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Annals of Mathematical Modeling, 2 (1), 2022, 16-28

Effects of blum's phase based instruction on the mathematical modelling abilities among year 5 pupils

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Abstrak: Skills required by pupils for the 21st century differ from what was required twenty years back. The results of the 21st century concentrates on the abilities and knowledge pupils must learn to be successful in college, life and work. In order to do this, pupils should be taught to master critical thinking skills. The effective way is by including modelling in their syllabus. In mathematics learning, mathematical modelling deals with modelling and application in mathematics teaching, characterising pupils' modelling abilities and application of modelling activities toward building their competencies. In this study, seventy fifth grade pupils from a school in Selangor, Malaysia, were chosen as the participants. Quantitative approach was used in this study. These pupils were selected using convenience sampling procedure. Open ended tasks based on some real-world problems were given to the pupils. Their answers were assessed using a rubric score table. The scores ranged from 1 to 3 and there was explanation in each score to give marks to their answers. descriptive statistics and Analysis of Covariance (Ancova) were used for answering the research questions. The findings showed that the pupils in the experimental group performed very well in their modelling task whereas pupils in the control group could not perform well in the modelling task.

Keywords: *Phase based instruction; mathematical modeling; Primary pupils*

INTRODUCTION

Mathematics educators today are presuming to elevate pupils who will have the ability to create effective solution in real mathematical issues and make use of mathematics efficiently in their daily life. This process of development as well as change caused brand new investigations in the educational program and it became compulsory to try out new methods, approaches in the education realm. Modelling approach improve children's problem-solving abilities, provided it deals with the mathematical understanding, processes, along with communication abilities they need for the 21st century. Mathematical modelling allows pupils to connect and use mathematics in meaningful real-world scenarios. Mathematical modelling is utilized in a number of scientific and technological disciplines and this caused a terrific effect on the teaching as well as learning of mathematical modelling. In order to help students develop mathematical modelling abilities relevant for their additional training and subsequent professions, it is crucial that the pupils work with reasonable as well as genuine real-life model.

The concept of using mathematics modelling in mathematics education started in the mid-1970s at Pontifical Catholic Faculty of Rio de Janeiro by Aristides C. Barreto after he started teaching at his institution. Mathematical modelling relates to the procedure of building a model which will be used in solving mathematical issues. The mathematical model is obtained when issues are converted from hypotheses language into conventional symbolic words. In other words, the essence of an issue is extracted and changed into systematic mathematical language.

Forman and Steen (2001) have summarized the effective approach to teach mathematical modelling. The 3 major elements are contextual, student-centered, and active. Modelling abilities are the necessary skills to conduct modelling procedures sufficiently in a goal-oriented manner. In detail, modelling abilities includes sub competencies to carry out specific stages in modelling procedure, metacognitive modelling skills as well as the ability to reason the connection to the modelling activity. Mathematical modelling abilities are the skills to apply studied mathematics to answer real life issue, and it is also known as model building abilities (Maab, 2006).

The modelling cycle of Blum Phase Based instruction will be applied in this study. Blum Phase based instruction is a cognitive model of the modelling process due to its focus on the cognitive processes that occur as students negotiate within and between real world domain and the domain of mathematics. In an ideal form, solving of a modelling task can be classified into 4 levels. The 4 steps are namely, realizing the issue by building a personal model, establishing the model by simplifying, structuring a genuine model and translating it to mathematical model, administer mathematical approach and interpret the mathematical solution with regard to authenticity and finally validating the outcome with reference to the initial circumstance.

The research area for this study is the effects of Blum's Phase based instructions on the mathematical modelling abilities among year 5 pupils. Mathematical modelling is among the greatest techniques to motivate the connections of daily life in the classroom. Mathematical modelling is actually described as a learning environment where pupils are actually requested to resolve issues from daily life situations, skilled areas, or everyday life in scientific disciplines, through mathematics (Barbosa, 2006). Mathematical modelling stresses that certain tasks from teachers and students discourse daily predicament in the classroom implementations in the students' modelling processes (Lindmeier, 2010). Activities requiring modelling rather than problem solving draw interest in students because of their multi-faced and dynamic characteristics (Crouch & Haines, 2004). Modelling issue adhere to a great deal of style principles which facilitate possibilities for very long learning for all young children compared to standard word problems (Lesh, Doerr, Carmona, & Hjalmarson, 2003). Modelling teaches us to find out how we can hold out an analysis which directs understanding as well as sensible selection (Ferri, 2006).

Many studies have been carried out on mathematical modelling internationally but very few have been done in Malaysia. Besides, the concepts of mathematical modelling are not clearly defined in our literature. In Malaysia, Leong (2013) discussed the importance of Mathematical modelling and the importance of implementing it in our Malaysian Mathematics Curriculum. The following year, two more studies were done related to modelling, namely Secondary Students' Mathematical Competencies Assessments (Leong & Tan, 2015) and Mathematical Modelling Competencies of Secondary Students (Tan & Leong, 2015). A few studies done overseas in mathematical modelling have used Blum's phase-based instructions. Freeman (2014) investigated the effect of small group mathematical modelling tasks on students' comprehension of quadratic and linear features. Schukajlow, Kolter, and Blum (2015) did a study on scaffolding mathematical modelling with a solution plan using the outcome of Blum's Phase Based instruction as a scaffold for improving pupils' mathematical modelling abilities.

The present study uses Models and Modelling Perspective (MMP) as its underpinning theory. Models and modelling theory is chosen as the theory for this research because it is suitable to be used for data collection to answer the research question for this study. This study is to identify pupils' mathematical modelling abilities by doing model-eliciting activities. Model-eliciting activities are specially designed to use with this theory. This theory will help to quantify, collect data and information for this study.

MMP emphasises on thinking mathematically and utilizing mathematical interpretations on real life scenarios (Lesh, Doerr, Carmona, & Hjalmarson, 2003). MMP suggests that beyond content mastery and abilities in solving conventional textbook word problems, it is crucial that pupils acquire the ability to represent real world issues in mathematical terms as well as to construct models as a solution to the problem. When pupils are engaged in modelling, their thinking does not manifest as an individual or one-dimensional sequence but instead as series of cycles, in which the psychological models representing the given situation are actually expressed, tested as well as revised. The aim of this study is to determine the effect of Blum's Phase Based instruction in Year five pupils mathematical modelling ability. In this regard, answers were sought to the following questions;

1. Do the Year five pupils mathematical modelling abilities in experimental group improve significantly after the treatment?
2. Is there any significant difference in the post-test of the mathematical modelling abilities between Year five pupils in experimental and control group when controlling for the pre-test?

Modelling Ability

The term modelling ability refers to ability to identify relevant questions, variables, relations or assumptions in a given real world situation, to translate these into mathematics and to interpret and validate the solution of the resulting mathematical problem in relation to the given situation, as well as the ability to analyze or compare given models by investigating the assumptions being made, checking properties and scope of a given model (Blum, Galbraith Henn, & Niss, 2007). Sub-competencies of mathematical modelling as an essential part of modelling competencies are based on the underlying modelling cycle and include the abilities needed to perform the different steps of the cycle (Kaiser & Schwarz, 2006). Based on the modelling cycle from Maaß (2006) the sub skills of mathematical modelling are distinguishable by simplifying the real-world problem, explicating the aim, interpreting the problem, ascribing the primary variables and their relations, articulating mathematical statements, choosing a model, explicate the end result in a real life context and justifying the suitability of the results.

Blum Phase Based Instructions

It is well known that learning mathematical modelling is a difficult task for students both in primary and higher level (Galbraith, Brown, Galbraith, & Ng, 2016). Modelling cycle or also instruction is a proses that guides pupils to start and end with a problem situation in real life; they translate the problem into mathematical terms and devise a mathematical solution. Additionally, the modelling cycle varies based on whether it is to be used for investigation or teaching (Ferri, 2006). A few modelling cycles are close to mathematics education, namely modelling cycle by Pollak (2007), by Blum and Leiß (2007), by Berry and Nyman (1998), by Girnat and Eichler (2011), and the Blum Phase Based solution plan by Blum (2007).

Model-Eliciting Activities

Model-Eliciting Activities (MEAs) were initially created in the mid-1970s by mathematics educators (Chamberlin & Moon, 2005). These activities have been referred as Case Studies for Kids and Thought Revealing Activities. Model Eliciting Activities will be used to relate to the responsibilities mainly because this specific title is currently being employed by practically all MEA developers. MEA developers had two goals in mind every time they created MEAs. First, MEA will inspire pupils to generate mathematical models to solve complex issues, just as applied mathematicians do in the real world (Lesh, Doerr, Carmona, & Hjalmarson, 2003). Second, MEAs were designed to enable researchers to investigate students' mathematical thinking (NCTM, 2000). In this study, MEA will be used to investigate pupils mathematical modelling abilities.

Ng and Lee (2012) developed a marking scheme to find out students' mathematical modelling abilities. This marking scheme consists of three scores. This rubric will be used in this study because the marking scheme aligns with the task and Blum's phase-based instructions.

Table 1. scheme consists of three scores

Score 1	Score 2	Score 3
*Inappropriate mathematical problem stated with respect to the given real-world problem. *Inappropriate model of problem was developed *Model is full of errors in mathematical arguments and calculations. *Solution not feasible or not complete. *Flow in interpretation of the real-world problem. *Lack of consideration of appropriate variables. *Some of the assumptions set do not make sense. *Parameter for the solution approach are not articulated clearly or were not feasible.	*Appropriate mathematical problem stated with respect to the given real-world problem. *Appropriate model of problem was developed. *Model has some errors in mathematical arguments and calculations. *Solution not comprehensive in line with the model. *Reasonable interpretation of the real-world problem. *Appropriate variables chosen. *Assumptions chosen are generally reasonable. *Parameters for the solution are generally articulated clearly.	*Appropriate mathematical problem stated with respect to the given real-world problem. *Sophisticated model of problem was developed. * Model has sound mathematical arguments and accurate calculations. *Solution is comprehensive in line with the model. *Reasonable interpretation of the real-world problem. *Appropriate variables chosen. *Assumptions chosen are generally reasonable. *Parameters for the solution are generally articulated clearly.

Conceptual Framework

The conceptual framework (see figure 1) illustrated the connections of the variables that helps in achieving the objective of the study.

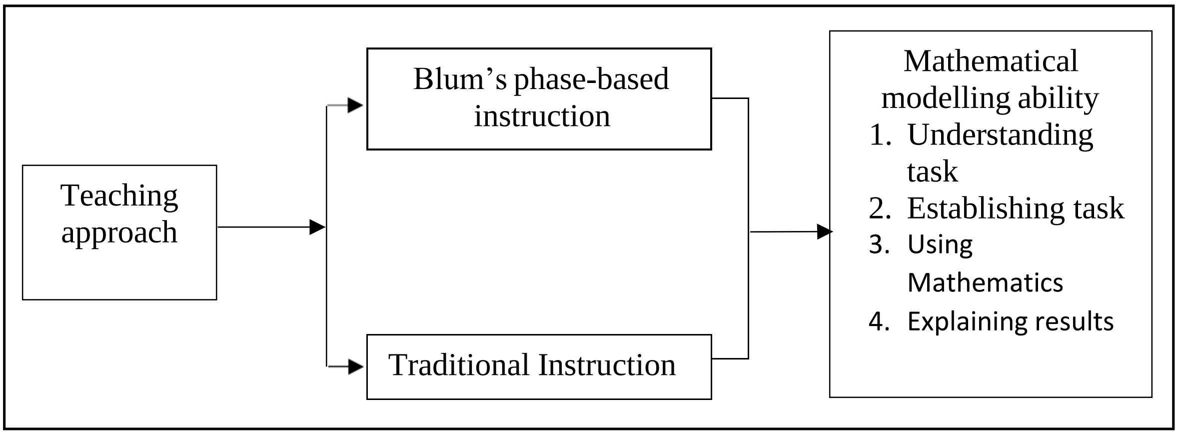

Figure 2. conceptual framework

The first column of the conceptual framework is the teaching approach used in this study. The teaching approach used which is also known as the independent variable in this study is Blum's Phase Based instruction and traditional instruction. Blum's phase-based instruction will be used for the experimental group while traditional instruction will be used for the control group (see Figure2.1). The dependent variable in this study is subject that is measured, which is the mathematical modelling abilities of Year 5 pupils.

METHOD

This study is a quasi-experimental non-equivalent group pre-test and post-test design. In this study, the researcher attempts to make comparison between two groups of respondents in which one group acts as the treatment group and the other as the control group. Control Group are pupils in one Year 5 class that will receive traditional classroom instruction using lectures, textbook, and activity book. Treatment group are pupils in another Year 5 class that will receive mathematical modelling activities that emphasises model development, in addition to receiving traditional classroom instruction using lectures, textbook, and activity book.

Participants

The participants were seventy Year Five pupils from two intact mixed-ability classrooms. Both classes were not streamed. All of the pupils were ten years old. The researcher used coin-toss and assigned one of the classes as the experimental group and another class as the control group. There was no treatment given to the control group. The control group students were taught using textbook and activity book in the class. They had 3 hours of Mathematic lesson per week with an hour of lesson each session. The treatment group had 2 hours of Mathematics lesson and an hour for modelling activities. For the 2-hour lesson the teacher used the school textbook and activity book. Worksheets on Mathematical tasks were given to them for the balance hour-long lesson. Each activity was designed to require students to mathematize a problem based on real world situation and encourage students to use Blum Phase Based instruction to solve it. Students worksheet is evaluated using a rubric score adapted from Ng and Lee (2012).

Data Collection Procedure

The research procedures are illustrated as shown in Table 3.2. First, pre-test (see Appendix) was administered to the pupils in both the experimental and the control group to determine their initial mathematical modelling competency.

Table 2 Research Procedures

Groups	Research Procedures
Experimental Group	1. Pre-test 2. Introductory lesson of Mathematical Modelling 3. Mathematical modelling task Lesson 1: Filling Up Lesson 2: Charity Draw Tickets Lesson 3: Trolls Set Activity Lesson 4: Olympic Games Lesson 5: Sukma Games Lesson 6: Cows and Chickens 4. Post-test
Control Group	1. Pre-test 2. Post-test

A few days after the pre-test was given, the researcher introduced modelling eliciting activities to the pupils in the experimental group. The researcher guided them with the task given. Beginning from the second week, the experimental group pupils underwent the mathematical modelling approach; meanwhile the control group had their lesson using traditional approach. The sample of lesson plan and worksheets provided for the pupils is in instrumentation. Eight weeks after the intervention period, post-test (see Appendix) was given to the pupils in both groups to evaluate on their mathematical modelling competency. During the evaluation process using the pre-test and post-test, both groups of pupils were given the same questions and the same environment during the assessment. The flow of the research is illustrated in Figure 2.

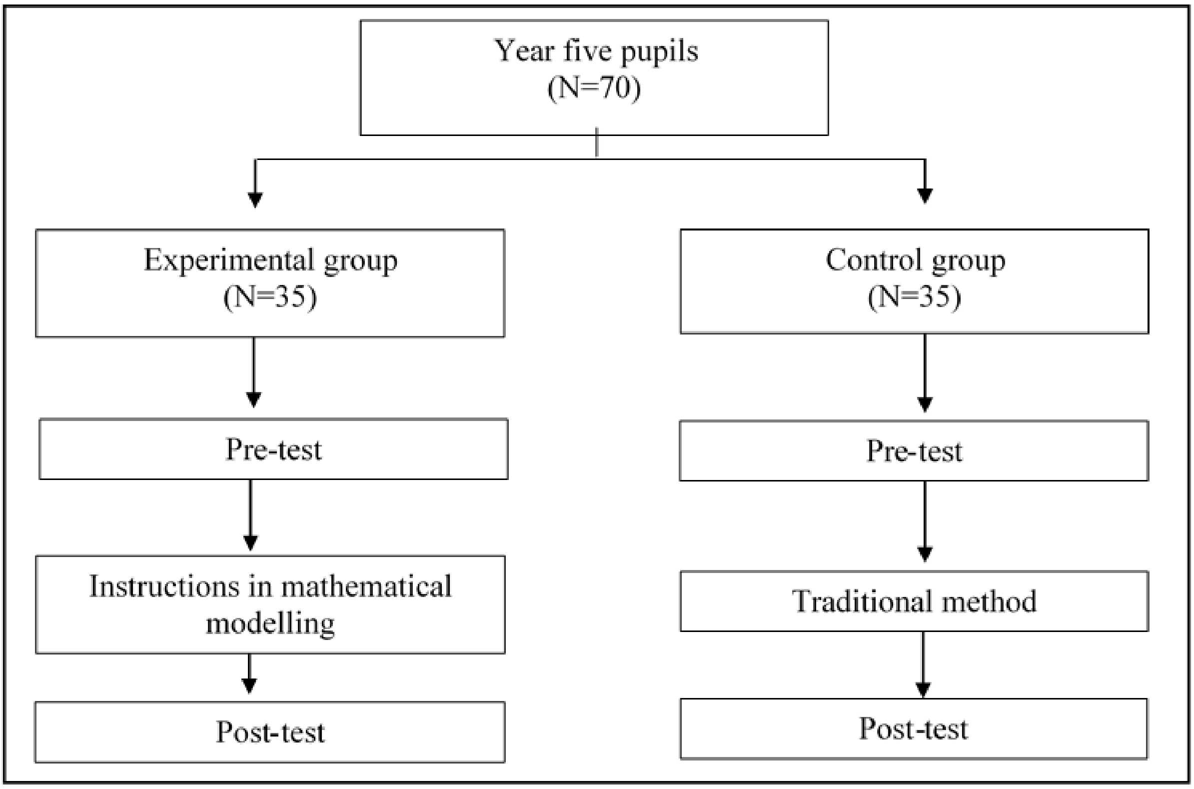

Figure 2. Flow environment during the assessment

Data Analysis

After gathering all the data, inferential statistics were used to answer the research questions. Inferential statistics details the connection between variables, describes the qualities of the sample selected as a result of the characteristics and also whether the sample actually generalized to the population. The significant value of 0.05 was used for this study. For the first research question, paired sample t-test was used to find out if any improvement occurred in the mathematical modelling abilities between the pre-test and post-test of the experimental group. For the second research question, Analysis of Covariance (ANCOVA) was utilized to locate the differences in the post test of the mathematical modelling skill among Year five pupils in experimental group and control group when controlled for pre-test.

Table 3 Data Analysis Method of Each Research Questions

Research Questions	Statistical Analysis
RQ1: Do the Year Five pupils mathematical modelling abilities in experimental group improved significantly after the treatment?	Paired sample *t*-test
RQ2: Is there any significant difference in the post-test scores for the mathematical modelling abilities between Year Five pupils in experimental and control group when controlled for the pre-test?	One-way ANCOVA

Findings

This section includes the findings and interpretations obtained from the statistical analyses performed concerning answers of the pupils in the experimental and control group. Paired sample *t*-test was used in order to analyze research question one and one-way Ancova was used to answer question two. Prior to the testing of any hypotheses related to the research in this study, the assumptions required to run hypotheses tests were met. All hypotheses were evaluated at 5% level of significance.

Results of Analysis for RQ1

Do the Year five pupils mathematical modelling abilities in experimental group improve significantly after the treatment*?*

Paired-samples *t*-test was conducted to evaluate whether there was improvement in Year five pupils mathematical modelling abilities after the treatment. Table 4.1 shows that data had been normally distributed for the experimental group, as assessed by Shapiro Wilk test (p = 0.392). Normality of the data is a requirement for lots of statistical assessments since normal data is an underlying assumption in parametric testing (Laerd, 2016). You will find two primary techniques of assessing normality that is numerically and graphically.

Table 4 Descriptive statistics of control group and experimental group

		PRETESTEX	PRETESTCONT
N	Valid	35	35
	Missing	0	0
M		20.800	21.457
SE		.521	0.414
Med		21.000	22.000
SD		3.085	2.453
Range		11.00	9.00
Sum		728.00	751.00

Table 4.2 shows that the research result is significant $t(34) = -8.685$, $df = 34$, $p < 0.001$. Based on the result, at 5% level of significance the study rejected the null hypothesis stating there is no improvement in Year five pupils mathematical modelling abilities between the pre-test and post-test of the experimental group. Thus, the data provide sufficient evidence to conclude that Year five pupils' mathematical modelling abilities in experimental group improved significantly after the treatment.

Table 5 Paired Samples Test

					95% CL				
		M	*SD*	*SE*	*LL*	*UL*	*T*	*Df*	*P*
Pair 1	PRETESTEX – POSTTESTEX	-3.000	2.044	.345	-3.702	-2.298	-8.685	34	.000

Table 4.3 shows effect size for paired sample *t*-test. There is significant mean increase, 95% CI [0.983,1.943], $t(34) = 8.685$, $p < 0.001$, with large effect size $d = 1.468$. Therefore, the data provide sufficient evidence to conclude that there is a significant improvement in Year 5 pupils mathematical modelling abilities between pre-test and post-test of the experimental group.

Table 6 Effect size Paired Samples *t*-Test

	t	*df*	*p*	*Cohen's d*	95% CI for Cohen's d	
					LL	*UL*
POSTTESTEX - PRETESTEX	8.685	34	< .001	1.468	0.983	1.943

Note. Student's *t*-test.

Results of Analysis for RQ2

Is there any significant difference in the post-test of the mathematical modelling ability between Year 5 pupils in experimental and control group when controlling for the pre-test?

To answer research question two, a One-way ANCOVA was conducted to determine whether the mathematical modelling abilities between Year 5 pupils were different between the experimental group and control group when controlling for the pre-test.

Table 4.4 shows that there was homogeneity of regression slopes as the interaction slopes as the interaction term was not statistically significant, $F(1,66) = 0.001$, $p = 0.973$

Table 7 Test of Homogeneity of Regression slope

Dependent Variable: POSTTEST

Source	*Type III SS*	*df*	*MS*	*F*	*P*
Corrected Model	434.388[a]	3	144.796	43.547	.000
Intercept	28.325	1	28.325	8.518	.005
GROUPS	1.751	1	1.751	.527	.471
PRETEST	355.596	1	355.596	106.943	.000
GROUPS * PRETEST	.004	1	.004	.001	.973
Error	219.455	66	3.325		
Total	37271.000	70			
Corrected Total	653.843	69			

The Tests of Between-Subjects Effects analysis presented in Table 4.5 has adjustment for pre-test scores; there was a statistically significant difference in the mean of the post-test score between the two groups, $F(1,67) = 30.595$, $p < 0.05$, partial $\eta^2 = 0.313$. The effect size suggests that about 31.3% of the variance in post-test scores can be accounted for by the pre-test and post-test of the experimental group. Therefore, the null hypothesis stating the mathematical modelling abilities of the pre-test and post-test scores of Year five pupils in Experimental Group are not different is rejected at significance level of 0.05.

Table 8 Tests of Between-Subjects Effects

Dependent Variable: POSTTEST

Source	*Type III SS*	*Df*	*MS*	*F*	*P*	*Partial Eta Squared*
Corrected Model	434.384[a]	2	217.192	66.308	.000	.664
Intercept	30.188	1	30.188	9.216	.003	.121
PRETEST	374.027	1	374.027	114.189	.000	.630
GROUPS	100.215	1	100.215	30.595	.000	.313
Error	219.459	67	3.276			
Total	37271.000	70				
Corrected Total	653.843	69				

Discussion of the Findings

In this section, the discussion of the results in chapter four is presented. The discussion is divided into two parts based on the objectives of the study. The first part discusses the effectiveness of the Blum's Phase Based instructions on Year five pupils mathematical modelling ability. The second section determine the differences in the four phases of mathematical modelling abilities between Year five pupils in experimental group and control group when controlled for pre-test.

Effectiveness of the Blum's Phase Based instructions on Year five pupils mathematical modelling abilities.

Review of literature has shown that students with no prior knowledge of mathematical modelling manage to solve modelling tasks given to them using diversity approaches (English, 2010). Mathematical modelling is everywhere around us as well as its usually in connection with effective technological resources. Mathematical modelling is actually designed to assist pupils comprehend the world, build different mathematical competencies as well as correct attitudes, contribute to an ample image of mathematics as well as assistance mathematics learning in the type of inspiration, concept formation, comprehension and retaining. Thus, it's essential to impose with mathematical modelling duties starting from preschool. Mathematical modelling helps pupils in using mathematics in the everyday life of theirs and the professional life of theirs, help pupils in understanding the world of theirs when they've in order to cope with new circumstances as well as to assist pupils acquire better attitude towards mathematics (Niss, 2007).

This result is in line with findings from other scientific studies that have found healthy consequences of choosing guidelines on self-regulation and methods (Azevedo and Hadwin, 2005). Pupils were guided how to answer questions based on the four stages specifically Understanding the Task, Establishing Model, Using Mathematics and Explaining the Results. The steps also taught them to practice their mind to go along with the guided questions even when the worksheets weren't used.

The results showed that there was significant difference in the post test of the mathematical modelling ability among Year five pupils in experimental group as well as control group when controlled for the pre-test. The results corroborated with a study done by Stevens, Adler, Gray, Briggs, & Holman (2000), in which mathematical modelling is efficacious at supporting the pupils to discover mathematics as beginning of production in their lives outside school and in developing an appropriate surrounding for the improvement of their mathematical abilities. In this question, pre-test was controlled to make an effective assessment of the difference between the post-test in experimental group as well as control group. This study proves that novice modellers are able to finish the modelling task at various levels.

Difference in the four phases of modelling abilities between Year five pupils in experimental and control group when controlled for the pre-test.

The results revealed that a significant difference existed in the mean of post-test score between understanding the task, using mathematics and explaining results in the experimental group and control group. This might be because students are familiar with these three schemas because they are similar to George Polya's problem solving steps, namely understanding the task, carry out plan, check and interpret. Till today, Polya's problem solving step is used by students in solving problem solving questions. Additionally, substantial discussion of methods and the continuing presence of the approach as a helpful scaffold for solving the activities have definitely stimulated the pupils to comprehend the approach into the solution process for their modelling activities. This outcome supports the finding of various other studies which revealed that it is feasible to enhance students' approach use in relatively short period of time (Heinze et al., 2009).

There was no significant difference in the mean of post-test scores for establishing model in the experimental group and control group. This could be because in Establishing the model, pupils are supposed to look at the information given in the task and make assumptions if necessary. Then they will look for mathematical relations by means of geometrical formula or an equation. Results of the post-test scores align with Verschaffel, Greer, and DeCorte (2000) that this particular method is an example of well-known superficial approach where pupils disregard the context, extract all of the numbers from the text and compute based on their usual schema which they use in the daily classroom for fixing problems. Establishing the Model plays an important role in answering the task. Once the model is developed, pupils will be able to solve the third and fourth Phase Based Instructions.

Implication of the study

This study has important implications for improving students' mathematical modelling abilities. The outcome of the study indicated that the experimental group performed much better in the post test compared to the pre-test. Meanwhile, the students in the control group showed a slight improvement after being taught without intervention. The outcome of this particular study showed pupils from the experimental group outperformed the control group for each construct, specifically in understanding the task, establishing the model, using mathematics and explaining the results. These findings show that the teaching approach provide positive outcome to the students as well as the teachers. By implementing Modelling Eliciting Activities, students are taught on how to use the Blum Phase Based Instructions in solving the tasks. This finding will be useful in helping educators on how to use mathematical modelling tasks in highlighting mathematical frameworks as well as to interact with pupils in representing and evaluating ideas of their own.

This study is essential because Mathematical Modelling is actually the bridge to STEM education. Nowadays, technology-based resources have been widely used in numerous professions such as science, arts, engineering and business, and even in agriculture (Doerr & Lesh, 2003). Many emerging occupations require competency, to some degree, in STEM and countries gradually fell inadequacy of the current education in STEM parts (Roehrig, Moore, Park, & Wang, 2012). Inside conceptualization of STEM education, the most substantial idea is actually the integration of different disciplines during the instruction process (Corlu et al., 2014). In the model supplied by Corlu et al. (2014), mathematics and science training are given a main role whereby engineering and technology components of STEM education are restricted to supportive roles. In short, Mathematical Modelling provides pupils with substantial localized conceptual innovations and deep learning of fundamental mathematical ideas in authentic scenarios.

The result of this study shows the effect of Blum Phase Based instructions on the mathematical modelling abilities among year 5 pupils depends on well planned lessons according to the pupils' abilities.

Recommendation for Further Research

In view of the findings of this study and the implications, we need to carry out further research in introducing modelling in future and for a clearer and more accurate picture about mathematical modelling using Blum Phase Based Instructions. Many further studies could be conducted as a follow up to further investigate the effectiveness of Blum Phase Based Instructions and their interactions with gender factor on Year five pupils' mathematical modelling ability.

Teacher's understanding and concerns about mathematical modelling would be an ideal longitudinal study. It would be great to follow the teachers through the first year of implementation in order to understand whether and how their concerns are addressed, their understanding is increased, and their implementation begins. It would be interesting to note how teacher's willingness to change practice is affected by professional development and implementation in the classroom. As more teachers actually implement mathematical modelling in their classrooms, it will be of interest to see how their concerns change, and if they remain optimistic about the reform.

This study's experimental design could also be leveraged. Future researches could conduct studies that adapt the study design by incorporating different modelling activities that emphasizes other aspects of the modelling process. The study can focus on measuring the impact of modelling activities on students' attainment of different mathematical learning outcomes or measuring the impact of modelling abilities on different mathematical attitudes or beliefs.

CONCLUSION

Based on the results of this study and the comprehensive discussion, major findings emerged from the study. The variable for this study was instructions in mathematical modelling. The students' overall mathematical modelling ability in experimental group improved significantly. Students' mathematical modelling abilities improved, where they became better in identifying the keywords, drawing sketches and explaining mathematical solutions. From the theoretical element, the findings of this particular study are actually in congruence with Oswalt (2012). This implies that modelling undertaking in any mathematically rich issue which engages pupils in mathematical thinking, drawing upon earlier discovered understanding and supporting the understanding of their mathematical ideas presently being covered. In addition, the outcome of this particular study is in accordance with Stevens, Adler, Gray, Briggs, and Holman (2000), in which mathematical modelling is effective at supporting the pupils to discover mathematics as a source of production in their lives outside school and in developing a suitable environment for improving mathematical ability.

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