The Eurasia Proceedings of
Educational & Social Sciences (EPESS)
ISSN: 2587-1730

The Eurasia Proceedings of Educational & Social Sciences (EPESS), 2020

Volume 16, Pages 29-37

ICEMST 2020: International Conference on Education in Mathematics, Science and Technology

Improve the Effectiveness of Mathematics Learning by Motivating Students

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Abstract: A lot of students have learning difficulties in mathematics because of both practical and emotional problems. All mathematics teachers have a challenge how help to students to solve this problem in learning mathematics. The aim of the research was, to give an answer to this question. If not a student ready to learn any subject in mentally, he or she can't go further through the subject. No matter what is the subject or how many we use teaching or learning techniques. Therefore, students first should be ready to learn in mind. We can do it through the motivation. The research was based on this concept and it had been doing for 5 years, from 2014 to 2018. The targeted group was the students of grade 11 at T/Trincomalee Girls' High School, Trincomalee, Sri Lanka. This paper describes the most important activity in achieving the success of mathematics learning is, motivating students in every activity.

Keywords: Mathematics learning, Students, Motivation

Introduction

Mathematics is the ancestor and the foundation of almost all subjects. Cockcroft writes "It would be very difficult – perhaps impossible – to live a normal life in very many parts of the world in the twentieth century without making use of mathematics of some kind". We have to correct Cockcroft as "It is impossible to live a normal life without making use of mathematics of some kind in 21st century". There is also impossible thinking of the development of science and technology without mathematics. However, the difficulty of learning mathematics is a common problem for students in both of centuries. If mathematics be the foundation of almost all subjects, why do more students hate mathematics? Mathematics teachers use a lack of mathematics learning processes too. But why do more students failure in learning mathematics. How we can stop students getting bored in learning mathematics? It is essential that innovative teaching in mathematics and more researches to develop the skills of teaching and learning mathematics.

When we consider mathematics education in the world, mathematics instructions differ from country to country. Stigler, J.W. and Hiebert, J. had been working for more than 10 years about that. According to them, teaching methods in Japan differed markedly from what they observed in all of the other countries. Japanese students, for example, spent an average of 15 minutes working on each mathematics problem during the lesson, in part because students often were asked to develop their own solution procedures for problems that they had not seen before. The researchers emphasized the importance of spending time engage in the serious study of mathematical concepts instead of spending more in practicing procedures. Hong Kong and Japan were the highest-achieving countries. In both countries, the majority of making connections problems are implemented as making connections problems; a much smaller percentage are transformed into lower-level using procedure problems. Programme for International Study Assessment (PISA) - 2015, Singapore became the first of the mathematics score. Hong Kong, Macau and Japan get second, third, and fourth places respectively among 72 countries. About the mathematics education in Sri Lanka will be discussed briefly later.

The rest of the paper is organized as follows:

The first sub-section discusses varied research activities which have done in mathematics teaching and learning. Mathematics education in Sri Lanka is described in the second sub-section. The methodology is presented in

section 2 with describing the research participants and the research design in sub-sections. The section 3 presents the results and analysis. The research is concluded by the section 4.

Related Work

Prof. Michael T. Battista who focuses research on how students' knowledge of and fluency with mathematics develops, and how teachers understand and use research-based learning progressions discusses how engage students in meaningful mathematics learning. Yuanita, P. et al. discuss about identifying the role of mathematics representation as a mediator between mathematical belief and problem solving. They say that the Realistic Mathematics Education (RME) approach successfully increased the arithmetic problem-solving ability of students. According to their research, students who were taught using RME approach had higher mathematical belief than students who were exposed to the traditional method. Krainer, K. says "the growth of mathematics education as a scientific field can be regarded as a continuous process of having a deeper and deeper understanding of the complexity of learning and teaching". Kusmaryano, I. describes the importance of mathematical power to improve student's achievement in mathematics learning. The learning process in the classroom more focused on students' ability to memorize information. The ability to think is not developed by a learning process. Teledahl, A. examines that students' writing in school mathematics and the various understandings of the relationship between students' written communication and their achievements. Sidabutar, R. has done a research to investigate the effect of various, innovated teaching models to improve the student's achievement in various topics in mathematics. Student's achievement in the teaching of mathematics with the aid of contextual was found higher the teaching the same topic by using conventional methods. Student's achievement with another innovated teaching method by using of web for the teaching distillation was found higher than that with the conventional method. A related research to our research has done by Abramovich, S. et al. They show that the approach in mathematics education based on action learning in conjunction with the natural motivation stemming from common sense is effective. Also stimulating questions, computer analysis (internet search included) and classical famous problems are important motivating tools in mathematics, which are particularly beneficial in the framework of action learning. The main concluding message of their research is that by repeatedly utilizing concept motivation and action learning at all levels of mathematics education, overall student success has great potential to improve. The ability of problem solving is very important in mathematics. Eviyanti, C.Y., et al.say that the ability of problem solving in mathematics can be improved by the problem-based learning model. According their study, the increase in mathematical problem solving ability of students who received application of problem-based learning model is better than students who received conventional learning the material opportunities.

Mathematics Education in Sri Lanka

It is a common problem in Sri Lanka that students having low marks for mathematics comparing other subjects. There are two important public certificate examinations in Sri Lanka. One of these examinations is, the General Certificate of Education (Ordinary Level) examination. This examination is based on the Cambridge University Ordinary Level qualification. The other one is the General Certificate of Education (Advanced Level) examination. The G.C.E. (A/L) examination is based on the Cambridge University Advanced Level qualification. Students have to face 9 subjects for the G.C.E. (O/L) examination. They must pass at least 5 subjects with 3 credits to qualify for the G.C.E. (A/L). But, students can't sit for the G.C.E. (A/L) examination without pass G.C.E. (O/L) mathematics.

Table 1. G.C.E. (O/L) Examination – Sri Lanka- Performances of School Candidates (1st attempt) -from 2014 to 2017-

Year	2014	2015	2016	2017
Number of candidates sat for the G.C.E. (O/L) examination (5 or more subjects)	257,322	273,224	286,251	296,812
Qualified for the G.C.E. (A/L)	177,612	189,428	200208	216,815
The G.C.E. (A/L) qualified percentage	69.02%	69.33%	69.94%	73.05%

(Source: Results reports of Department of Examinations, Sri Lanka)

Table 2. G.C.E. (O/L) Examination- Sri Lanka – Mathematics Performance of School Candidates (1st attempt) - from 2014 to 2017-

Year	2014	2015	2016	2017
Number of students sat for the mathematics paper	256,800	272,723	285,537	296,205
Number of pass students	145,602	150,481	179,358	199,173
Pass percentage	56.70%	55.18%	62.81%	67.24%

(Source: Results reports of Department of Examinations, Sri Lanka)

In 2018, 235,373 of candidates qualified for the G.C.E. (A/L). The percentage of qualified candidates for the G.C.E. (A/L) was 71.66%.

Here we consider the G.C.E. (O/L) performances in Trincomalee district, Sri Lanka, because of the research was based on a school situated in Trincomalee. Trincomalee is the capital city of Eastern province, Sri Lanka. The city was severely affected for 30 years by the civil war. The nation of Trincomalee started to enter to the normal life since 2009, after the civil war. During the war, the education had been broken down. In this situation it is not effectiveness talking about mathematics teaching or mathematics learning.

According to the G.C.E. (O/L) results analyzing report of Department of Examination, Sri Lanka , Trincomalee district got 24th , 23rd and 25th places for performance of school candidates who qualified for G.C.E. (A/L) in 2016, 2017 and 2018 years respectively, among 25 districts of Sri Lanka. It manifests that the education in Trincomalee has to be more developed.

The G.C.E. (O/L) performances of school candidates (1st attempt) in Trincomalee district are described in the table 3.

Table 3. G.C.E. (O/L) Examination Performances of School Candidates (1st attempt) –Trincomalee District- -from 2014 to 2018-

Year	2014	2015	2016	2017
Number of candidates sat for the G.C.E. (O/L) examination (5 or more subjects)	4968	5653	5832	6065
Qualified for the G.C.E. (A/L)	3139	3199	3309	3858
G.C.E. (A/L) qualified percentage	63.18%	56.59%	56.74%	63.61%

(Source: Results reports of Department of Examinations, Sri Lanka)

4724 of candidates qualified for the G.C.E. (A/L), in 2018. The percentage was 53.17%.

Method

If not a student ready to learn any subject in mentally, he or she can't go further through the subject. No matter what is the subject or how many we use teaching or learning methods. Therefore, first should be ready to learn in mind. We can do it through the motivation. The research was based on this concept.

Participants

The research based on Trincomalee Girls' High School, Trincomalee, Sri Lanka and was started after 5 years of the ending of the civil war, in April, 2014. The grade 11 students of Trincomalee Girls' High School were the

first targeted group. There were 12 students in the class. They had to sit for one of the national examinations of Sri Lanka, G.C.E. (General Certificate of Education) Ordinary Level examination. The G.C.E. (O/L) mathematics pass percentage was 50% , in 2013. There was a big challenge to increase G.C.E. (O/L) mathematics pass percentage up to 50% within 7 months, because of the examination holds on December, in every year.

Research Design

First, we discussed about the research with Mrs. Jayanthi Ranasinghe who was the principal of Trincomalee Girls' High School in 2014. She satisfied with the methodology and organized a parents meeting of the grade 11 students. We discussed with them about the research. But, they had no any idea about the research. They said that they only want to pass their children in G.C.E. (O/L) mathematics.

In the first day, lots of students had given up before started the mathematics lesson. They did not engage with the lesson. They were afraid of mathematics. Therefore, the first lesson was not about mathematics. It was about some people such as scientists, sportsmen, soldiers who had accomplished their goals with many difficulties.
From the second day, we started from the basic mathematics such as addition, subtraction, multiplication and division of the all types of numbers. The reason to start the research with the basic mathematics, it is very familiar to students. After these lessons, the students understood that they know something in mathematics. That step was the foundation of the research because of there was a reason to start motivation. "Look, you know mathematics. So, why do you afraid of mathematics? If you know these basic things of mathematics, you can get a good result easily for mathematics in the examination." were the first sentences of our motivation programme. After learning of basic mathematics, the students were exhorted to study the mathematics lessons which are targeted the G.C.E. (O/L) examination, by themselves. The teacher acted only as a facilitator. However, we had only 40 minutes for a day. Therefore extra classes were held after the school time. We tried with only few sentences. "You did it. Please go ahead." After 4 months, almost all students were very active in mathematics learning. Almost all participated to extra mathematics classes. Sometimes they had organized extra mathematics classes! If someone was success in learning, then she also acted as a facilitator for other students. This caused the G.C.E. (O/L) mathematics pass rate had increased to 75% in 2014.

Results and Discussion

Table 4. Comparison of G.C.E. (O/L) Mathematics Results in 2014with G.C.E. (O/L) Mathematics Results in 2013- Trincomalee Girls' High School

Year	No of students sat for the G.C.E. (O/L) examination	Grades					Pass Percentage
		A	B	C	S	W	
2013	6	1	-	-	2	3	50%
2014	12	1	2	3	3	3	75%

$$75\ marks \leq A, \quad 65\ marks \leq B < 75\ marks, \quad 55\ marks \leq C < 65\ marks,$$
$$35\ marks \leq S < 55\ marks, \quad W < 35\ marks\ (failure\ in\ mathematics\ paper)$$

There was no test control group. The success of the research was measured only by comparing the previous G.C.E. (O/L) mathematics results.

Because of the success of the research, it was preceded for next 4 years.

The programme was started again, since December 2014, for 2015 G.C.E. (O/L) batch. The students were motivated daily. Sometimes, only one sentence such as "wow, better solving than yesterday" was sufficient to achieve their mathematical goals. Almost all students were very active in solving mathematical problems related to geometry. Finally, the G.C.E. (O/L) mathematics results were increased to 78.2% in 2015. 65.2% of students had got above 54 marks for mathematics. (See the Table 5).

The programme was continued to 2016 batch with a new idea. Ten of the parents of grade 11 students were also motivated. Parents meetings were organized twice for a month. The results were, those parents had made a better environment to their children at the home and they also started to motivate their children. "Yes, you can",

"You will pass the examination very well". The results were very amazing. The pass percentage decreases to 71.9%. But, every 1 of 3 students had got an "A" pass for G.C.E. (O/L) mathematics. (See the Table 5 and the Figure 1).

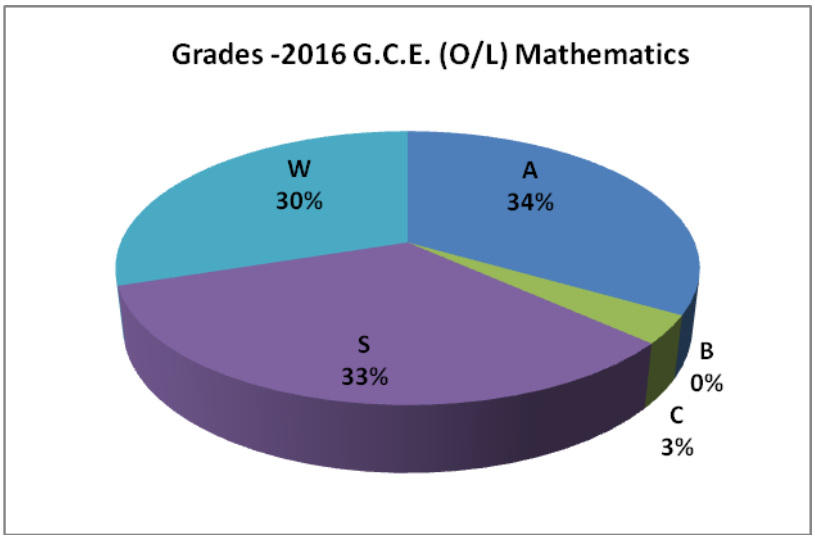


Figure 1. Grades - G.C.E.(O/L) Mathematics Results 2016 - Trincomalee Girls' High School

The research had been continued for next 2 years, 2017 and 2018 for grade 11 students who sat for the G.C.E. (O/L) examination. In 2017, all students of grade 11 and their parents were motivated. Some parents did not engage with the programme continuously. But, almost all parents engaged with the programme continuously. A mathematics seminar for the students also was organized by 2nd year engineering students at University of Peradeniya, Sri Lanka, in the last week of November 2017. The seminar had been held for 3 days. The most important thing was, the engineering students started the seminar by motivating grade 11 students as "If you exhort to get a good result for the G.C.E. (O/L) mathematics paper since now, you can do it. Don't worry about the time. The time is much enough for you. So, just try." The grade 11 students were highly motivated by these words. Finally, the G.C.E. (O/L) mathematics results increased to 80% in 2017. 53.3% of students had got above 54 marks for mathematics. (See the Table 5 and the Figure 2).

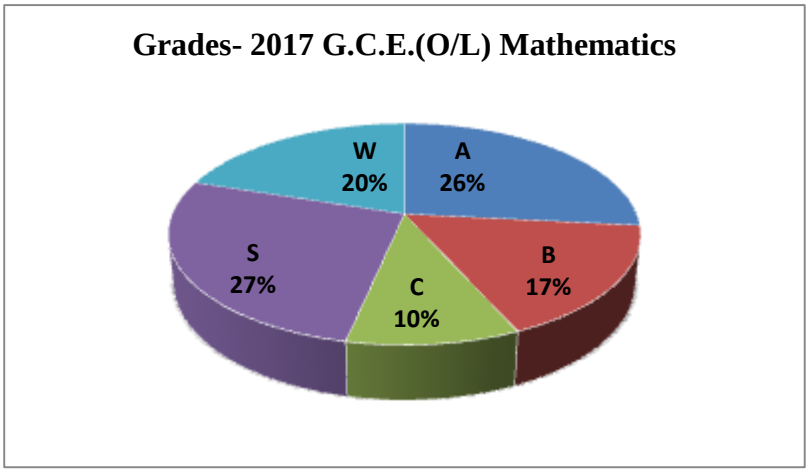


Figure 2. Grades - G.C.E.(O/L) Mathematics Results 2017 - Trincomalee Girls' High School

In 2018, mathematics lessons from basic were started with motivating grade 11students as previous years. In this year, almost all of their parents did not engage with the motivation programme. The G.C.E. (O/L) mathematics results of 2018 increased to 83.3%. But, 41.1% of students had got above 54 marks for mathematics. (See the Table 5).

Table 5. Comparison of G.C.E. (O/L) Mathematics Results from 2014 to 2018- Trincomalee Girls' High School

Year	No of students sat for the G.C.E. (O/L) examination	Grades					Pass Percentage
		A	B	C	S	W	
2014	12	1	2	3	3	3	75%
2015	23	1	4	10	3	5	78.2%
2016	32	10	-	1	12	9	71.9%
2017	30	8	5	3	8	6	80%
2018	24	3	2	5	10	4	83.3%

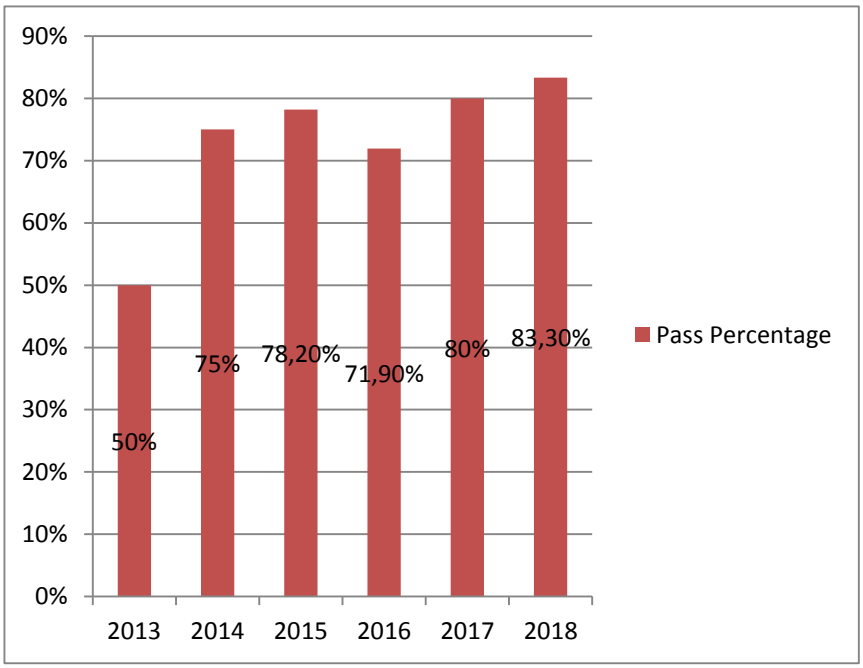
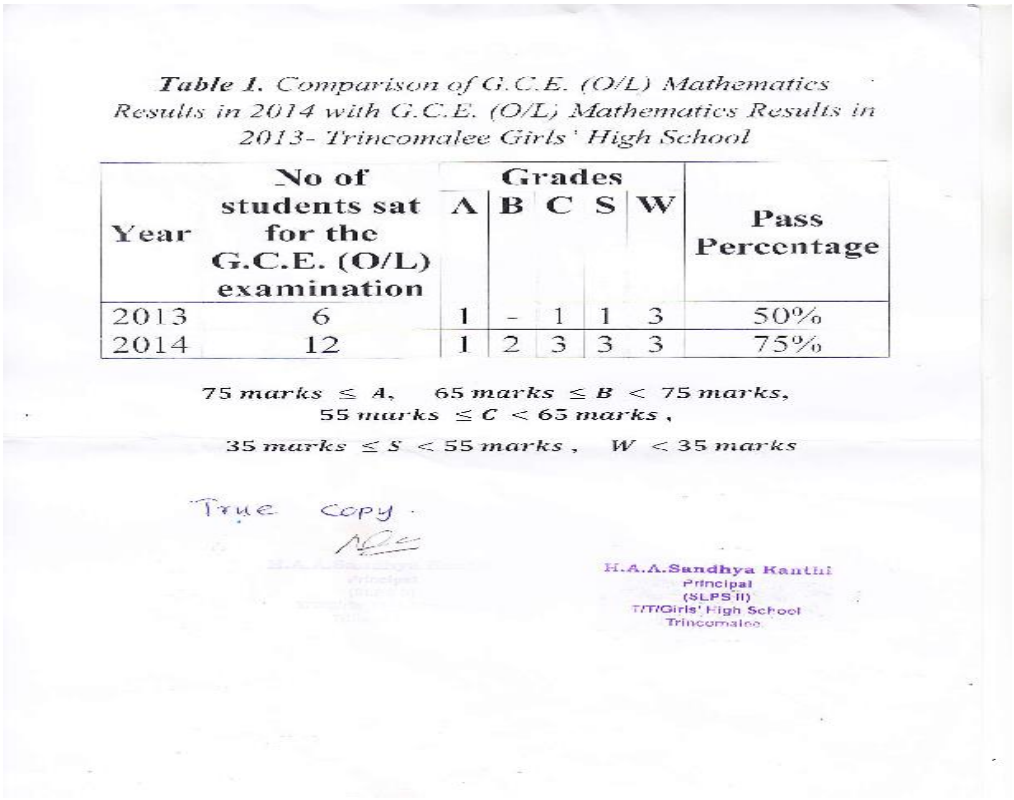


Figure 3. G.C.E. (O/L) Mathematics Pass Percentage Trincomalee Girls' High School from 2013 to 2018



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2014	12	1	2	3	3	3	75%

$75\ marks \leq A$, $65\ marks \leq B < 75\ marks$,
$55\ marks \leq C < 65\ marks$,
$35\ marks \leq S < 55\ marks$, $W < 35\ marks$

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Figure 4. Certified Results by the Principal-Trincomalee Girls' High School, Trincomalee

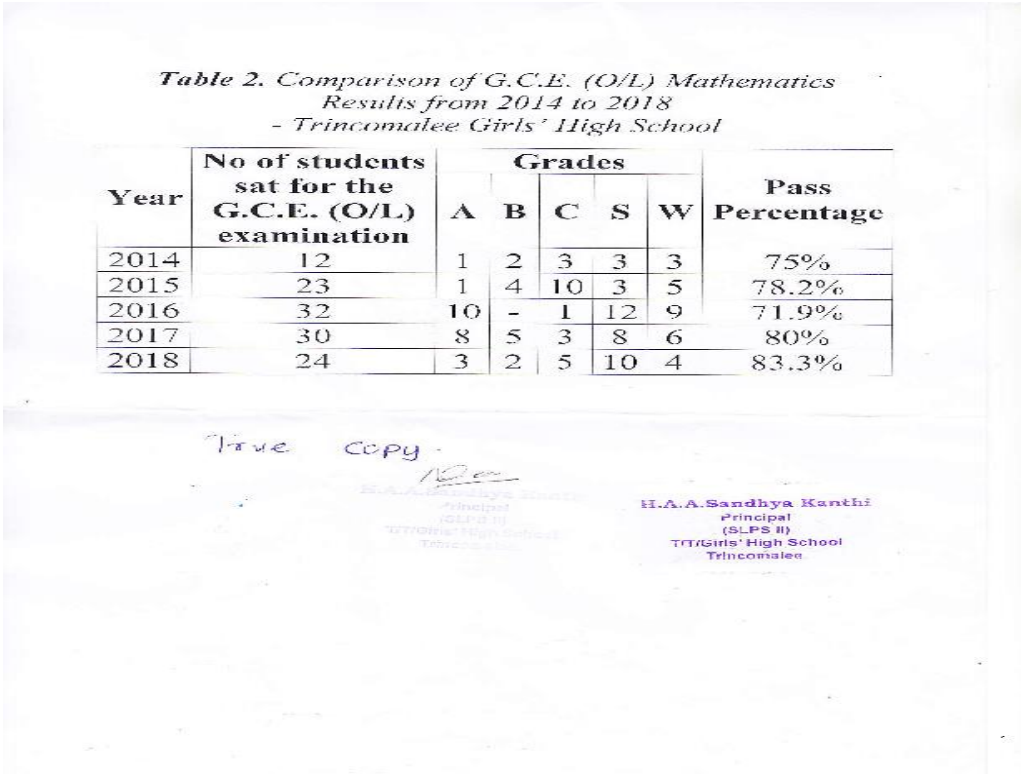

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Figure 5. Certified Results by the Principal-Trincomalee Girls' High School, Trincomalee

Conclusion

The G.C.E. (O/L) mathematics results of Trincomalee Girls' High School were increased up to 83.3% within five years by motivating students. The students were not forced to do mathematics activities or were not forced on solving mathematics problems. When we motivated them, they had started to do mathematics activities and solve mathematics problems by themselves. The teacher acted only as a facilitator. Sometimes, we had to correct students carefully and respectfully in solving mathematics problems. Finally, students wanted to success in G.C.E. (O/L) mathematics paper. Therefore, they exhorted by themselves to get a better result for G.C.E. (O/L) mathematics. The foundation of the success only was motivating students. Based on the G.C.E. (O/L) results from 2014 to 2018, it can be concluded that the effectiveness of mathematics learning can be improved by motivating students.

The methodology is suitable for any student, any school or any country. We can use this methodology to improve the effectiveness in learning any subject too. The research had done with minimum facilities with no fund. If someone uses this methodology with more facilities, they can improve more the effectiveness of teaching and learning mathematics than us.

Acknowledgements

I would like to thank Mr. Mansoor, M.K.M. (Provincial Director of Education, Eastern Province, Trincomalee), Mrs. Arulanandan, J. (Zonal Director of Education, Trincomalee), Ms. Niroshani, D.M.M. (Assistant Director of Education- Mathematics & Primary, Provincial Department of Education, Eastern Province, Trincomalee), Mrs. Malani, D.H. (Assistant Director of Education, Zonal Education Office, Trincomalee).

I would like to thank Mrs. Sandya Kanthi (principal of Trincomelee Girls' High School) who provided a good background for the research programme since November 2017. I would like to express my deep gratitude to Mrs. Jayanthi Ranasinghe (Former principal, Trincomalee Girls' High School (May 2010-May 2016)) for the help and encouragements given us during the research work. She provided guidance and support that facilitated for the research programme. She also motivated us in the programme. I also thank Ms. Sriyani Padmalatha (former principal, Trincomalee Girls' High School (May 2016- November 2017)). She facilitated in continuing

the research programme. I thank teachers, students and their parents at T/Trincomalee Girls' High School, who supported to success the research programme.

I would like to thank Mr. Sajun Badrajith, Ms. Enara and Ms. Yumethya for the support in organizing extra mathematics classes from 2014 to 2018.

I would also like to thank 2nd year engineering students (2017) at University of Peradeniya, Sri Lanka, for their contribution in increasing G.C.E. (O/L) mathematics results in 2017. The Engineering Students Union of Faculty of Engineering, University of Peradeniya, Sri Lanka organizes valuable seminar programmes called "Arunalla" for grade11 students who live in rural areas in Sri Lanka. Their aim is pass or grade up every student in G.C.E. (O/L) mathematics through these mathematics seminars. I would also like to thank Dr. Sandirigama, M. (Department of Computer Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka) for the support in organizing the mathematics seminar programme in 2017.

I thank Mrs. Shanthi and Mrs. Kannamma (Non-Academic Staff, T/ Trincomalee Girls' High School, Trincomalee) for their support during the research programme).

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