IDEAS FOR 21ST CENTURY EDUCATION





Ideas for 21st Century Education

Editors

Ade Gafar Abdullah, Ida Hamidah, Siti Aisyah, Ari Arifin Danuwijaya, Galuh Yuliani & Heli S.H. Munawaroh Universitas Pendidikan Indonesia, Bandung, Indonesia





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Preface

Invited speakers, Distinguished Guests, Presenters, Participants, and Authors of Asian Education Symposium.

It is such an honor to have had you at the Asian Education Symposium (AES) 2016, organized by the School of Postgraduate Universitas Pendidikan Indonesia. The AES 2016 is an international refereed conference dedicated to the advancement of theories and practices in education. The AES 2016 promotes collaborative excellence between academicians and professionals in education. The conference aimed to develop a strong network of researchers and pioneers in education worldwide. The aim of AES 2016 was to provide an opportunity for academicians and professionals from various educational fields with cross-disciplinary interests to bridge the knowledge gap, promote research esteem and the evolution of pedagogy.

The AES 2016 main theme was Ideas for 21st Century Education. Education plays an important role in countries all over the globe. It will enable countries to achieve sustainable development goals by 2030. As for countries in the Asian region, education is a vehicle that can move people's mobility particularly in a time when we are welcoming the Asian Economic Community. It is without a doubt, there is a need to develop a strong collaboration and partnership among countries, both at regional and international levels. This symposium was one of our attempts to provide space for networking among academics and researchers in education. It is our hope that the symposium would contribute to the development of education as a distinct body of knowledge.

This symposium was a platform for us to disseminate and discuss our research findings. It is our expectation that the conversation from this symposium will inform policy and practices of education. It was also hoped that this symposium will open up future research on education, while at the same allowing all participants to expand their network. It is our hope that during this two-day symposium, all the participants had engaged in fruitful and meaningful discussions.

This AES 2016 proceedings contains papers that have been subjected to a double blind refereeing process. The process was conducted by academic peers with specific expertise in the key scopes and research orientation of the papers. It provides an opportunity for readers to engage with a selection of refereed papers that were presented during the symposium. The scopes of this symposium proceedings are: i) art education, ii) adult education, iii) business education, iv) course management, v) curriculum, research and development, vi) educational foundations, vii) learning/teaching methodologies and assessment, viii) global issues in education and research, ix) pedagogy, x) ubiquitous learning, and xi) other areas of education. We strongly believe that the selected papers published in the symposium proceedings will pay a significant contribution to the spread of knowledge.

We also would like to express our gratitude to all the keynote speakers from overseas who have travelled to our country to deliver and exchange their ideas. Our appreciation also goes to all the committee members who have worked hard to make this event possible. Once again, deepest gratitude for everybody's participation to the symposium as well as the proceedings.

> Ade Gafar Abdullah, Ida Hamidah, Siti Aisyah, Ari Arifin Danuwijaya, Galuh Yuliani & Heli S.H. Munawaroh Universitas Pendidikan Indonesia, Bandung, Indonesia



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Determinate factors of mathematics problem solving ability toward spatial, verbal and mathematical logic intelligence aspects

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ABSTRACT: This research aimed to know and to analyze the direct and indirect effects of three multiple intelligences (spatial, verbal, mathematical-logic intelligences) towards students' mathematical problem solving ability. The subjects were 280 of 9th grade students of SMP Negeri 37 Surabaya. The data were collected by mathematical logic intelligence, problem solving ability, and psychological tests. The psychological test was used to measure psychological constructs of spatial and verbal intelligences. The data analysis used inferential statistics, path analysis. The results showed that: (1) the mathematical logic intelligence was the first determinant factor in the students' ability in mathematical problem solving (42.7%), and the second was the verbal intelligence (29.2%); (2) the verbal and mathematical logic intelligence affected indirectly the ability of mathematical problem solving. Individually or simultaneously, it appears that verbal and mathematical logic intelligences had a direct effect to the ability of mathematics teachers of SMP/MTS should give more opportunities and stimulus of mathematical logic problems and verbal abilities to their students.

1 INTRODUCTION

Gardner's Multiple Intelligence Theory has contributed a lot in the world of education (Klein 1997). It especially has enriched and inspired teachers to create various kinds of teaching methods and techniques which help stimulate student's potentials (Murtadlo 2012). However, of all nine types of intelligence, only some of them are relevant and effective in helping students to solve mathematical problems because mathematical problem solving process needs not only one's understanding of the problem itself, but also high imagination and ability to visualize and configure spatial knowledge as well as ability to observe and analyze numbers (Tambunan 2006).

A student's language competence has great impact to his ability to solve problems since the ability will help him in understanding mathematical problems, which are normally stated in written form using mathematic abstract symbols. He will eventually be better able to describe phenomenon, generalize concepts, and to draw conclusions than his peers who are strong in other types of intelligence (Nugraha 2012). This ability relates closely to what Gardner mentioned as verbal intelligence.

Meanwhile, the ability of the child to visually imagine spatial configurations requires a special skill which needs practice and proper regular repetitions. This is related to spatial intelligence. Children with this intelligence are more likely to dabble with visual objects than with abstract symbols. They are also relatively easy to learn to use visual images and have advantages in terms of visual imagination (Tambunan 2006).

The ability to observe and analyze numbers requires logical thinking. This intelligence is a combination between numeracy ability and logic. Children who have logical-mathematical intelligence tend to be able to understand a problem, and analyze and solve them appropriately (Suhendri 2011). With this intelligences, children are able to think and devise solutions (exit) from the logical sequence (reasonable), are able to understand the pattern of relations as well as the process of deductive and inductive thinking (Susanti & Werdiningsih 2009).

The role of those three kinds of intelligences towards students' problem-solving ability has been supported by some previous studies. A study conducted by Landau (1984) and Campbell et al. (1995), for example, found a relationship between the spatial and mathematical problem-solving ability. Battista (1990) and Fennema & Tartre (1985) found an interaction between verbal intelligence with problem-solving abilities.

In Indonesian context, similar research was conducted with the focus on students 'achievement, not on their mathematical problem-solving ability. One of the examples is a research conducted by Tambunan (2006) which found out a positive relationship between spatial ability and academic achievement. Suhendri (2011) in his study found a significant influence of logical-mathematical intelligence on students' mathematics learning outcomes.

Based on the above explanation, it appears that verbal intelligence, spatial and mathematical logic does not always have a contribution to mathematical problem solving ability. This situation is thought-provoking and very much an open possibility of further research. Therefore, this study specifically attempted to test this situation.

2 LITERATURE REVIEW

Learning is expected to provide enough space for children to develop their full potentials (Jayantika et al., 2013). In this context, learning does not only focus on the cognitive development of students alone, but it is also directed to develop their talents and potential.

Every child has different talents; sports, art and some are gifted in the field of processing numbers (numerical). A child who is gifted in specific areas is more likely to achieve better in the field than other children. That potential intelligence is unique for each child (Murtadlo 2012).

Problem solving activity is one of the ways to develop children's intelligence. Through problemsolving experiences given to a child, a schema on facts and experiences will be established and can be used to solve the next problem (Tri Hariastuti & Saman 2007). In solving a mathematical problem, in particular, it takes specific understanding, analysis, calculation and imagination as well as verbal intelligence, logical mathematical and visual-spatial (Indragini 2010).

Studies which examine the contribution of three kinds of intelligences on learning outcomes or mathematical problem solving skills continue to emerge. One of these studies was conducted by Jayantika et al. (2013). The results indicated that spatial intelligence and logical mathematical intelligence both simultaneously and significantly contributed to mathematics achievement. These results show that spatial intelligence and logical mathematical intelligence are important factors that determine the mathematics achievement. Therefore, this study proposed that mathematics achievement can be improved by increasing the students' spatial and logical mathematical intelligence.

Another study conducted by Foster (2012) indicated that the relationships between the students' verbal skills and between their spatial skills were not as strong as would be expected. In fact, each of the two skills appeared to have stronger relationships with the other problem type. Additionally, although no strong relationships were observed among the students' cognitive skills (i.e., verbal, spatial, and analytical skills), the strongest pairwise relationship was shown to exist between their verbal and analytical skills.

Although Campbell et al. (1995) found that vividness of visual imagery had no effect on students' problem solving success, Diezmann & Watters (2000), in Brisbane, Australia, found that spatial intelligence has a significant contribution to the students' achievement on mathematics subject. This supports the argument that logical reasoning was a greater contributor to mathematical succes than vivid visual images.

From studies that have been described above, it appears that there is a lack of agreement in the role of spatial, verbal, mathematical-logic intelligences to a child's mathematical problem solving abilities. It may be caused by the different researchers' perspectives to problem-solving ability, or that there is a definition on the spatial, verbal, mathematicallogical intelligences themselves and how each intelligence correlated to each other. Therefore, this study has the possibility to provide the initial framework in interpreting the studies that have been conducted before and to find the link of each intelligence (spatial, verbal, mathematical-logical intelligences) or how each intelligence contributes to a child's ability of mathematical problem solving.

3 RESEARCH METHODS

3.1 Research design

The study began with a theoretical study of multiple intelligences affecting mathematics. The results would be used to build a structural model (lines) of the theoretical relationship between the variables being discussed. In addition to quantitative data, qualitative data is also used to strengthen the quantitative data interpretation. The participants of the study were 280 of class IX students of SMP Negeri 37 Surabaya, the academic year of 2016/2017.

3.2 Research variables

The variables of this study were divided into two parts, namely the independent variable (exogenous) and the dependent variable (endogenous). The independent variable is the spatial intelligence (X1), verbal intelligence (X2) and logical-mathematical intelligence (X3), while the dependent variable is the mathematical problem solving ability (Y).

3.3 Research instruments

Two types of research instruments were used in this research: (1) tests—to collect data on logical

mathematical intelligence, verbal intelligence problem-solving ability, and (2) psychological test—to measure psychological constructs of spatial intelligence.

3.4 Data analysis

Data collected for this research were analyzed both quantitatively and qualitatively. Quantitative analysis was done using inferential statistics which included path analysis and regression analysis. The qualitative analysis was used to supplement the information obtained from the quantitative analysis.

4 RESULTS AND DISCUSSION

In this research report, the variable of spatial intelligence is symbolized with X1, verbal intelligence with X2, logical mathematical intelligence with X3 while mathematical problem solving ability with Y. The results summary of the calculation of the four variables is presented in the Table 1.

The correlation between variables was calculated using the Pearson product moment correlation. The results are set forth in the form of a diagram as the representation of the theoretical model which is built in this study (Figure 1).

Testing of the model was done using path analysis. Trimming model of path analysis was applied in this research with an expectation to improve the structural model of path analysis itself. This was done by excluding the exogenous variables with insignificant path coefficient.

Testing is done to look at the contribution of each variable (X_1 to Y, X_2 to Y, X_3 to Y, X_1 and X_2 to Y, X_2 and X_3 to Y, X_1 and X_3 to Y, and X_1 , X_2 , and X_3 towards Y). The results showed a relationship between variables X_1 , X_2 , and X_3 towards Y as follows.

Figure 2 shows that verbal intelligence contributes to a student's mathematical problem solving ability in the amount of approximately 29.2%. Likewise, logical mathematical intelligence

 Table 1. Result summary of the calculation of the four variables of the research.

| | x | x | x | v |
|-----------|------|--------------|-------|-------|
| | 11 | 2 1 2 | 113 | |
| Mean | 4,63 | 5,27 | 13,33 | 16,22 |
| Median | 5 | 5 | 13 | 15,5 |
| Modus | 4 | 6 | 11 | 15 |
| Standard | 1,33 | 1,57 | 3,56 | 3,86 |
| Deviation | | | | |
| Variance | 1,78 | 2,49 | 12,68 | 14,92 |
| Total | 167 | 190 | 480 | 584 |



Figure 1. The coefficient correlation between variables X_1, X_2, X_3 and Y on a theoretical.



Figure 2. Line Model along with the path coefficient linking between the three kinds of intelligences and mathematics problem-solving skills.

contributes to the mathematical problem solving abilities as big as 42.2%. However, this figure also showed that spatial intelligence does not directly affect a student's ability of solving mathematical problems. Spatial intelligence contributes to the student's logical thinking ability and verbal thinking skills, which in turn affects the ability of solving mathematical problems.

These findings suggest that the stronger one's ability to think logically and the higher his verbal thinking skills, then his math problem-solving abilities would also increase. This statement indicates that a child with logical mathematical intelligence and verbal skills has the ability to manage logic and understand the context of the problems by applying logical thinking, counting, arranging pattern of relationships, and solving problems. The result is in line with Foster's (2012), who found that children with high verbal ability and logical-mathematical skills outperform other children.

A child with strong verbal intelligence and logic, according to Gunawan (2003), is able to think and devise solutions in logical sequence, have good numeracy skills and be able to think logically and orderly. On the other hand, children who have weaker ability in math and arranging solutions in logical sequence, results in the inability to apply the concepts, principles, formulas, and units, which will eventually have an impact on their lack of ability in solving mathematical problems (Fatoke et al., 2013).

Meanwhile, the result of this research, which shows the absence of a direct impact on the ability of spatial intelligence research in mathematical problem solving, is different from the results of the study conducted Landau (1984) and Campbell, Collis & Watson (1995). The differences occurred most probably because the instrument used to measure the spatial intelligence in this research is a psychological test. This means that the spatial abilities measured did not focus dimensional spatial ability and spatial geometry as the material that is usually taught and is often found when children learn geometry in junior high school, but on how to recognize the geometrical pattern changes that exist both in 2 dimensions and 3 dimensions.

5 CONCLUSIONS

Based on the previous description, the following conclusions can be drawn: (1) the mathematical logical intelligence was the first determinant factor of the students' ability in solving mathematical problems (42.7%), while the second was the verbal intelligence (29.2%); and (2) when combined, the verbal and mathematical logic intelligences had direct effects to the students' ability of mathematical problem solving, while the spatial intelligence had indirect effect on the ability of mathematical problem solving.

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