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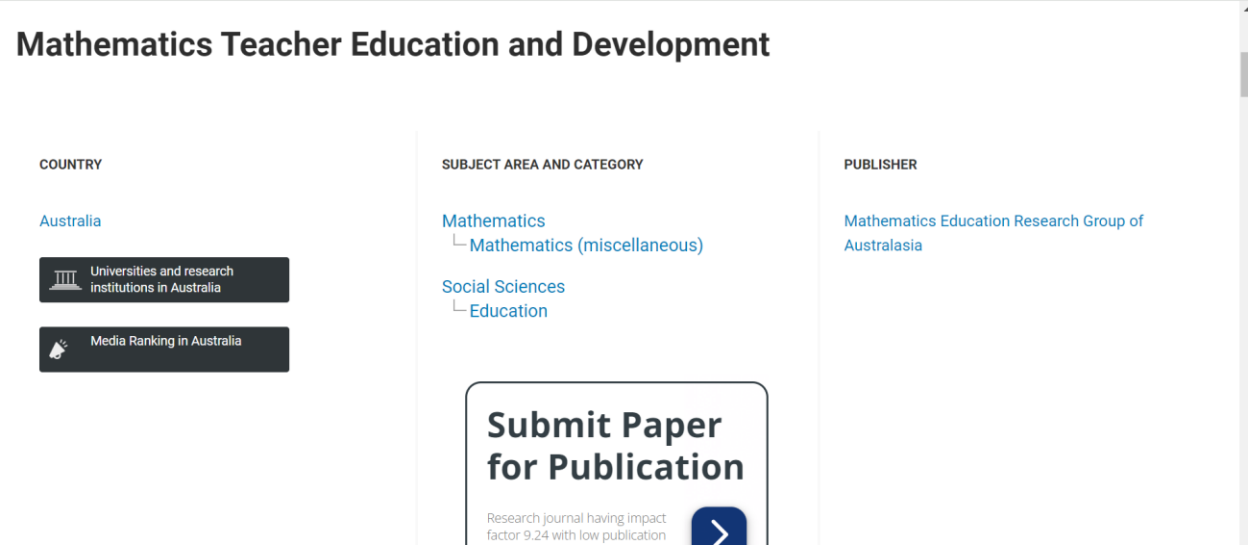

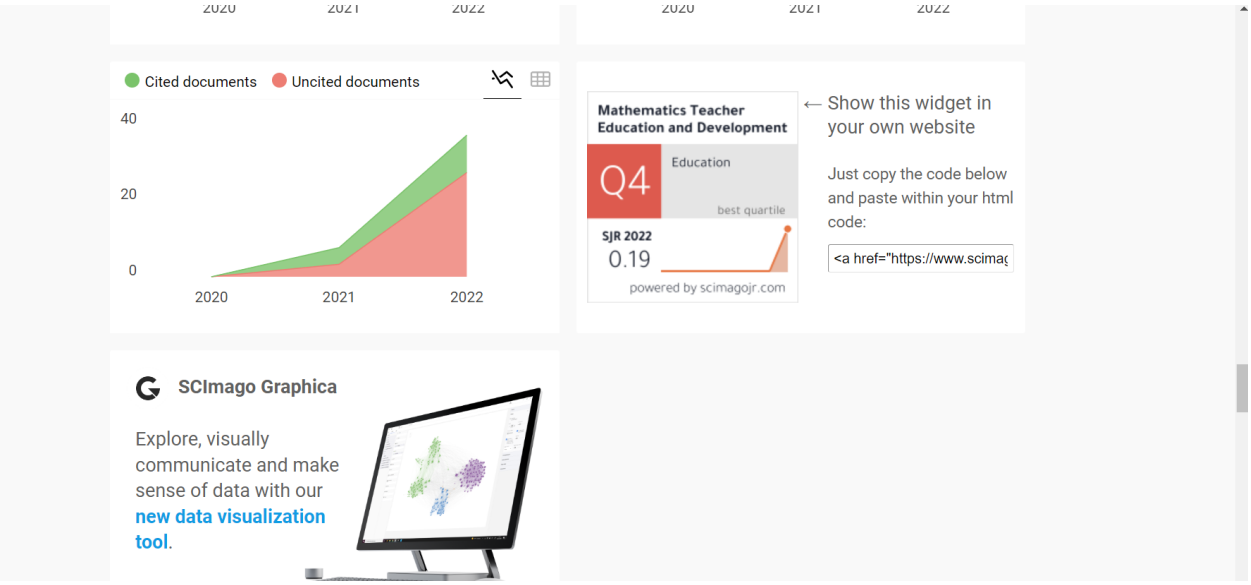

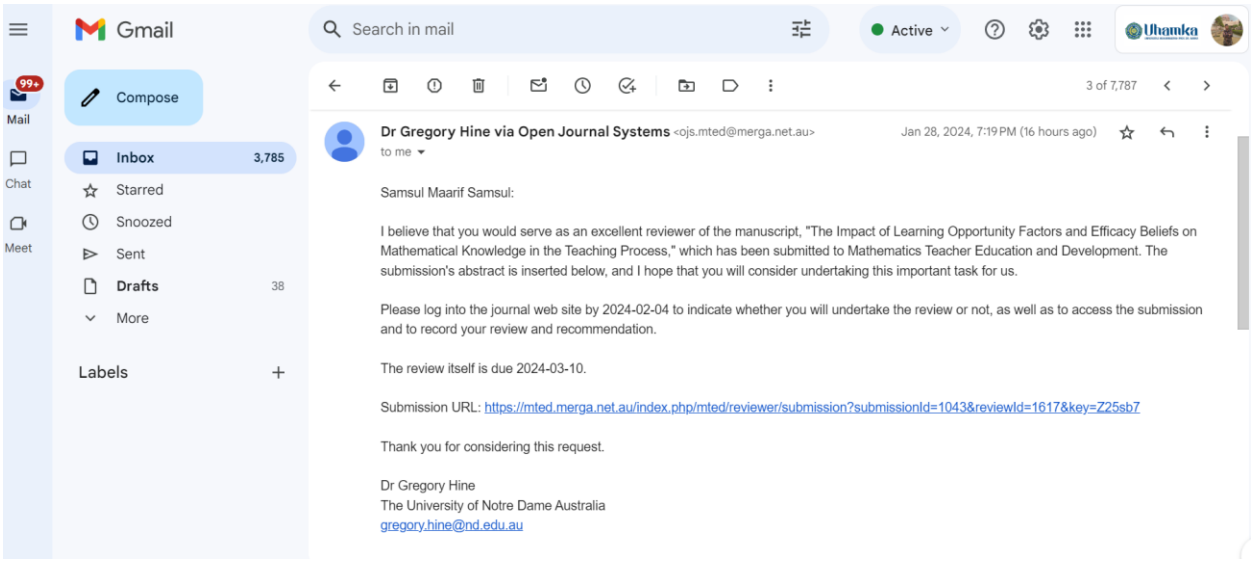
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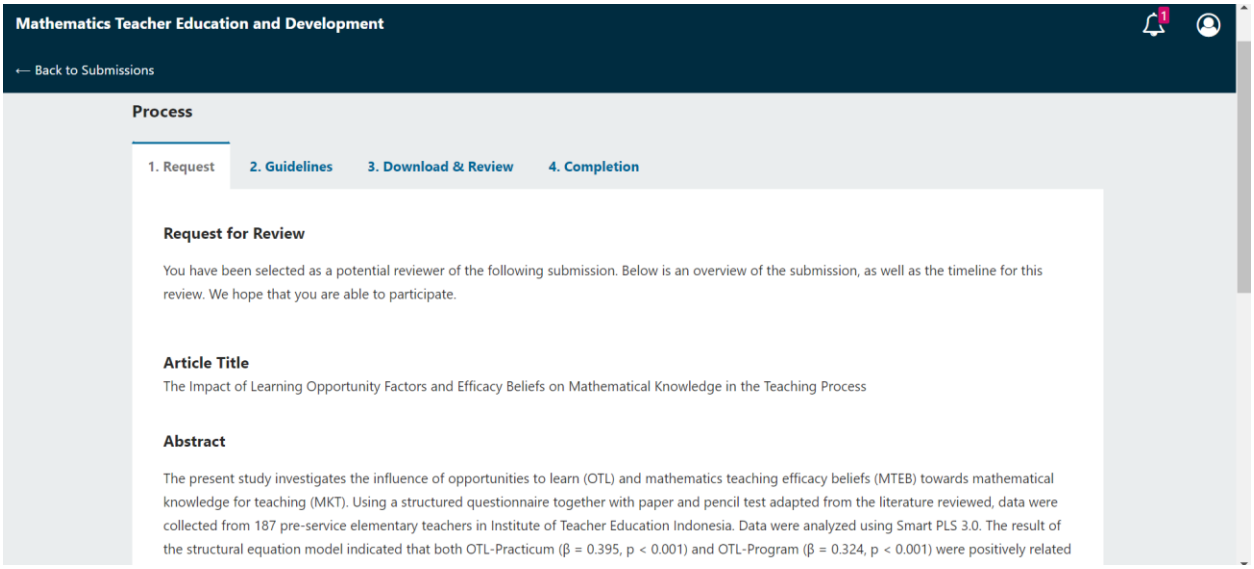
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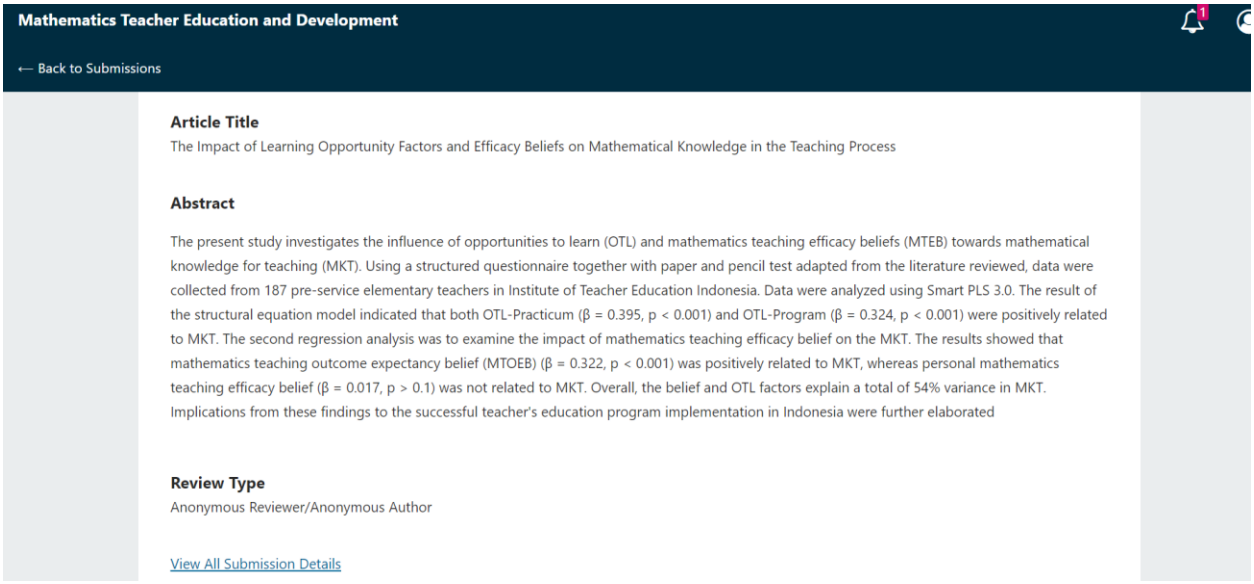
Abstract
The present study investigates the influence of opportunities to learn (OTL) and mathematics teaching efficacy beliefs (MTEB) towards mathematical knowledge for teaching (MKT). Using a structured questionnaire together with paper and pencil test adapted from the literature reviewed, data were collected from 187 pre-service elementary teachers in Institute of Teacher Education Indonesia. Data were analyzed using Smart PLS 3.0. The result of the structural equation model indicated that both OTL-Practicum (β = 0.395, p < 0.001) and OTL-Program (β = 0.324, p < 0.001) were positively related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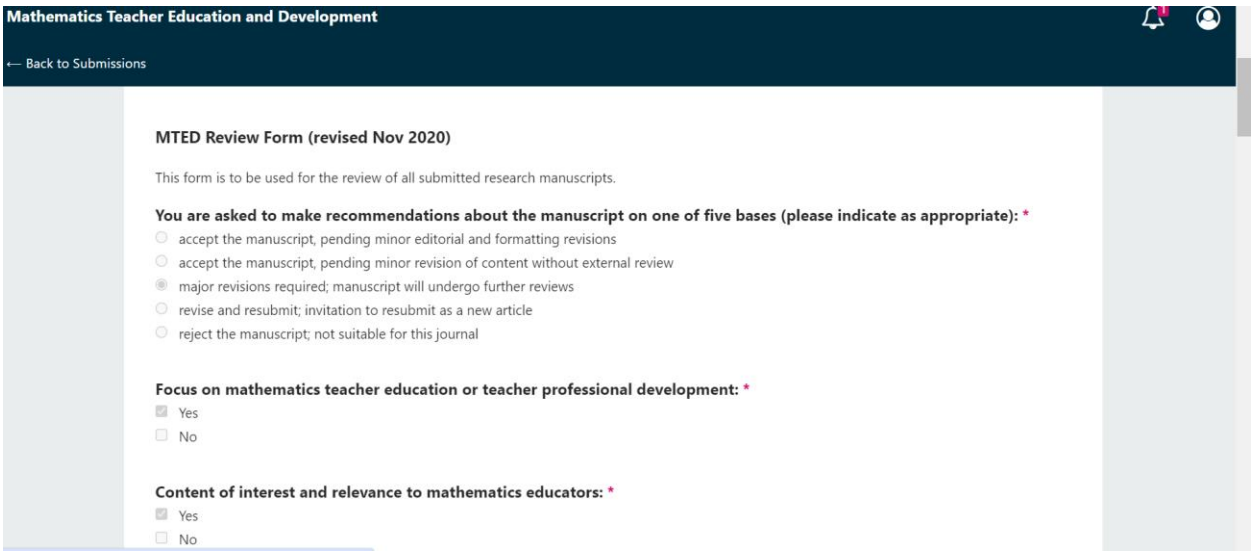
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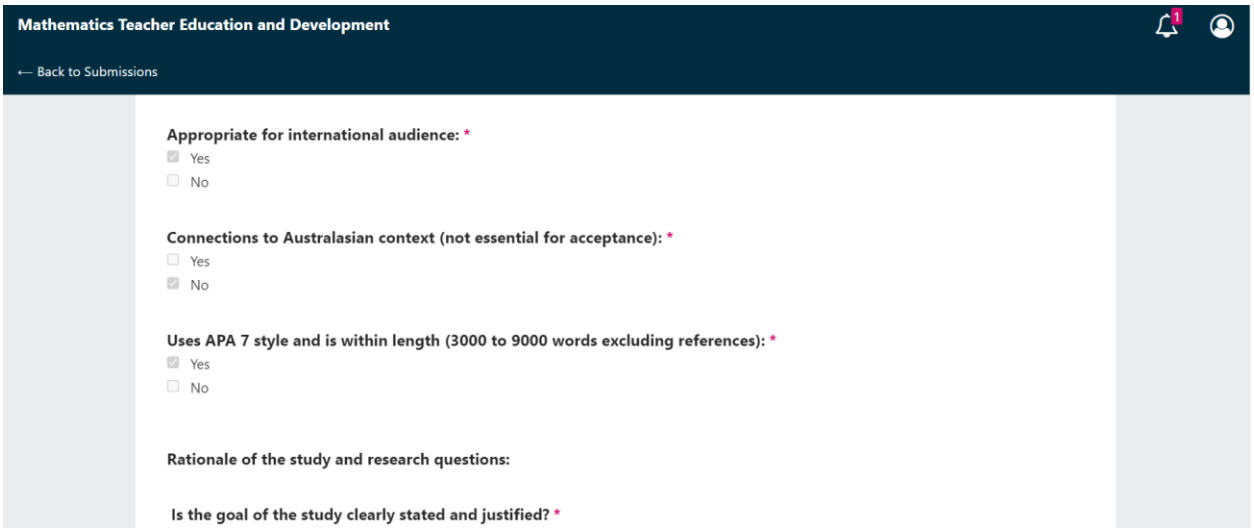
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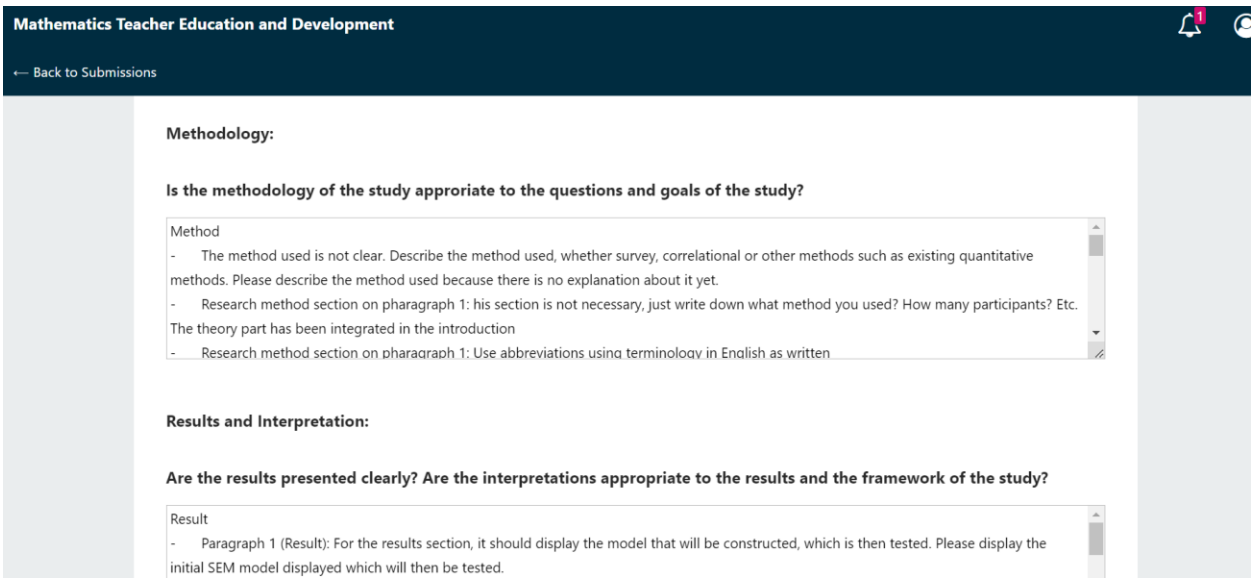
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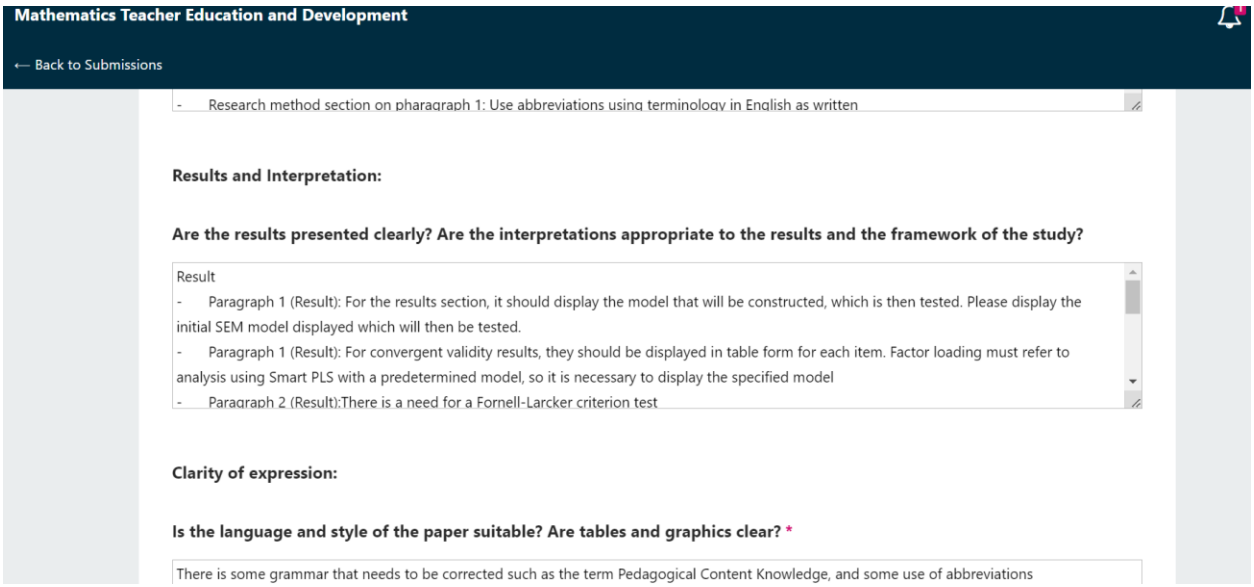
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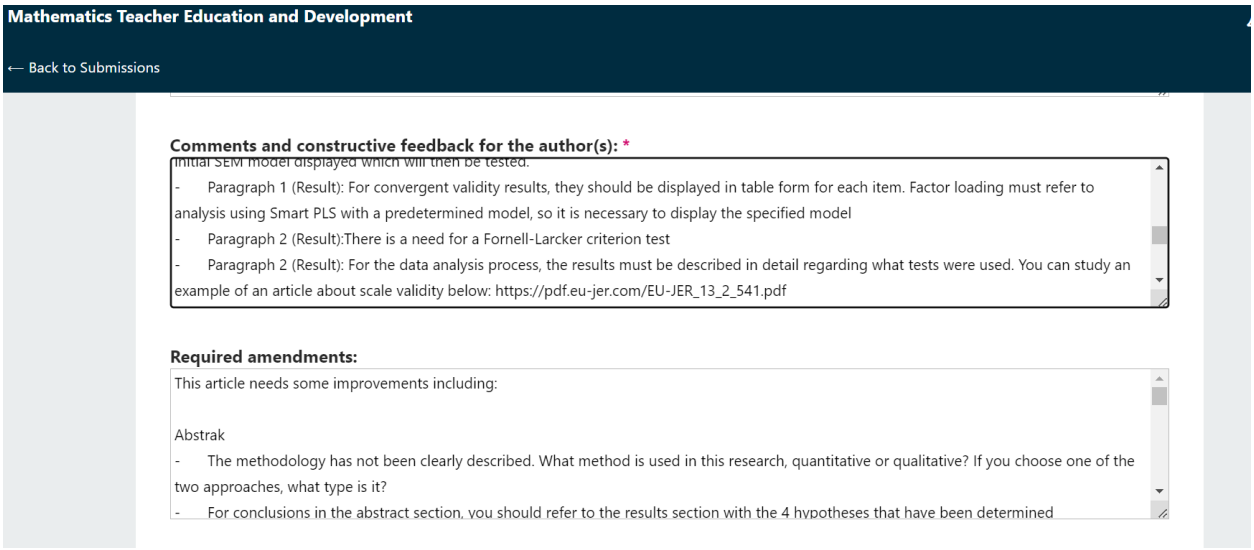
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- Paragraph 2 (Result):There is a need for a Fornell-Larcker criterion test
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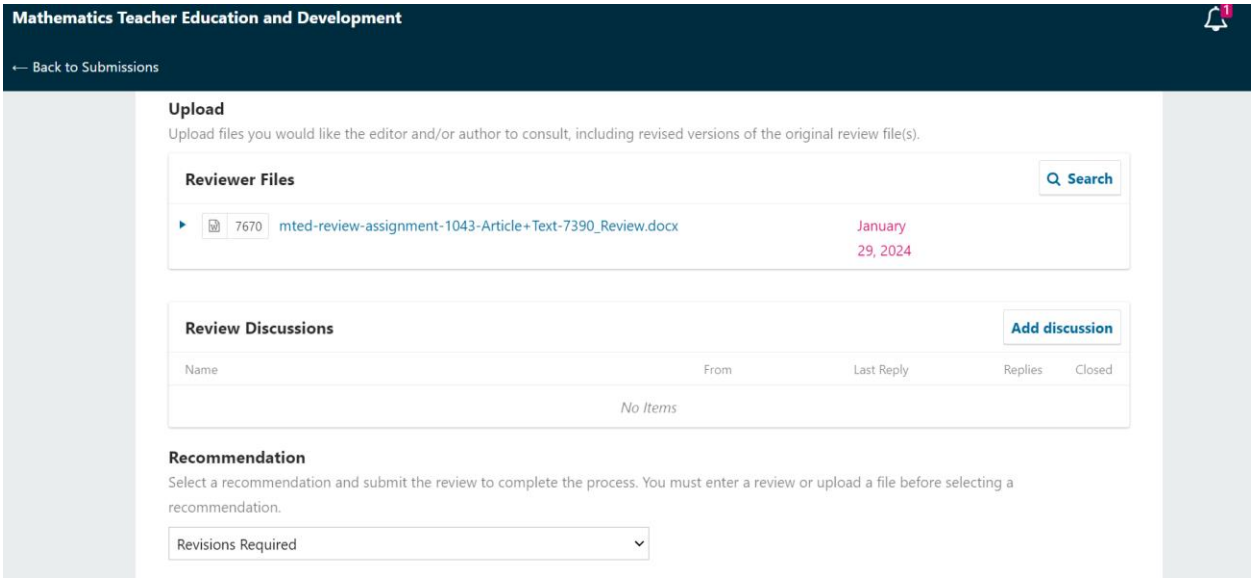
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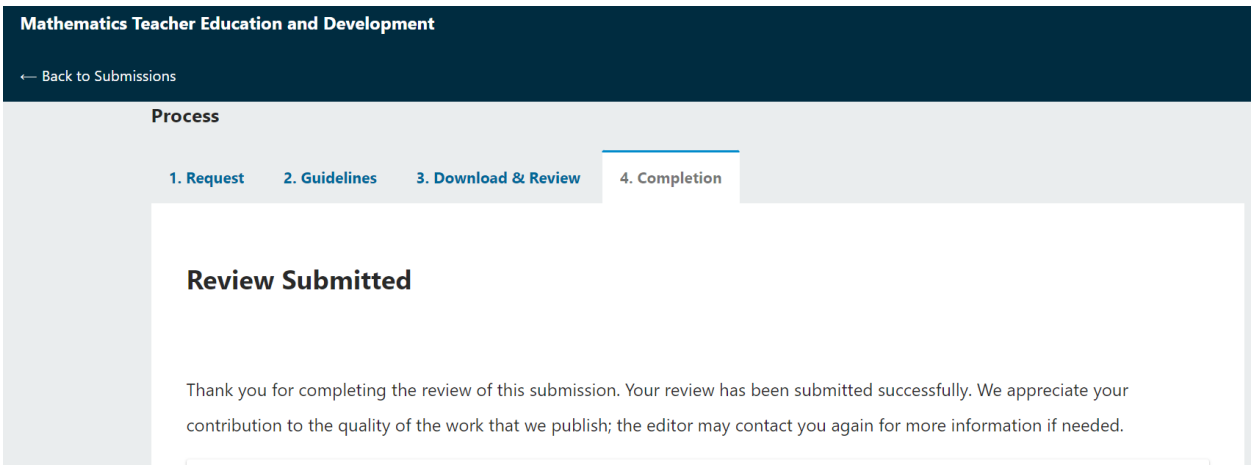
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The Impact of Learning Opportunity Factors and Efficacy Beliefs on Mathematical Knowledge in the Teaching Process

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The present study investigates the influence of opportunities to learn (OTL) and mathematics teaching efficacy beliefs (MTEB) towards mathematical knowledge for teaching (MKT). Using a structured questionnaire together with paper and pencil test adapted from the literature reviewed, data were collected from 187 pre-service elementary teachers in Institute of Teacher Education Indonesia. Data were analyzed using Smart PLS 3.0. The result of the structural equation model indicated that both OTL-Practicum ($\beta = 0.395$, $p < 0.001$) and OTL-Program ($\beta = 0.324$, $p < 0.001$) were positively related to MKT. The second regression analysis was to examine the impact of mathematics teaching efficacy belief on the MKT. The results showed that mathematics teaching outcome expectancy belief (MTOEB) ($\beta = 0.322$, $p < 0.001$) was positively related to MKT, whereas personal mathematics teaching efficacy belief ($\beta = 0.017$, $p > 0.1$) was not related to MKT. Overall, the belief and OTL factors explain a total of 54% variance in MKT. Implications from these findings to the successful teacher's education program implementation in Indonesia were further elaborated.

Keywords • mathematics teacher education • learning opportunities • expectations of teaching mathematics • keyword 4 • keyword 5

Introduction

Teachers are individuals who are responsible for implementing the effective teaching and learning process (PdP) to ensure that students master every skill contained in the mathematics curriculum (Wildeman et al., 2022). The knowledge possessed by the teacher plays a role in ensuring the effective implementation of PdP activities and subsequently able to improve students' mathematical performance (Andersson & Palm, 2017; Cook et al., 2020). The low level of mastery of mathematics content knowledge and pedagogy among teachers will indirectly contribute to the implementation of the mathematics PdP process which is less effective (Volk et al., 2017). Mathematical Knowledge for Teaching (PMUP) is the concept of mathematical knowledge that teachers need to teach effectively (G. Hine & Lesseig, 2021). It includes evaluating the student's response, answering the questions presented by students, preparing assignments and making lesson plans (Musgrave & Carlson, 2017). According to Mohsenpour et al. (2021), the PMUP concept developed by Liu et al., (2020) is a multi-dimensional construct consisting of content knowledge (KK) and content pedagogical knowledge (PPK).

The Teacher Education Development Study in Mathematics (TEDS-M) was conducted by the International Association for the Evaluation of Educational Achievement (IEA) in 2008 on 17 countries to provide information related to the knowledge of prospective primary and secondary school teachers throughout their education program. Teachers (Ingvarson & Rowley, 2017). Indonesia is one of the countries involved in the study. A total of 524 primary school pre-service teachers and 388 junior secondary pre-service teachers who are in their final year of study were involved in the study (Leong et al., 2015). The findings of the study released in 2012 show that the level of mastery of PMUP among pre-service teachers in Indonesia is low (Senk et al., 2012). Apart from the findings of the TEDS-M study in 2008 as explained by (Blömeke et al., 2022), studies by Hainora Hamzah et al., (2022), and (Zulkpli et al., 2017) also found that the level of knowledge mastery of mathematics teachers in Indonesia is low.

The low level of mastery of PMUP among teachers also affects the success of a teacher education program provided. According to (Tatto et al., 2015), the knowledge possessed by pre-service teachers at the end of the teaching course is the main indicator of the success of the teacher education program that has been followed. The Indonesian Ministry of Education (KPM) has allocated a large amount of money every year to the Teacher Education Institute (IPG) to ensure that the teacher education

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programs offered are capable of producing quality teachers (Napitupulu et al., 2017). If the PMUP level among teachers at the end of the teaching course is low, this illustrates that the teacher education program followed is less effective in producing competent teachers and subsequently causes the return on the investment made by the Ministry of Education to be not worthwhile. In order to address the issue, there is a need to conduct a study to identify the factors that influence the mastery of PMUP among pre-service teachers in IPG.

Personal (KEPMP) tested. In addition, Tajudin et al. (2017) suggested that teachers' PPK should also be linked to opportunities to learn (PUB) innovative teaching strategies. Simsek and Lorscheider et al. (2016) also suggested that factors such as gender, age and the opportunity to follow teaching training should also be taken into account. Based on the recommendations given by previous researchers, this study will test the influence of the Belief in Efficacy of Mathematics Teaching (KEPM) and PUB factors on PMUP. Thus, based on the PMUP model by (Richardson, 2013), this study will test the conceptual model of the study by integrating the PMUP model, Social Cognitive Theory by Bandura (1989a; 1989b) as well as several sets of variables related to PUB obtained from the literature review to study the influence of PUB factors and efficacy beliefs towards PMUP among pre-service teachers in IPG.

Methods

The theory that is the basis of this study is the PMUP model by Liu et al. (2020). This theory was chosen based on its suitability to measure the level of mastery of PK and PPK mathematics among pre-service teachers. The PMUP theory was also used by previous researchers to measure the mastery level of mathematics teachers' knowledge. Among them is a study by Shabana et al. (2017), who studied the perception of pre-service teachers related to the course they followed and its effect on mathematics PPK. In addition, De Costa and Norton (2017) also used the PMUP model to study the relationship between the level of confidence and mathematics PK and PPK among trainee teachers. Other researchers who also use the PMUP model in their studies are Qian and Youngs (2016), Pape et al. (2015), Kleickmann et al. (2015), Venkat & Spaull (2015), Hine et al. (2015), Mei et al. (2015), Fauskanger (2016), Thanheiser et al. (2013), and Senk et al. (2012). PMUP covers three categories of knowledge related to teacher PK:

1. Content Knowledge (PK), which is mathematical knowledge and skills that are not only specialized for teaching mathematics.
2. Specific Content Knowledge (PKK), which is unique mathematical knowledge and skills specific to teaching mathematics.
3. Horizon Content Knowledge (PKH), which is the awareness of the relationship between each topic in mathematics

In addition, PMUP also consists of three categories of knowledge related to PPK:

1. Content and Student-related Knowledge (PKPel), which is knowledge related to students' mathematical thinking, which requires interaction between specific mathematical understanding and understanding of students' mathematical thinking.
2. Knowledge related to Content and Teaching (PKP), which is knowledge related to teaching design, which requires interaction between understanding mathematics and understanding related to pedagogical issues that affect student learning.
3. Knowledge related to Content and Curriculum (KKK), which is knowledge related to teaching materials and programs. (Lertlumnaphakul et al., 2022)

This study also integrates theories related to teacher efficacy beliefs. Social Cognitive Theory by Mozahem and Adlouni (2021) was chosen to be used in this study. The theory was chosen because of the appropriateness of the variables to explain the influence of the belief factor in the effectiveness of mathematics teaching on pre-service teachers' mastery of PK and PPK mathematics. This is based on the findings of studies by Ekstam et al. (2017), De Costa and Norton (2017), Oppermann et al. (2016), Travis et al. (2015), and Hughes et al. (2019). According to Oxelgren et al. (2017), there is an indirect

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relationship between teacher efficacy beliefs and PK. Meanwhile, findings from a study by De Costa and Norton (2017) also found that there is a significant relationship between the level of teacher confidence and mathematics PK. Studies by Travis et al. (2015), and Sutton and Austin (2015) also found that there is a relationship between efficacy beliefs and teacher knowledge. Apart from the PMUP model and teacher efficacy beliefs, the researcher will also test the effect of the opportunity factor to learn (PUB) or better known as Opportunity to Learn (OTL). This factor has been selected based on the findings of previous studies which found that the PUB factor plays a role in influencing teachers' mastery of PK and PPK. Among them are studies by Höhn et al. (2017), Jenßen et al. (2019), and Qian and Youngs (2016). Nevertheless, the influence of the PUB factor on teachers' mastery of knowledge from previous studies is mostly concentrated among language teachers abroad, especially in Europe.

After examining the research literature and identifying relevant and appropriate theories, the researcher formed a research model as shown in Figure 1. The variable of efficacy beliefs is represented by the variables Belief in the Efficacy of Personal Mathematics Teaching (KEPMP) and Belief in Expected Results of Mathematics Teaching (KJHPM). The PUB variables consist of the opportunity to undergo teaching training (PUB-Praktikum) and the opportunity to follow a coherent teacher education program (PUB-Program). A study conducted has proven that KEPMP factors affect the dominance of PMUP. In addition, studies by Mathelier et al. (2016) and Hart et al. (2009) also found that KEPMP and KJHPM factors influence teachers' mastery of PPK mathematics. A study by Swars et al. (2007) also found that there is a significant relationship between KEPMP and KJHPM with pre-service teachers' mastery of mathematics PK. Therefore, this study will examine the influence of KEPM factors on PMUP among pre-service teachers in IPG.

H1: Belief in Personal Mathematics Teaching Efficacy (KEPMP) has a significant direct effect with mastery of PMUP.

H2: Beliefs and Expectations of Mathematics Teaching Outcomes (KJHPM).

Past studies prove that the PUB variable affects teachers' mastery of PK and PPK. Among them, a study by Höhn et al. (2017) on prospective secondary school English teachers found that PUB of content and PUB of teaching training had influenced their mastery of PPK. Regression analysis shows that PUB can positively predict the PPK test scores of trainee teachers with a β value equal to 0.28 ($p < 0.01$) for PUB content, and a β value equal to 0.29 ($p < 0.01$) for PUB teaching training (practicum). In addition, a study by Yeşildere and Akkoç (2010) also found that PUB teaching training (practicum) significantly affects teachers' PPK mastery. Studies by Yeşildere and Akkoç (2010) and Senk et al. (2012) on pre-service teachers also found that the opportunity to follow a coherent teacher education program (PUB-Program) also affected teachers' mastery of PK and PPK. This indicates that PUB is an important factor that affects the mastery of knowledge and academic achievement of prospective teachers. Therefore, this study will also examine the influence of PUB on the dominance of PMUP among pre-service teachers in IPG.

H3: Opportunity to undergo teaching training (PUB-Practicum) have a significant direct effect with the mastery of PMUP.

H4: The opportunity to follow a coherent teacher education program (PUB- Program) has a significant direct impact with PMUP.

Data Collection Methods

The data collection method used is to conduct a survey using a questionnaire on 187 pre-service teachers at IPG. Before conducting the survey, the researcher first prepared a set of questionnaires that contained the information needed to answer the research questions that had been submitted. The questionnaire consists of three parts. The first part contains questions related to demographic information, the second part contains questions related to teacher efficacy beliefs and the last part consists of information related to PUB. Apart from that, the researcher also used a pencil and paper test to obtain data related to the PMUP level. A cluster random sampling method was used to select the study respondents. The questionnaire used was adapted from previous studies relevant to this study. Because the instruments used have met the aspects of validity and reliability, then the aspects of content validity have been met (Sanchez-Franco & Roldán, 2010). In addition, the researcher has also referred

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to several experts to ensure that the instrument used is valid in terms of its content. The value of the content validity index (I-CVI) shows that all items are valid because the value exceeds 0.70 (Ã & El-masri, 2005). The formation of research tools to measure PMUP variables was adapted. The items to measure the PMUP of pre-service teachers consist of 15 items related to mathematics PK and 17 items that test mathematics PPK. For items that test math PK, 4 items are from common content knowledge domains and 11 items are from specific content knowledge domains. While for the items that test the mathematics PPK, 13 items consist of knowledge domains related to content and students and another 4 items from knowledge domains related to content and teaching. Instrument to measure the KEPM variable was adapted from. (Matney et al., 2016). The instrument consists of two dimensions, namely KEPMP and KJHPM. The instrument contains 21 items in total, namely 13 items related to KEPMP and 8 items related to KJHPM.

Data Analysis

Statistical Package for the Social Sciences (SPSS) version 23 software was used for descriptive analysis. Descriptive analysis was used to obtain information such as mean values, percentages, standard deviations, normality tests, missing data analysis and multivariate hypothesis tests. Normality testing, missing data analysis and multivariate hypothesis testing are important to perform before hypothesis testing analysis is conducted. Smart PLS 3.0 software was used to analyze the data to test the research hypothesis. Two data analysis procedures were used in this study, as suggested by Hair et al. (2017) namely measurement model evaluation and structural model evaluation data.

Results

According to Larabi et al. (2019), hypothesis testing will only be conducted if the measurement model reaches the desired level of reliability and validity. To assess the reliability of each study variable, Cronbach's alpha and Composite Reliability values were used. Based on the analysis that has been carried out, it was found that Cronbach's alpha value for each construct exceeds 0.7, which is the minimum level (Holmbeck & Devine, 2009). In addition, the researchers also referred to the Composite Reliability value to determine the reliability of each construct. Based on the analysis that has been carried out, it was found that the Composite Reliability value for all constructs is above 0.7, so it is acceptable. Construct validity testing is conducted through the assessment of Convergent Validity and Discriminant Validity aspects. A variable is considered to have convergent validity if three criteria are met, first, the factor loading value of all individual items must exceed 0.708. However, items that have factor loading values between 0.4 to 0.7 can be considered to be retained (Guad et al, 2021). Based on the findings of the study in Table 1, it was found that there are some items that have factor loading values that are less than 0.708 but those items are retained because by removing the item in question (in bold) it does not increase the AVE value and composite reliability of the construct in question (As et al., 1968). Second, the composite reliability value is not less than 0.6 and thirdly the AVE value must be above 0.5 (Dash & Paul, 2021).

Table 1
Analysis results of the measurement model

Construct	Item	Internal (Cronbach's alpha)	Factor loading	Composite average *reliability* Variance extracted
PUB-Practicum	PUB_Prak1	0.916	0.801	0.9320.631
	PUB_Practice2		0.830	
	PUB_Prak3		0.863	
	PUB_Prak4		0.808	
	PUB_Prak5		0.770	
	PUB_Prak6		0.780	
	PUB_Prak7		0.741	

Commented [SM18]: For research instruments, you must start with content validity, which is how to construct a questionnaire instrument. Does the instrument adopt or adapt existing instruments? If so, then it should be shown what instrument it refers to. The instrument must also be validated by experts in the field so that there is no bias in the questionnaire that has been created. Apart from that, the instruments must also have clear indicators, so it is necessary to display the indicators for each instrument complete with the items.

Commented [SM19]: There are 4 hypotheses that must be tested, whether descriptive analysis is sufficient. In the abstract, regression is revealed, why isn't it explained?

Commented [SM20]: In the data analysis section, it should be adjusted to the methodology used and the hypothesis to be tested. Describe each stage used to test the hypothesis. If there are prerequisite tests, describe them in detail, for example normality tests, homogeneity tests and so on. This section must be clear, not just write down the software used. However, what tests are carried out? Align it with the results section so that the data analysis steps are described well.

Commented [SM21]: Untuk bagian hasil, seharusnya menampilkan model yang akan dikonstruksi, yang kemudian model tersebut diuji. Silahkan tampilkan model SEM awal di tampilkan yang kemudian akan diuji.

Commented [SM22]: For convergent validity results, they should be displayed in table form for each item. Factor loading must refer to analysis using Smart PLS with a predetermined model, so it is necessary to display the specified model

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	PUB_Prak8		0.752	
PUB-Program	PUB_Prog1	0.896	0.790	0.9210.660
	PUB_Prog2		0.730	
	PUB_Prog3		0.870	
	PUB_Prog4		0.815	
	PUB_Prog5		0.823	
	PUB_Prog6		0.840	

Table 2
Summary of research hypothesis testing

Hypothesis	*b*	*t*-value	Decision
(H1) KEPMP → PMUP	0.017	0.284	No
(H2) KJHPM → PMUP	0.322*	5,669	Yes
(H3) PUB-Practicum → PMUP	0.395*	6,853	Yes
(H4) PUB-Program → PMUP	0.324*	5.179	Yes
(H5) PUB-Practicum → KEPMP	0.277*	3,745	Yes
(H6) PUB-Program → KEPMP	0.260	3.256	Yes
(H7) PUB-Practicum → KJHPM	0.024	0.281	No
(H8) PUB-Program → KJHPM	0.108	1.244	No

Note: **p* value < 0.001

Discriminant validity is fulfilled if the value of the power root of AVE is greater than the correlation value of the latent variable (Ab Hamid et al., 2017). In addition, discriminant validity can also be assessed through testing the cross loading of study items (Hair et al., 2017). As shown in Table 2, the AVE root value of this research variable is higher than the correlation value. Of the latent variable, therefore, the pilot study data show that each study variable meets the required criteria. A structural model explains the relationship between one latent variable and another latent variable (Hair et al., 2017). Structural model analysis is not only aimed at testing hypotheses, but it also involves testing the strength of the relationship between the dependent variable and the independent variable. In addition, the structural model also displays the amount of variance (R2) explained by the independent variable over the dependent variable and the entire model. Table 1 and table 2 show the findings from the analysis that was carried out. Findings from the analysis of the structural model as attached (refer to the Appendix) show, (H1) KEPMP does not have a significant direct effect on mathematical knowledge for teaching ($\beta = 0.017$, $p > 0.1$), (H2) KJHPM has a significant direct effect on mathematical knowledge for teaching ($\beta = 0.322$, $p < 0.001$), (H3) PUB-Practicum has a significant direct effect on mathematical knowledge for teaching ($\beta = 0.395$, $p < 0.001$), (H4) PUB-Program has a direct effect which is significant to mathematical Knowledge for teaching ($\beta = 0.325$, $p < 0.001$). In addition, the findings from the analysis that has been carried out also found that the factor (H5) PUB-Practikum has a significant direct effect on KEPMP ($\beta = 0.277$, $p < 0.001$) and (H6) PUB-Program also has a significant direct effect on KEPMP ($\beta = 0.260$, $p < 0.001$). While the influence of factors (H7) PUB-Practicum and (H8) PUB-Program was found to have no significant direct effect on KJHPM ($\beta = 0.024$, $p > 0.1$ and $\beta = 0.10$, $p > 0.1$). Overall, the model explains the value of the variant against

Discussion

This study was conducted to examine the factors that influence PMUP among pre-service teachers in Indonesia. This study has tested the influence of KEPM and PUB factors on PMUP and the influence of PUB factors on teachers' KEPM. Based on the analysis conducted, it was found that the KJHPM factor has a significant relationship with PMUP ($\beta = 0.322$, $p < 0.001$). This finding confirms that pre-service

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For the data analysis process, the results must be described in detail regarding what tests were used. You can study an example of an article about scale validity below: https://www.eu-jer.com/core.php?ajax=count&link=EU-JER_13_2_541.pdf

teachers who have a high positive KJHPM will also master the PMUP learned while attending the teacher education program at IPG.This finding confirms that pre-service teachers who have a high KEPM will also master the PMUP learned while attending the teacher education program at IPG.

There are several possibilities that cause KJHPM factors to play a role in influencing the level of pre-service teachers' mastery of PMUP. Among them is because they believe that effective teaching methods can affect students' mathematics achievement (Hwang et al., 2021). Pre-service teachers' beliefs regarding the importance of effective teaching may have influenced their PMUP to some extent. This is because according to Blazar, (2015), effective teaching activities can influence student achievement. For example, if a teacher believes that effective teaching can contribute to students' mathematics achievement, then this will encourage them to study PMUP to ensure that they can teach more effectively in the future. Findings from testing this hypothesis are supported by some findings from previous studies. Among the findings from the study by Swars et al. (2007; 2009) who found that KJHPM is one of the factors that influence the PMUP of pre-service teachers in the United States. However, it is different for the findings of the study by Newton et al.(2007) showing that the KJHPM factor does not affect the teacher's PMUP. As the party responsible for training pre-service teachers who will serve as primary school mathematics teachers, IPGM should take some necessary steps to ensure that the level of KJHPM can be improved? The increase in the level of KJHPM is important because it is one of the factors that contribute to the increase in the mastery of PMUP among pre-service teachers in IPG. Apart from the PUB factor obtained while following the teacher education program at IPG, other factors which identified to influence their KJHPM is emotional intelligence (Alsiraji & El-Shatshat, 2017). Therefore, it is suggested that the IPGM can design a mathematics education curriculum that can stimulate the emotional intelligence of pre-service teachers in the future.

In addition, according to Lotter et al. (2016) on the other hand, the level of belief in teacher efficacy can be increased through professional development programs. While following the teacher education program at IPG, the trainee teachers were exposed to various courses to ensure they are able to become competent teachers in the future. Therefore, the IPGM is suggested to redouble its efforts to provide more robust professional development courses and programs to ensure that the level of confidence in the efficacy of pre-service teachers can be increased and indirectly contribute to an increase in their mastery of PMUP. Findings from the hypothesis testing that has been carried out show that the PUB factor has the strongest positive relationship with the PMUP of pre-service teachers in IPG. More information about the results of the analysis carried out has been displayed in Table 2. This finding confirms that pre-service teachers who obtain a high positive PUB will also master the PMUP learned while attending the teacher education program at IPG. Based on the analysis that has been carried out, it is also found that the PUB factor among pre-service teachers is explained by the opportunity factor to undergo teaching training more dominantly ($\beta = 0.395$, $p < 0.001$) than the opportunity factor to follow a coherent teacher education program ($\beta = 0.325$, $p < 0.001$).

According to Gerasimova et al. (2017) the balance between theory and practice is important to produce quality prospective teachers in the future. Every pre-service teacher at IPG has been given sufficient opportunities to deepen knowledge either in terms of theory or practice. The curriculum designed by the IPGM covers all aspects to ensure that the potential teachers produced are able to compete and can successfully educate students. In addition, the opportunity to undergo teaching training (practicum) for two phases, which is about three months for each phase with the guidance of experienced lecturers and mentors, also contributed to some extent to the perception of pre-service teachers related to PUB obtained during the education program teacher at IPG. According to Toh, Kaur. (2009) the period of undergoing sufficient teaching training can affect the level of mastery of PMUP of pre-service teachers. This finding confirms that pre-service teachers who obtaining a high positive PUB will also master the PMUP learned while following the teacher education program at IPG.

This finding is supported by some findings from previous studies. A study by O'Neill & Stephenson. (2012) found that PUB is one of the factors that influence the PMUP of pre-service teachers. A study by Okumuş et al. (2016) also found that PUB factors have influenced teachers' knowledge. In addition, a study conducted by Livy et al. (2016) on two pre-service teachers in Australia also found that practicum experience is an important factor that can help them form mathematical PK. Findings from a study by Tatto (2015) showed that there is a significant relationship between PUB obtained by in-service teachers while following a teacher education program and PMUP. The study was conducted on pre-service teachers in several countries using data from the IEA. Meanwhile, a study by Qian and Youngs (2016) conducted on teachers in five countries using TEDS-M data also found that the PUB

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factor affects the knowledge mastery of a pre-service teacher. Findings from other studies also support the findings of this study, including studies by Blömeke et al. (2017) and Höhn et al. (2017). Findings from a study conducted by Blömeke & Delaney (2012) showed that there is a significant relationship between PUB and PMUP of pre-service teachers. The study was conducted on pre-service in Germany. Meanwhile, a study by Höhn et al. (2017) also conducted on 444 Germans, also found that the PUB factor affects pre-service teachers' mastery of knowledge. A recent study conducted by Livy and Downton (2018) for teachers in Australia also found that PUB factors affect teachers' PMUP. In addition, a study by Murray, Durkin, Chao and Star (2018) also shows that there is a significant relationship between PUB and PMUP.

IPGM's role as an institution responsible for producing competent mathematics teachers, is a sign from the Ministry of Education and Culture to provide sufficient allocations to ensure that the widest possible PUB can be enjoyed by pre-service teachers. Apart from providing opportunities to undergo practicum and coherent teacher education programs, pre-service teachers should also be given opportunities to learn knowledge related to pedagogy more effectively. The opportunity factor to learn knowledge related to general pedagogy and mathematics pedagogy can influence the level of knowledge mastery of pre-service teachers. The delivery of knowledge related to pedagogy to pre-service teachers is directly related to the structure of the curriculum and the quality of lecturers. Therefore, in order to guarantee the delivery of knowledge related to pedagogy more effectively, it is suggested that the IPGM always update the mathematics education curriculum and at the same time also carry out continuous efforts to improve the competence of mathematics lecturers in the delivery of knowledge related to pedagogy (mathematics education). Findings from testing H5 and H6 show that the PUB factor has a positive relationship with KEPM. More information from the analysis conducted has been displayed in Table 3. This finding confirms that pre-service teachers who obtain a high positive PUB will also influence their KEPM. This situation may occur due to the experience that pre-service teachers go through while following the teacher education program has influenced their self-efficacy beliefs. For example, the experience of going through school-based experiential programs, micro-teaching exercises and practicum experiences have led them to believe that student learning is influenced by effective teaching (KJHPM). In addition, the experiences they have had while following the teacher education program are also likely to have caused them to feel more confident about their ability to teach (KEPMP). This finding is supported by some findings from previous studies. Among the findings from the study by Koszycki et al. (2010) who found that PUB is one of the factors that influence the KEPM of pre-service teachers. Findings from other studies also support the findings of this study, including a study by Philippou et al. (2021) who also found that the opportunity factor to follow a coherent teacher education program affects teachers' KEPM. A recent study conducted by Berger et al. (2018) on 154 vocational teachers also found that the factor of teaching experience (PUB-Practicum) affects teachers' efficacy beliefs.

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Limitations and Suggestions for Future Research

Research related to teacher knowledge is an ongoing and developing field of study. Based on the critical analysis that has been carried out, it was found throughout the year 2017 until June 2018, there are already almost 30 studies related to teacher knowledge published in selected journals. This clearly proves that research related to teacher knowledge is important and is the focus of researchers around the world. According to Ren et al., (2018), more research is needed in the future to explain how mathematics knowledge and teachers' beliefs are interrelated with each other. This study only focuses on the factors that affect PMUP among pre-service teachers only. Therefore, in the future it is suggested that the scope of the study be expanded to in-service mathematics teachers and mathematics lecturers at IPG and Public Higher Education Institutions. In addition, it is also suggested in the future that this study be extended to pre-service teachers in the field of early childhood education and rehabilitation. This is because both fields also require mastery of PMUP in implementing their teaching. In addition, from the point of view of model testing, it is suggested in the future to test factors such as socio-economic status and involvement in teaching and research (teaching and research) as variables that affect PMUP. This is because according to (Wen et al., 2019), socio-economic status factors also influence pre-service teachers' mastery of PK and PPK. Meanwhile, a study by (Mu et al., 2018) found that the factor of involvement in teaching and research also affects teachers' knowledge. Therefore, in the future

it is suggested that these two factors be included and tested in the model of factors that affect pre-service teachers' PMUP.

Conclusion

The findings from this study reveal that the main factor influencing PMUP for prospective teachers is PUB. The provision of opportunities to participate in coherent teacher education programs as well as opportunities to attend teaching training by the IPGs had a positive effect on their PMUP. This factor has implications for students' understanding and way of thinking in understanding the material being studied. According to Barnard-Brak et al., (2018) besides being able to increase PMUP, PUB factors can also increase the mathematics learning achievement of prospective teachers. Apart from the PUB factor, the KJHPM factor was also found to influence the PMUP of prospective teachers. Overall it is known that the resulting model of the factors that influence PMUP for prospective teachers is valid. Based on the analysis conducted, it is known that the two factors, namely KEPM and PUB, have a contribution of 54% to the PMUP variant. That is, overall this model has moderate predictive power. Thus it is necessary to carry out further research in the future by considering the factors that have been suggested to increase the predictive power of this model. Therefore, in the future it is recommended that IPG open more PUB opportunities for prospective teachers to assist them in improving their mastery of PMUP. The research suggests further research to develop these findings and combine them in the world of digital technology in the learning process.

Commented [SM30]: Untuk bagian limitasi akan lebih bagus menyoroti bagaimana jumlah sampel yang digunakan, cakupan wilayah, calon guru pada jenjang sekolah dapat juka kejuruan, karakteristik guru yang diteliti, kekurangan instrumen yang digunakn. Sehingga, dapat dijadikan acuaan untuk penelitian selanjutnya

Commented [SM31]: Adapt the conclusion section to the proposed hypothesis. Because the principle of quantitative research is to test predetermined hypotheses. Next, also align the introduction and abstract sections, so that there is coherence.

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