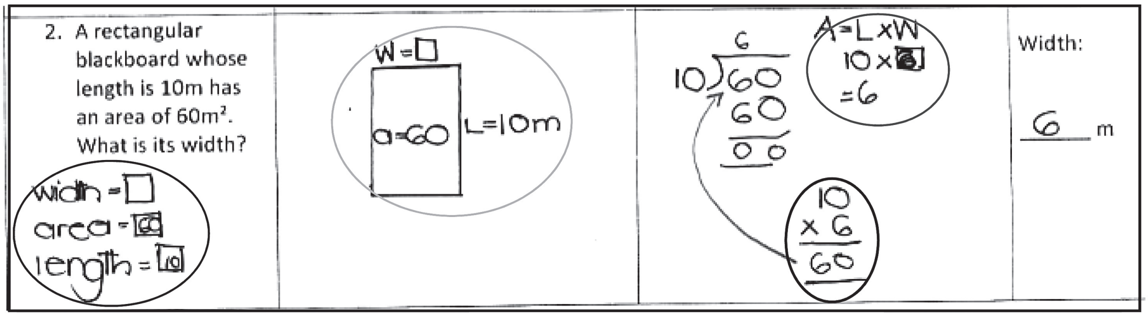


Figure. 11 (Post-Test Worksheet) (source: author)

6. Conclusion

The study has evidently proven that the new teaching through problem-solving model does not only support the development of students' key 21st century competencies but it also enhances other areas of learning such as conceptual understanding, problem solving skills and the elimination of misconceptions of basic rectangle area concepts as well. The integration of the Japanese problem solving model, Neun's problem posing model and Polya's problem solving model has imposed greater influence on the effectiveness of the new teaching approach to produce key learning outcomes that is deeply embedded in Fiji National Education curriculum framework.

However, due to the constant use of the traditional teacher-centered approach, and a persistent support of teaching mathematics for problem solving by teachers, students have been consequently deprived of opportunities to have their 21st century competencies and deep conceptual understanding developed. Even though, they may have been showered with a vast amount of knowledge through the traditional teaching model, such knowledge will soon be forgotten as they are not deep, very impractical and non-transferable to other context.

Therefore, if Fiji primary school teachers are sincerely seeking an effective teaching approach capable of developing students' key 21st century skills and deep mathematics conceptual understanding in the classroom, then adopting the new integrated teaching model which supports teaching through problem solving is highly recommended. This new model has been proven in the study to be an ideal pedagogical model that can be contextualized in Fiji primary school classrooms to boost students' academic performance and their readiness for life challenges in the 21st century. However, under the current Fiji education system, if teaching through problem-solving approach cannot be fully administered in the classrooms autonomously, then a transitional approach in teaching is highly recommended where both the traditional and the new instructional models are accommodated in the learning process so that students' competency development is incorporated and sustained at all times. In such proposition, teachers need to be fully acquainted with the new teaching model in order to integrate them successfully in the teaching and learning process.

REFERENCE

APEC. 2008. 2nd APEC Education Reform Symposium: 21st Century Competencies. Xi'an, China, Asia-Pacific Economic Cooperation Human Resources Development Working Group.

Dede, C. 2010. Comparing frameworks for 21st century skills. J. Bellance and R. Brandt (eds), 21st Century Skills, pp. 51-76. Bloomington, IN, Solution Tree Press.

Final Report. 2016. Quality Teachers and Teacher Education in Fiji. Identities, Challenges & Priorities. Retrieved from www.rarionz.com.nz/international/programme/datelinepacific/audio/ 201783440/fijieducationalreforms-impress-but-challenges-remain.

Griffin, P., McGaw, B. and Care, E. (eds). 2012. Assessment and Teaching of 21st Century Skills. Dordrecht, NL, Springer.

Learnovation. 2009. Inspiring Young People to Become Lifelong Learners in 2025. Vision Paper 1. Brussels, MENON, pp. 1-12. www.menon.org.gr/wp-content/uploads/2012/10/Learnovation-Vision-Paper-1_Learning-at-School-Ages 1.pdf (Accessed 21 August 2018).

Lingam, G., Lingam, N., & Sharma, L. (2017). Educational Reforms and Implications on Teachers' world of work: Perspectives of Fijian Primary Teachers. Australian Journal of Teacher Education, 42(1).

McLoughlin, C.and Lee, M.J.W. 2008. The three p's of pedagogy for the networked society: personalization, participation, and productivity. International Journal of Teaching and Learning in Higher Education, Vol. 20, No. 1, pp. 10-27. http://files.eric.ed.gov/fulltext/EJ895221.pdf (Accessed 21 August, 2018).

Ministry of Education (MOE), 2009. The Singapore Model Method for Learning Mathematics. Curriculum Planning & Development Division. ISBN 978-981-280-660-4.

Ministry of Education (MOE), 2013. The Fiji National Curriculum Framework. Quality Education for Peace, Change and Progress. ISBN 978-982-332-031-1.

Ministry of Education (MOE). 2015 -2018. Education Sector Strategic Development Plan. Retrieved from www.education.gov.fj/images/AnnualBusinessPlans/2015-2018_ESSDP.pdf .

Nunes,T., Bryant, P., Gottardis, L., Terlektsi, M., & Evans, D. 2015. Can we really teach problem-solving in primary school? Retrieved www.atm.org.uk .

P21. 2007a. The Intellectual and Policy Foundatios of the 21st Century Skills Framework. Washington DC, Partnership for 21st Century Skills. http://route21.p21.org/images/stories/ epapers/skills_foundations_final.pdf. (Accessed 28 August, 2018).

Polya, G. (2004). How to solve it: a new aspect of mathematical method. Princeton: Princeton University Press.

Redecker, C. and Punie, Y. 2013. The future of learning 2025: Developing a vision for change. Future Learning, Vol. 1, pp. 3-17. www.academia.edu/6470910/The_Future_of_Learning_2025_Developing_a_vision_for_change (Accessed 21 August, 2018).

Salas-Pilco, S. Z. 2013. Evolution of the framework for 21st century competencies. Knowledge Management & E-learning: An International Journal, Vol. 5, No. 1, pp. 10-24.

Singer, F. M. & Voica, C. 2012. A problem-solving conceptual framework and its implications in designing problem-posing tasks. Educ Stud Math 83:9-26. DOI 10.1007/s10649-012-9422-x.

Scott, C.L. 2015. UNESCO Education Research and Foresight Working Papers. The Future of Learning 2: What kind of Learning for the 21st century? www.unesdoc.unesco.org/images/0024/002429/242996E.pdf (Accessed 21 August, 2018).

Takahasi, A. 2006. Characteristics of Japanese Mathematics Lessons. Tsukuba Journal of Educational Study in Mathematics. Vol.25, 2006. Retrieved from www.human.tsukuba.ac.jp/-mathedu/2504.pdf.