The Influence of vocabulary mastery and reading comprehension towards performance of students in mathematics

V Virgana\textsuperscript{1,*} and M Lapasau\textsuperscript{2}

\textsuperscript{1} Departement MIPA, Universitas Indraprasta PGRI Jakarta, Indonesia
\textsuperscript{2} Departement English Education, Universitas Indraprasta PGRI Jakarta, Indonesia

* virganaunindra@gmail.com

Abstract. This study aims to find out about the influence of the vocabulary mastery and reading comprehension towards students' mathematical performance in PISA, either directly or indirectly. This research uses survey method with a quantitative approach and path analysis as a research design. The respondents are 70 students of Junior High School in Jakarta. Data collection is done through research instrument in the form of tasks about vocabulary and reading comprehension, while the mathematical questions about Space and Shape are taken from PISA 2015. The results of the analysis shows that there are: direct influence of vocabulary mastery towards students’ performance in mastering mathematical problems in PISA; direct influence of reading comprehension towards students’ performance in mastering mathematical problems in PISA; direct influence of vocabulary mastery towards reading comprehension; direct influence of vocabulary mastery towards students’ performance in mastering PISA’s mathematical problems through reading comprehension. It can be concluded that in order to enhance student’s mathematical competence in PISA, we also have to improve their competence in vocabulary mastery and reading comprehension through improvement of teacher’s competence and infrastructures at school such as language laboratory. We hope that this study can be beneficial for further research to improve mathematical competences of the students.

1. Introduction

English as lingua franca today is the most spoken language in the world and it plays an important role in international affairs, diplomacy, international law, the media, business and in tertiary education as well as in scientific research. Some of the constraints in mastering English for students in Indonesia who learn English mostly as a second language are the limited English-speaking environment, the lack of interest of students in learning English, and insufficient competence of teachers in teaching English.

Program for International Student Assessment (PISA) is a test of international academic activities devoted for children aged 15 years. PISA activities evaluate student’s performances in the field of reading, mathematics, and natural science. Those activities are held fully in English. For Indonesian students, who learn English as second language or even as a foreign language it is a very challenging task to solve mathematical problems in English. Word knowledge is crucial for reading comprehension and to determine how well students will be able to comprehend the texts they read in middle and high school level [1]. With sufficient vocabulary knowledge, learners will be able to get
access to knowledge, express ideas, communicate, and learn new concepts [2]. Reading habit and the use of English in the environment can also affect the test results, such as the results of research conducted by [3]. According to them, impact of the test language being spoken at home is significant to student’s performance in three educational systems (Chinese Taipei, Hongkong, Singapore).

1.1 Vocabulary mastery.
One of the weaknesses to study of English is the lack of vocabulary especially for students who learn English as a second language. Vocabulary knowledge is often viewed as a critical tool for second language learners because a limited vocabulary in a second language impedes successful communication and under scoring the importance of vocabulary acquisition [2].

1.2 Reading comprehension.
Some researchers have done the related studies about the importance of mastering English and reading skill in order to achieve better results in mathematics. They find among other things that there is a significant relationship between the ability of reading comprehension with the ability to understand task given in mathematics [4,5].

1.3 Students’ performances on the results of mathematical problems in PISA.
Mathematics has a language of its own style which can condense a long sentence, namely with the symbols of universal. Mathematics has its own language and symbols which cut short the lengthy statements [6]. This research uses mathematical problems in PISA about space and shape, covering the phenomenon related to the visual world (real world) that involve patterns, the nature of the object, it’s position and orientation, a representation of the object, the coding of visual information, navigation, and dynamical interactions related to the real form. This category exceeds the content aspects of geometry in mathematics in the curriculum in Indonesian school. While the content of the material problems of mathematics in PISA grouped into four parts, namely, Change and Relationship, Space and Shape, Quantity, and Uncertainty and Data [7]. In 2015 Indonesia gains score 386 with mean OECD score 490 and in 2013 with score 375 with the mean OECD score 494. Equally important, those students who had reached Grade 10 by the age of 15 were significantly ahead [8].

2. Methods
This study uses a quantitative approach by using survey method with causal techniques, descriptive statistics include the size of the centrality and the size of the spread. Data is analyzed through path analysis. The study analyzes the influence of one variable towards another variable, namely variable mastery of vocabulary ($X_1$); reading comprehension ($X_2$); and the students’ performances on the results of mathematical problems in PISA ($X_3$). Structural path analysis model in Figure 1, is as follows:

![Figure 1. Influence of structural model of variables.](image)

2.1 Hypothesis
Hypothesis: there is a significantly direct influence of vocabulary mastery towards performance of students in mastering mathematical problem in PISA; significantly direct influence of reading comprehension towards performance of students in mastering mathematical problem in PISA;
significantly direct influence of vocabulary mastery towards reading comprehension; significantly indirect influence of vocabulary mastery towards performance of students in mastering mathematical problem in PISA through reading comprehension.

2.2. Sample research
Sample research of this study are 70 students from 7 State Junior High Schools in South Jakarta who are selected as the best 10 students from their results of learning mathematics at their respective schools. The research is carried out on the even semester of academic year 2017/2018 in September 2017 until January 2018.

2.3. Research instruments
Variable data collection techniques for research instruments of mastery of vocabulary and reading comprehension is carried out by using objective test, while for students' performances on the results of mathematical problems in PISA we use mathematical problems of PISA 2015 with the material “Space and Shape”. The materials are taken into the research because they correspond to the existing school curriculum in Indonesia. Testing instruments include test validity and test reliability, and the respondents were taken out of research sample. The results of the test details of the instruments are obtained that are valid ($r_{count} > r_{table}$), and invalid ($r_{count} < r_{table}$).

3. Results and discussion
Normality test results using SPSS 20 mastery of vocabulary is of 0.685 which means that the value of 0.05 means $>$. GIS data is Gaussian (0.685 > 0.05). Normality of reading comprehension is of a 0.726, it means that the value of 0.05 means $>$. GIS data is Gaussian (0.726 > 0.05), normality and test students' performances on the results of mathematical problems in PISA is of 0.66 which means that the value of the sig. data, i.e. 0.05 $>$ Gaussian normal (0.66 > 0.05). The results of the test linearity mastery of vocabulary towards the students' performances on the results of mathematical problems in PISA with the value of the Deviation from Linearity = 0.967 for all samples over 0.05 (sig. > 0.05), so the line of regression the relationship between variables (X1) and variable is linear, then test results linearity reading comprehension towards the students' performances on the results of mathematical problems in PISA with the value of the deviation from linearity = 0.837 for all sample more than 0.05 (sig. > 0.05), so the line of regression relationships between variables (X2) and variable (X3) is linear. Linearity test results and mastery of vocabulary towards reading comprehension (X2) with the value of the deviation from linearity = 0.086 for all samples over 0.05 (sig. >0.05), so the line of regression relationships between variables and variable is linear. Testing Multicollinearity, based on the test results obtained value Tolerance 0.855 still under value of 1 and Variance Inflation Factor (VIF) is 1.170 approaching to value of 1. Then we can infer that the variable mastery of vocabulary and reading comprehension variables has no colinierity or multicolinearity, so that we can use the regression analysis in this study. There are several steps in the determination and testing path coefficient analysis and correlation coefficient that include: intervariabel in the structural model; determination and significance of coefficients test line on each substructure contained within the structural model table 1.

| Relationships Between Variables | The Correlation coefficient | Path coefficient |
|---------------------------------|-----------------------------|-----------------|
| Mastery of vocabulary and students' performances on the results of mathematical problems in PISA | $r_{13} = 0.591$ | sig. = 0.003 | $p_{21} = 0.300$ |
| Reading comprehension and students' performances on the results of mathematical problems in PISA | $r_{32} = 0.748$ | sig. = 0.000 | $p_{32} = 0.603$ |
| Mastery of vocabulary and reading comprehension | $r_{12} = 0.483$ | sig. = 0.001 | $p_{21} = 0.483$ |
The correlation coefficient between variable in the table above all > 0.05, then all this research on the correlation values were all significant. The results of calculating the coefficient used to test the hypothesis posed and measuring influence either directly or indirectly against exogenous variables are endogenous variables in the structural model, the withdrawal of the conclusion of the hypothesis is done through the calculation of statistical values t each path coefficient, and if \( t_{\text{count}} > t_{\text{table}} \) then the path coefficient is significant, but if \( t_{\text{count}} < t_{\text{table}} \) then the coefficient line is insignificant. All of the coefficient variable of path analysis on this research are \( t_{\text{count}} > t_{\text{table}} \), thus all path coefficient in this research line are all significant. Based on the calculation of the correlation coefficient is obtained according to the number of significant > 0.05. This proves that the path diagram drawn up can be accepted, and shows that there are a direct influence of the vocabulary mastery towards performance of students in mathematics in PISA, a direct influence of the vocabulary mastery towards reading comprehension; a direct influence of reading comprehension towards performance of students in mathematics in PISA and an indirect influence of the vocabulary mastery towards performance of students in mathematics in PISA through reading comprehension. We can interpret the results of the analysis of the above data as follows:

3.1. Hypothesis testing direct influence of vocabulary mastery towards performance of students in mastering mathematical problem in PISA

There is a significant direct influences of vocabulary mastery towards students' performances as the results of mathematical problems in PISA. Based on path analysis, it is obtained that the coefficient of the variable line mastery of vocabulary towards students' answers on the results of mathematical problems in PISA, \( p_{31} = 3.530 \) for \( \alpha = 0.05 \) and \( dk = n-k-1 = 70-1-1 = 68 \) on test two parties obtained value table \( t = 1.980 \). Because the value of \( t_{\text{count}} > t_{\text{table}} \) (3,530 > 1,980), then the H1 is accepted and it can be concluded as: there is a significant direct influences of vocabulary mastery towards students' performances on the results of mathematical problems in PISA. Research findings indicate that students' performances on the results of mathematical problems in PISA can be measured by mastery of vocabulary, it also shows a significant correlation and has a strong influence (higher than 0.05) towards students’ mastery of mathematical concept. The dimension of the direct influence of the emotional intelligence towards the mastery of mathematical concepts is \( KD = p_{31}^2 \times 100\% = 0.300 \times 0.300 \times 100\% = 9\%, 91\% \) and the rest is influenced by other factors outside the mastery of vocabulary. Related research states that the conceptual approach to mathematical vocabulary with research-based literacy strategies is a worthwhile path to explore and one that can improve students' mathematics learning [6]. Academic vocabulary knowledge significantly predicate four grades in primary school [9].

3.2. Hypothesis testing direct influence of reading comprehension towards performance of students in mastering mathematical problem in PISA

There is significant direct influence of reading comprehension towards the students' performances on the results of mathematical problems in PISA. Based on path analysis, it is noted that the coefficient of the variable line reading comprehension towards the students' performances on the results of mathematical problems in PISA, where \( p_{32} = 0.603 \) and retrieved the value \( t_{\text{count}} = to = 7.093 \) as well as Sig. 0.000, while for \( \alpha = 0.05 \) and \( dk = n-k-1 = 68-2-1 = 65 \) on test two parties obtained a value of \( t_{\text{table}} = 1.980 \). Because the value of \( t_{\text{count}} > t_{\text{table}} \) (7,093 > 1,980) and Sig. 0.000 < 0.05 (Sig. 0.000 is less than 0.05), then the H1 is accepted (Ho declined) and to summ up: there is a significant direct influence on reading comprehension towards the students' performances on the results of mathematical problems in PISA. This is shown by the numbers of the correlation coefficient of 0.748 and GIS analysis on the correlation of 0.05 <. There is a significant direct influence on reading comprehension towards the students' performances on the results of mathematical problems in PISA. This is shown by the line coefficient value of 0.603 (higher than 0.05).

The influence of reading comprehension towards the students' performances on the results of mathematical problems in PISA: \( p_{23}^2 \times 100\% = 0, 603 \times 0, 603x 100\% = 36.4\% \), while the rest of
63.6% are influenced by other factors outside reading comprehension. The results of a previous related research by Sedita [1] indicate that students who are successful on reading also show great success on math & science. Based on the applicable criteria, the value of r as high as 0.726 shows a correlation between reading comprehension skills with the ability to understand language in decoding task given is classified strong (0.60-0.799) [5].

3.3. Hypothesis testing direct influence of vocabulary mastery towards reading comprehension

There is a significant direct influence of vocabulary mastery towards reading comprehension. Based on path analysis, it is noted that the coefficient of the variable line mastery of vocabulary towards reading comprehension, $p_{21} = 0.483$ and retrieved the value $t_{count} = 4.545$ as well as Sig. 0.001, which for $\alpha = 0.05$ and $dk = n-k-1=68-2-1= 65$ in a test of two parties obtained values of $t_{table} = 2.000$, because the value of $t_{count} = t_{table} = 4.545 > 1.980$ and Sig. 0.001 < 0.05 (Sig. 0.05 less than 0.001), the H1 is accepted (Ho declined) and summed up: there is a significant direct influence of mastery of vocabulary towards reading comprehension. The big influence of vocabulary mastery towards reading comprehension is: $KD = P_{12}^2x 100\% = 0.483x 0.483x100\% = 23.33\%$, while the rest of 76.67% is affected by other factors outside vocabulary mastery. The results of previous research state  that there is a significant correlation between vocabulary and reading comprehension [10]. Vocabulary strategies from the field of literacy are effective ways to help students assimilate the unique concepts and terms that they will encounter in mathematics [11].

3.4. Hypothesis testing indirect influence of vocabulary mastery towards performance of students in mastering mathematical problem in PISA through reading comprehension

There is a significant indirect influence of vocabulary mastery towards students' performances on the results of mathematical problems in PISA through reading comprehension. Based on path analysis, we note that the coefficient of the variable path knowledge mastery of vocabulary towards students' performances on the results of solving mathematical problems in PISA through reading comprehension is $p_{123} = p_{21} x p_{32} = 0.483 x 0.603 = 0.29$. When compared to the value of $p_{31}$ then the value of $p_{123} = 0.29 < p_{31} = 0.300$. We can interpret that the intervening variables are no more effective than direct influence without going through the intervening variable. From the raw data and calculations with the help of SPSS and Excel is retrieved: $t_{count} = \frac{p_{321}}{sg} = \frac{0.29}{0.112} = 2.59$. For $\alpha = 0.05$, and $dk = n-k-1 = 67$ on test of two parties value table $t = 1.980$ is obtained. Because the value of $t_{count} > t_{table} (2.59 > 1.980)$ then H1 can be accepted and we can conclude that there is a significant indirect influence of mastery of vocabulary towards students' performances on the results of mathematical problems in PISA through reading comprehension. It can be seen from the dimension of the influence of indirect i.e. $P_{12}xP_{23}x100\% = 0.483x 0.603x 100\% = 29.12\%$, while the rest of 70.88% is affected by other factors. We can assume that it will be more effective to improve students' performances on the results of mathematical problems in PISA if we increase their mastery of vocabulary first, which is in the end impacts to increase reading comprehension. The teacher should prepare and find out the appropriate techniques, which will be implemented for teaching purposes [12], and it is also important that critical (encouraging students to read critically and be able to differentiate facts from opinions) literacy plays a positive role in helping students to read beyond the text [13]. Based on the results of analysis and statistical tests towards the proposed hypothesis, the test results for each hypothesis can be summarized as pictured in table 2.
In conclusion, we can conclude that in improving students’ performances on the results of mathematical problems in PISA, it would be more effective if done with increased mastery vocabulary in advance. Students' performances on the results of mathematical problems in PISA are affected by variations level of variable mastery of vocabulary and reading comprehension both directly and indirectly. The findings also indicate that policy makers, teachers, and parents should consider an improved collaborated English and mathematic lesson in designing the policies and curricula needed in educational system in Indonesia. Last but not least, the writers would like to express deepest gratefulness to God Almighty and say many thanks for the help from all parties in writing this article.

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