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Predictors of Students' Competence in Applying Mathematics in Real World Problems

Melanie G. Gurat[1] and Rommel S. de Gracia[2]

[1]Mathematics Department and University Research Center, Saint Mary's University, Nueva Vizcaya, Philippines

[2]Schools Division of Nueva Vizcaya, Philippines

Corresponding author: Melanie G. Gurat, Mathematics Department and University Research Center, Saint Mary's University, Nueva Vizcaya, Philippines

Abstract. Today's societies place challenging demands on individuals, who are confronted with complexity in many aspects of their lives. Individuals need to acquire a wide range of competencies in order to overcome the complex challenges of today's world. Using real-world problems is important not only to hone students' mathematical thinking and competency but also to prepare them in making well-grounded decisions that involve logical and mathematical reasoning. Thus, this study explored the competence of the students in applying mathematics in real world problems and determined the predictors using the selected profile variables. Regression analysis was used to identify if there are predictors that determine the results of the assessment. The main tool of the study was the Programme for International Student Assessment (PISA) test in mathematics. Findings revealed that the predictors include confidence level, repeated kinder, mother work status and highest level of education to complete. This study could be a guide for determining the strengths and weaknesses of students in applying mathematics in the real world as framework in helping them handle the rigors of connecting math with their lives.

Keywords: mathematics, curriculum, competencies, performance, real-world problem and predictors.

1. INTRODUCTION

Today's societies place challenging demands on individuals, who are confronted with complexity in many parts of their lives. Consequently, what do these demands imply for key competencies that individuals need to acquire? The answer is very plain and simple. Individuals need to acquire a wide range of competencies in order to face the complex challenges of today's world. It is for this reason why a radical shift of literacy towards norms and standards relating to education's application to real life problems and lifelong learning or workforce knowledge is inevitable.

It is important to use real-world problems to improve students' mathematical thinking and literacy. This is also to prepare student to make well-grounded decisions that involve logical and mathematical reasoning (Bokar, 2013).

On the other hand, students struggle to connect mathematics and their lives. It is the job of math educators to explain and show that math is useful. More importantly, to teach the students to apply math to real-life problems.

Furthermore, the importance of real-world problem solving has been increasingly recognized at the global standard that is, students need to be able to use mathematical discourse effectively and must gain experiences in real-world problem solving during high school, in order to be prepared for the increasing frequency and complexity of quantitative data (Organisation for Economic Development [OECD], 2006).The National Council for Teachers of Mathematics (NCTM) has also pointed out on the importance of real-world problem solving. Thus, explaining importance of mathematics in the real-world: mathematics for life, mathematics as a part of culture, mathematics for the scientific and technical community, and mathematics for the workplace (National Council for Teachers of Mathematics [NCTM], 2000). This means that in focusing on applying mathematics to real-world problems, students will be prepared for their immediate and future lives.

Real-world problem-solving is emphasized in international, national, and state standards. The Organization for Economic Development (OECD) gives the Programme for International Student Assessment (PISA), which is an international assessment. In the mathematics portion of the assessment, the PISA emphasizes real-world problem-solving. Across the world, curriculums focus on real-life problem-solving, so that their students are competitive internationally. *A Framework for PISA 2006* explained that students be presented with real-world problems instead of problems to simply practice skills (OECD, 2006). This suggests that teachers try to place mathematical problems in real-world contexts, in which the students can also enhance their mathematical skills. Moreover, students should be able to communicate and justify their solutions to the real-world problems (OECD, 2006).

Since real-world problem-solving is a part of international, national, and state assessments and standards, mathematics curriculums should incorporate real-world problem solving. A guide on determining strengths and weaknesses on students in applying mathematics real world problems is to find relationship of their competence to their profile variables.

The Present Study

Since the assessment of PISA project was in the year 2000, not many researchers have conducted any research study about PISA. The studies assessed the competence in subjects like science and mathematics. The study assessed the performance of students, relate it with the student and school variables to find out what needs to be improved. Anagnostopoulou, Hatzinikita, and Christidou, (2010) compared the science competencies that students need to demonstrate during school examinations on the one hand and when they participate in PISA on the other. The fact that students have to demonstrate unfamiliar competencies during their participation in PISA could be a factor –among others– that explains the low performance of Greek students in the PISA

study. Martini and Ricci (2010) describes the outcomes of a two-level regression analysis of the PISA 2006 science test scores in the province of Bolzano (Alto-Adige) and identified which of variables were associated with better performances at student and school level. Ciascai (2009) conducted comparative analysis of Science curriculum TIMSS 2007 and Romanian Science school curricula of 4th and 8th grades. This analysis, based on Bloom's taxonomy of cognitive domain, identifies both the common points of these curricula and the system of competencies necessary to be developed for Romanian students in order to increase their results in international testings.

The mathematical performance of the students is an essential factor in the field of mathematics education, because the mathematics performance symbolizes the success in the mathematics education. The performance of the students in mathematics is the main focus in the research. Many researchers have studied the factors affecting the performance of the students in mathematics for a long time. The aim of the studies in this field is to investigate these factors in order to increase the students' performances in mathematics. On the basis of the findings of these studies, the educators can make the appropriate modifications in mathematics education.

Kamaliyah, Zulkardi, Darmawijoyo (2013) produce valid and practical the sixth level of PISA-like mathematics problems for Indonesian middle school students. The result revealed that the sixth level of PISA-like mathematics problems. Edo, Hartono and Putri, (2013) investigated secondary school students' difficulties in modeling problems PISA-model level 5 and 6. The result showed that students find it difficult to formulate situations mathematically and evaluate the reasonableness of a mathematical solution in the context of a real-world problem. In contrary, the students have no problem in solving mathematical problem they have constructed. Yalcin, Aslan and Usta (June 2012) examined maths, reading and science skills of the students at the age group 15 according to some variables in the scope of the Programme for International Student Assessment (PISA) 2009. It was found out that there is a significant difference

in students' maths, reading and science skills with regard to their having quality time at home with their parents. It was also found out that parents' education level and socio-economic status have a significant difference in the students' maths, reading and science skills. Stacey (2011) describes the design of the PISA assessments, discusses mathematical literacy and reports on a selection of results from the PISA assessments, associated surveys and related analyses to give a flavour of the information that has resulted from this major international initiative. Results for Indonesia are compared with the OECD average and with a selection of countries, addressing issues of overall achievement, equity, and classroom environment. Yildirim (2010) investigated the relationships among self-efficacy, intrinsic motivation and anxiety across Turkey, Japan and Finland to predict the PISA 2003 mathematics performance. In three of the countries, self-efficacy positively predicted mathematics achievement and this effect was relatively higher in Finland and mediating roles of intrinsic motivation and anxiety between self-efficacy and mathematics achievement were quite small. Görömbei (2009) explored the factors influencing the exam results such as previous knowledge, thinking ability or defectiveness of the special mathematics skills. He found out that most of the students from higher education have weak fundamental knowledge. In order to improve the results of the exams the individual improvement of those students who perform badly in the given fields is required.

Studies on comparing the international assessment were also conducted which also aims to assess the performance of students in mathematics. Kosko and Wilkins (2011) examined whether open-ended items typically measured aspects of quantitative communication, as compared to mathematical communication, or mathematical skills in TIMSS, NALS, IALS, and PISA. The study revealed that open-ended item rubrics in these QL assessments showed a strong tendency to assess answer only responses. Therefore, while some open-ended items may have required certain levels of

quantitative reasoning to find a solution, it is the solution rather than the reasoning that was often assessed. Marchis (2009) found out that the results of the Romanian pupils on international tests PISA and TIMSS in Mathematics are below the average in his comparative analysis of Mathematics Problems.

Competence of Students in Applying Mathematics in World in the Philippines

The mathematics competency in the Philippines can be reflected in the low achievement score of Filipino students. Philippines ranked 23 out of 25 countries in both math and science assessments in 2003 Trends in International Mathematics and Science Study (TIMMS) result. The scores of eighth graders for math placed the country in thirty-fourth place out of 38 countries and for science, forty-third out of 46 countries. This indicates that Philippines have poor quality of basic education. Thus, this shows that it is critical and urgent to enhance the quality of basic education in the Philippines.

Aside from the TIMSS results, and the results of National Achievement Test (NAT) also revealed the students' poor performance in core subjects such as English, Filipino, science, social studies and mathematics,. The NAT passing rate for grade 6 in SY 2009– 2010 was only 69.21%, around 5% lower than the standard passing rate of 75%. That same year, secondary school NAT participants correctly answered only 50% of the questions in the mathematics and science sections of the test. The secondary school NAT score in SY 2009–2010 was 46.38%, which slightly decreased from 47.4% in SY 2008–2009.

To address the concern on low performance of students not only in mathematics but in all other subject, Orgena, Laña and Sasota (2008) conducted study to assess the performance of Filipino students of Science High Schools (SHS) that participated in the 2008 TIMSS-Advanced, an international study conducted by the International Association for the Evaluation of Educational Achievement (IEA).This is to determine

possible areas where improvements in the teaching of science and mathematics in SHS could be initiated.

The Department of education in collaboration with Southeast Asian Ministers of Education Organization conducted comparative studies. Base from the result revealed that there is a need of change in the Philippine education system. One of the reasons presented was the poor quality education in national and international assessment. The Philippine education system shifted from 10 years of combined elementary and secondary education basic education to 12 year basic education prior to entering a college or a university in the Philippines.

Joining in benchmarking activities is important to be known as highly competitive in the world of education with deep economic implication. It can also acclaim itself to a democratic debate that is international in nature. It could also assert national administrations to directly deal with the country's educational concern, if administrations will be true to their promise of making the Philippines economically progressive.

Objective of the Study

The study aimed to determine the predictors of students' competence in applying mathematics in real-world problems of senior secondary high school students in Nueva Vizcaya.

Definition of Terms

Competence – skills/ capability to apply.

Real world problems - are problems encountered in everyday lives especially problems outside the classroom set up.

2. MATERIAL AND METHODS

Research Method

This study was quantitative type of research that aimed to predict students' competence in mathematics real world problem.

Population, Sample and Sampling Procedure

Selected senior students from the science high schools of recognized Engineering and Science Education Program (ESEP) and Philippine Science high school in Nueva Vizcaya served as the respondents of the study. All students during the conduct of the study were considered the respondents.

Data Gathering Instrument

The PISA Mathematics Test was the main tool to collect pertinent research data. This was composed of PISA released items involving mathematical content, mathematical processes, and situations. The test consists of real world problems of different levels that depend on the skills applied to solve the problem. Below is the table of specification of the different levels included in the test.

Competence level	Item location	Points	Percent
Level 1	A1, A2, B1,F1, O1	5	4.85
Level 2	A3,B21-B24,B3, D1,D2,F2,G1,G2,I21, O2,K,P2,P4	32	31.07
Level 3	C1,D3,F3,I3,J,L	18	17.48
Level 4	E1-E5,H1,H2, M	32	31.07
Level 5	P1, P3	10	9.71
Level 6	G3	6	5.83
TOTAL		103	100

In addition, the PISA Student Questionnaire was used to gather significant profile information from the respondents. The mathematics competency test of the pilot testing was 0.632 and all items were retained. In the current study, the mathematics competency test of the pilot testing has a good internal coefficient, with a Cronbach alpha coefficient of 0.875.

Procedure

The following procedures were followed by the researchers.

1. Necessary communication letters asked permission to conduct the research were forwarded to the right authorities for approval.
2. The questionnaires were administered in the selected science high school as soon as the research study was approved.
3. The data was analyzed.

Treatment of the Data

Means, standard deviations and inter correlations were obtained to describe the competency in applying Mathematics in real world problems and predictors variables

Regression analysis particularly simultaneous multiple regressions analysis was used to identify if there are predictors in profile variables that determine the result in the assessment.

3. RESULT AND DISCUSSION

Predictors of the result of competency in mathematics real world problems

Table 1.1. Means, Standard Deviations and Inter correlations for Competency in Applying Mathematics in Real World Problems and Predictors Variables

	M	SD	1	2	3	4
Competence	48.9	20.38	.46**	-.23**	-.25**	.51**
1	1.8	.70	-	-.18**	-.012	.34**
2	.19	.40	-	-	-.10	.001
3	1.45	.50	-	-	-	-.07
4	.57	.50	-	-	-	-

**significant at 0.05 level (2-tailed); **significant at 0.01 level (2-tailed); 1 confidence level; 2 repeated kinder; 3 mother's work status; 4 highest level expected to complete*

Table 1.1 shows the mean, standard deviation and inters correlations for competence in applying mathematics in real world problems and the predictor variables. The predictor variables includes confidence level in learning mathematics, whether student repeated kinder or not (repeated kinder), mothers' work status and highest level expected to complete. The competence was positively correlated with confidence level (.46**) and highest level expected to complete (.51**). While there was a negative correlation between competence and repeated kinder (-.23**) and mother's work status (-.25**). This indicates that higher the confidence level and having better mother's work status (reversely coded) and higher level expected to complete, the better the level of competence in real world problems. Students who did not repeat kinder have higher level of competence in mathematics real world problems.

Table 1.2 Simultaneous Multiple Regressions Analysis Summary for Confidence Level, Repeated Kinder, Mother's work status and Highest Level Expected to Complete in Predicting the Competence in Applying Mathematics in Real World Problems.

	Unstandardized Coefficients		SC	T	Sig.	Collinearity Statistics	
	B	E				T	VIF
C	44	10		4.4	.000**		
1	8	2.0	.28	4.1	.000**	.710	1.409
2	-10	3.1	-.19	-3	.003**	.905	1.105
3	-9	2.6	-.21	-3	.002**	.809	1.236
4	13	2.9	.32	4.6	.000**	.697	1.434

Note: R^2*=0.474;* $F(13) = 10.826$, $p < .001$

**significant at 0.05 level (2-tailed); **significant at 0.01 level (2-tailed); 1 confidence level; 2 repeated kinder; 3 mother's work status; 4 highest level expected to complete; Constant (C); standard error (E); Standardized Coefficient (SC); Tolerance (T)*

Multiple regressions was conducted to determine the best linear combination of confidence level, repeated kinder, mother's work status and highest level expected to complete for predicting competence in applying mathematics in real world problem. The means, standard deviations, and inter correlations can be found in Table 1.1. This combination of variables significantly predicted competency in applying mathematics in real world problems, $F(13) = 10.826$, $p < .001$, with all four variables significantly contributing to the prediction. The beta weights, presented in Table 1.2, suggest that high competency in applying mathematics in real world problem good grades in high school contribute most to predicting competence in applying math, having high math confidence, having not repeated kinder, and having parents who are more highly educated also contribute to this prediction. The adjusted *R* squared value was .43. This indicates that 43% of the variance in math achievement was explained by the model. According to Cohen (1988), this is a large effect.

4. CONCLUSION

Findings revealed that the predictors of the competence in mathematics include confidence level, repeated kinder, mother work status and highest level of education to complete.

This study could be a guide for determining the strengths and weaknesses of students in applying mathematics in the real world problems.

5. RECOMMENDATIONS

Based from the findings of the study, the following are recommended:

- Teachers to give extra effort to those students with not so good level of competence in applying mathematics in real world problems through considering the predictors identified in the study.
- To conduct further study through exploring the students' competence in real world problems in structural equation model approach and investigate the competence in mathematics real world problem by exploring the competence per level.

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