

Pre-service mathematics teachers' knowledge, beliefs, and attitude toward using PISA-based problem in mathematics education

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Abstract. Attitude and belief have been considered as particularly important aspects in building students' academic achievement. The current study aimed to examine Pre-Service Mathematics Teachers' (PSMTs) general knowledge of PISA and their attitudes and beliefs towards using PISA-based problem in mathematics education based on their year level in teacher education programs. The sample included a total of 146 PSMTs in mathematics teacher education program from nine Universities in Indonesia. Data were collected through the knowledge of PISA test and Attitudes and Beliefs Questionnaires. From this study we revealed the poor score results of PSMTs knowledge of PISA. However, generally the female scores improve along with the increasing of year level education. On contrary, we found the opposite result showed by male subject. This indicate that the teacher education program needs to improve the PSMTs PISA skills and knowledge. PSMTs have a positive belief and attitude towards the use of PISA-based problems in learning. However, the positive belief and attitude is at the lowest indicator. This is most likely because of poor knowledge of Pre-service teacher on PISA itself. This is appearing from most of them that are rare or even never read PISA result development. Additionally, it was inferred that females scores better than males in both, knowledge also belief and attitude. In conclusion, the Pre-service teachers' positive attitude and belief towards using PISA-based Problem emphasize that the importance of teacher education program for preparing the pre-services teachers implementing this alternative learning strategy.

1. Introduction

Indonesia has become one of the countries participating in the programme for international student assessment (PISA) six Times since 2000, where mathematical literacy became one of assessment domains. However, from the PISA results, Indonesian students are lag far behind compared to the countries in the same region (e.g Thailand and Malaysia). PISA 2015 showed Indonesia ranked 62 of 70 Participating countries in mathematics literacy [1], while in PISA 2012, Indonesia ranked 64 out of 65 countries [2]. Although these achievements are far from satisfying, between 2012 and 2015, mathematics performance among 15-year-old students in Indonesia rose by 11 score points.

Indonesia's participation in PISA carries influence in curriculum change in Indonesia. This is indicated by several things, for instance we found a PISA problem in the official book of 9th grade junior high school from the Ministry of Education and Culture, mathematics literacy contest (KLM) began to be held in Indonesia since 2010 by using questions developed based on the criteria used in the PISA Framework. Meanwhile, Using PISA results as one of the basic arguments, the government



revised the curriculum and implemented it starting from July 2013. In addition, PISA results have gradually influenced the curriculum of mathematics education in teacher education [3] and research trends in Indonesia. Therefore, Indonesia's student poor results and curriculum change provide a challenge for teachers or researchers to develop a learning model involving PISA items or PISA-Based problems for teaching and learning.

Numerous studies revealed that there is a strong positive relationship between mathematics affective factors and student achievement [4-6]. Furthermore, Guven & Cabakcor [5] stated that that students' affective factors influence on their problem-solving achievement. On the other hand, a considerable number of studies analyzed the students' or pre-services' mathematics literacy by using PISA-based problem (e.g. [7,8]) particularly in recent year. However, a focus on the contribution of PISA-based problem to pre-service teachers' related knowledge and their attitudes and beliefs towards using of PISA-based problem courses is rare. Therefore, it may not be possible for teacher to using PISA-Based problem in their instruction without the relevant knowledge and interest towards using it in their classroom.

In particular, the aim of this study was to examine Pre-service mathematics teachers' general knowledge of PISA-based problem and their attitudes and beliefs towards using PISA-based problem in mathematics education based on their year level in teacher education programs.

1.1 Pre-service Mathematics Teachers' Knowledge of PISA and PISA-based problem

OECD [1], in Programme International of Student Assessment (PISA) report, defined Mathematics Literacy as ““An individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well founded judgments and decisions needed by constructive, engaged, and reflective citizens”.

In other words, the definition is aligning with integrating literacy into mathematics educations or promotes a constructivist vision of learning. Yet, Colwell & Enderson [9] asserted that challenges remain when considering the integration of constructivist approaches to mathematics instruction and literacy into mathematics. In dealing with these challenges, teacher or pre-service teacher play key role in improving students' mathematical literacy. Consequently, the Pre-service Mathematics Teachers' Knowledge of PISA and PISA-based problem need to be concerned seriously.

1.2 Pre-service Teachers' Attitudes and Beliefs Towards Using PISA-Based problem in Mathematics Education

Attitudes and beliefs are part of the affective domain in mathematics education including beliefs, attitudes, emotional states, and values [10]. Additionally, Lee [11] stresses that Pre-Services beliefs, being such an influential factor that governs teaching, is definitely an area that warrants further attention. Attitudes describe orientations or predispositions toward certain sets of feelings (positive or negative) in particular (mathematical) contexts, while Beliefs involve the attribution of some sort of external truth or validity to systems of propositions or other cognitive configurations [10]. This contrasts from the more common view of attitudes as predispositions toward certain designs of behavior. Attitudes are decently steady, including an adjustment of connection influence and cognition. Beliefs are regularly exceedingly stable, highly cognitive, and highly organized – with influence interwoven in them, contributing to their stabilization.

The instruments in this study mostly focus on specific cases using PISA-Based problem in teaching mathematics. There is a need for a general picture of PSMTs knowledge about PISA and their attitudes and beliefs about the use of PISA-based problem or PISA items in order to understand the contribution of teacher education programs to this construction for future use of PISA-Based Problem in mathematics classes. Furthermore, gender as a conceivable factor influencing these constructs should be examined extensively to investigate the part of this variable and to supply data for further research. Thus, the research described here aims to explore pre-service teachers' knowledge of PISA and their attitudes and beliefs towards using PISA-based Problem with regard to year level in education program and gender.

2. Research Method

The aim of this study is to analyse Pre-service mathematics teachers' general knowledge of PISA-based problem and their attitudes and beliefs towards using PISA-based problem in mathematics education based on gender and their year level in teacher education programs. The cross-sectional survey research design was implemented in which surveys or tests are implemented in a fixed time.

2.1. Participants

The participants were 146 student teachers who were taking mathematics teacher education program. The participants were asked to finishing the Knowledge of PISA and the Attitude and belief questionnaire toward using PISA-based problem in Mathematics education. The participants were divided into junior PSMTs and Senior PSMTs. Senior PSMTs was the student teacher who was at first or second year in teacher education program, while senior was the student teacher who was at third or last, and even fresh graduated from teacher education program.

2.2. Instruments and Data Analysis

This study was used two instruments, the knowledge of PISA and the Attitude and belief questionnaire toward using PISA-based problem in Mathematics education that we adapt from Alpaslan Alpaslan, Isiksal & Haser [12] and Alpaslan, Isiksal & Haser [13]. The test consisted of a total 6 questions. Five questions were about basic knowledge and information about of PISA, while one question was short answer items of a PISA problem. PSMTs' scores on this test ranged between 0 and 100.

The Attitudes and Beliefs Questionnaire toward using PISA-Based problem in mathematics education used in this research aimed to analyze PSMTs about using PISA-based Problem in mathematics education. The questionnaire designed was not separated as 'Attitude items' and 'Belief Items' because the possibilities of overlapping in interpreting the definitions. First part of the questionnaire was about PSMTs' demographic (e.g. gender, year level in their education program). The second part of the questionnaire consist of 25 items on a five-point likert type scale that we adapt from Alpaslan et al [12]. The five response categories are strongly agree (5), agree (4), undecided (3), disagree (2), and strongly disagree (1) and thus total scores varied between 27 and 135. In the data analysis of attitude and belief, we divided into positive and negative attitudes. The positive attitude refers to more enjoyable emotions and negative attitude to less enjoyable emotions [14]. in this study we defined negative attitudes if PSMTs' obtained score below or equal to 2.5, while above the 2.5 was in the positive attitude category.

3. Results

Responses for the descriptive questions in the first part of the Attitudes and Beliefs Questionnaire towards Using PISA-Based Problem in Mathematics Education revealed that more than half of the pre-service teachers (76.71%) were introduced PISA in mathematics during their school before they enrolled in teacher education programs. While most pre-service teachers sometimes (51.37%) followed publications related to PISA such as books, magazines, documentaries, and articles few said often (4.11%) and some never (44.52%). When the instruments were implemented, 110 seniors (75.34%) and 36 (24.66 %) juniors were taking or had taken mathematics' teacher education program.

3.1 Knowledge of PISA

Pre-service teachers' mean (M) scores of the knowledge of PISA-Based Problem of Mathematics Test are presented with regard to year level in teacher education program and gender in Table 1. According to Table 1, it can be concluded that pre-service teachers' scores in the knowledge test are nearly moderate (M = 35) and females' related knowledge (M = 37) is close to that of males (M = 30) in general. The mean knowledge scores increased with year level in teacher education programs (juniors, M = 32; and seniors, M = 36). This increase was also seen for the females (juniors, M = 24; and seniors, M = 40). However, the opposites condition occurs in males (juniors, M = 49; and seniors, M = 20).

Table 1. Descriptive statistics regarding knowledge of PISA

Year level in teacher education program	Knowledge of PISA-Based Problem M (SD)			Sample size (female/male)
	Female	Male	Total	
Junior	24 (23.55)	49 (28.97)	32 (27.45)	36(11/25)
Senior	40 (32.47)	20 (25.19)	36(32.14)	110(88/22)
Total	37 (31.35)	30 (25.59)	35 (31.01)	146(113/33)

Since there was a significant interaction effect between year level in teacher education program and gender on pre-service teachers' knowledge of PISA. Simple main effects on knowledge of PISA were examined by year level in teacher education program across gender and gender across the year level through multiple comparisons of the related knowledge mean scores. Results of the comparisons are given in Table 2. Considering Table 2, it is asserted that female pre-service teachers' knowledge of PISA increased significantly on a regular trend as they progressed in the teacher education program. More precisely, senior females' knowledge of PISA was significantly higher than those in the first two years. On contrary, the males' knowledge of PISA in first two year was significantly higher than those in the last two years.

The multiple comparisons of knowledge of PISA mean scores by gender across year level in teacher education program given in Table 3. The results revealed that the male PSMTs' knowledge of PISA mean scores were significantly higher than those of females in the initial two years in teacher education program. In the last two years, the females' knowledge of PISA-Based Problem was higher than that of the males, but this time the difference is not too statistically significant.

Table 2. Multiple comparisons of knowledge of PISA mean scores by year level teacher education program across gender

Comparison		Mean Difference
Gender		
Female	Junior vs Senior	16
Male	Junior vs Senior	29

Table 3. Multiple comparisons of knowledge of PISA mean scores by gender across year level in teacher education program

Comparison		Mean difference
Year level in teacher education program	Gender	
Junior	Female vs Male	25
Senior	Female vs Male	20

3.2 Attitudes and Beliefs Towards Using PISA-Based Problem in Mathematics Education

Mean (M) values for pre-service teachers' Attitudes and Beliefs Questionnaire towards Using PISA-Based Problem in Mathematics Education scores are given with regard to year level in teacher education program and gender in Table 4. Pre-service teachers' attitudes and beliefs towards using PISA-Based Problem in mathematics education were considered as positive and availing (M = 3.09). Male pre-service teachers' related attitudes and beliefs (M = 2.84) are more positive and availing than those females have (M = 3.03). Attitudes and beliefs mean scores improve with year level in teacher education program (juniors, M = 3.18; and seniors, M = 2.93). The improvement was also noticed for females across the years (juniors, M = 3.32; and seniors, M = 2.94). The improvement was also noticed for males across the years (juniors, M = 2.81; and seniors M = 2.86).

Table 4. Descriptive regarding attitudes and beliefs towards using PISA-Based Problem in mathematics education

Year level in teacher education program	Attitudes and beliefs towards using history of mathematics in mathematics education (M)			Sample size (female/male)
	Female	Male	Total	
Junior	3.32 (.900)	2.81(.1.079)	3.18 (.968)	36(11/25)
Senior	2.94 (.927)	2.86 (.889)	2.93 (.916)	110(88/22)
Total	3.03 (.930)	2.84 (.954)	3.09 (.560)	146(113/33)

4. Discussion and Conclusion

The study results that more than a half of PSMTs have no initial knowledge about PISA and followed the publication or paper related to PISA. This might be due to the Indonesian curriculum in mathematics teacher education which still not integrated with PISA or mathematics literacy. The lack of PSMTs' knowledge in PISA might be related to Indonesia's student poor results in PISA from survey reported by OECD. Indeed, it is still limited to 'just an assumptions', further research is needed to support this assumption. Despite the limitation of this research, that is only a descriptive research, at least this condition describing the knowledge of PSMTs who need upgrading knowledge related to mathematics literacy or PISA yet through classroom learning or workshop for supporting the student teacher understanding. In further, we found that female scores improve along with the increasing of year level education, yet the opposite condition we found on male subject. Thus, it can be inferred that teacher mathematics education program (in Indonesia) give no contribution in improving PSMTs' PISA knowledge yet. A revision of the pedagogics curriculum in mathematics education program or designing a course for PSMTs may be needed regarding with the poor PISA Knowledge of student teachers. Supporting this finding, Colwell & Enderson [9] suggested to prepare teachers to enter 21st century classrooms and expose them to practices that include literacy-based strategies or scaffolds to aid in exploring, resolving, and reflecting on real problems in mathematics.

On the other hand, the result regarding PSMTs attitude and belief indicate that almost all the participants have positive attitude and belief toward using PISA-Based problem in teaching mathematics. However, male PSMTs have higher positive attitudes and beliefs than females. Hence, this positive attitudes and beliefs was the good opportunity to educate the PSMTs on PISA basic knowledge and PISA-based problem and its used in the primary or middle school mathematics teaching through courses in the education programs. Courses related to PISA or Mathematics literacy might also provide pre-service teachers with certain ideas about the use of it in teaching mathematics. Related to this, a brilliant suggestion was formulated by Colwell & Enderson [9], that is an impetus to reconsider how literacy and mathematics coursework is presented to PSMTs to better prepare teachers to integrate mathematics literacy (through PISA-Based problem) in a smooth and effective manner to support students' mathematical literacy learning.

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Acknowledgments

A great appreciation is given to the student teachers from Sidoarjo, Surakarta, Sumenep, Banjarmasin involved in this study.

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