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Exploring the Relationship between Preservice Science Teachers' Beliefs and Self-Regulated Strategies of Studying Physics: A Structural Equation Model

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ABSTRACT

This study aimed at exploring a structural equation model on the relationship between preservice science teachers' beliefs and self-regulation strategies of studying physics. The sample of the study consisted of 248 pre-service science teachers drawn from department of physics education at one state university and one state Islamic university in Jambi, Indonesia. The Colorado learning attitudes about Science Survey (CLASS) was used to measure their beliefs of physics and physics learning. Furthermore, motivated strategies for learning questionnaire (MSLQ) was also deployed to measure their self-regulation strategies on studying physics. Variance-based structural equation modeling (SEM with PLS) showed that sophisticated beliefs were positively correlated to the use of elaboration, organization, and metacognitive strategies whilst naïve beliefs were positively correlated with the use of rehearsal and elaboration methods. This study provides insightful implications for educators, especially lecturers, on how to plan, design, and practice the appropriate and effective pedagogical strategies to replace naïve beliefs with sophisticated ones, and to enhance the use of self-regulated strategies in studying physics.

Keywords: Self -regulated strategy, structural equation modeling, student beliefs.

INTRODUCTION

Physics, which is a branch of science, has its own uniquenes sincorporating abstract concepts and requires an idealization through a mathematical modeling. This makes physics difficult to be conceptually understood and taught (Duit, Niedderer, & Schecker, 2007). Higher percentage of researches in physics education compared to other science branches such as chemistry and biology support these facts. As a matter of fact, Duit et al. (2007) indicated that 64% of the documented studies were in the physics education, whilst the percentages of those in the biology education, and chemistry education were 21 and 15 respectively.Various educational studies indicated that student success in studying physics

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depends not only on the cognitive aspects, but also on the social and individual traits of students. That is, students' beliefs of characteristics of physics knowledge and knowing how to obtain it influence their successes in studying physics (Hammer, 1994; Kortemeyer, 2007; Otero, 2004). Furthermore, Kortemeyer (2007) states that students with sophisticated beliefs understand how the characteristics and processes of knowledge in physics are constructed. Also, they are able to monitor, evaluate, and improve their learning processes. On the contrary, students with naïve beliefs view physics as memorizable information or facts, and pay more attention to remember the formula and problem-solving algorithms instead of developing conceptual understanding of physics.

Students' beliefs and interrelated various aspects of student learning have mostly been explored in such European countries as Germany (Bromme, Pieschl, & Stahl, 2010), Italy (Mason, 2000; Mason & Boldrin, 2008), Norway (Bråten & Strømsø, 2005), and Spanish (Limon, 2006). For the Asian context, those have dominantly been investigated such countries as Taiwan (Lin, Deng, Chai, & Tsai, 2013, Tsai, 2000), Hongkong (Chai, Ho, & Ku, 2011), Singapore (Chai, Teo , & Lee, 2010), Korea (Hyo-Jeong, Ji-Yeon, Seak-Zoon, & Sang-Kon, 2010), and Turkey (Kapucu & Bahçivan, 2015; Yilmaz-Tüzün &Topcu, 2010). However, even though Indonesian physics studies have focused on students' beliefs and their relevance to various learning activities, how students use their self-regulated strategies in studying physics have still been unexplored. Cascallar, Boekaerts, and Costigan (2006) state that self-regulated ability plays a key role in determining student's active engagement in the learning process. Self-regulated learning, which is a complex feature, involves multidimensional constructs (i.e., cognitive, affective, motivational and behavioral aspects). Also, Hofer and Bendixen (2012) emphasize a need for portraying students' beliefs and related learning aspects (e.g., the role of self-regulated strategy in physics learning). Hence, the current study intends to broaden the researches on students' beliefs to a developing country (i.e., Indonesia).

Purpose

This study aimed at exploring a structural equation model on the relationship between preservice science teachers' beliefs and self-regulation strategies of studying physics. The following research question guided the current study: What doesthe structural equation model indicate on the relationship(s) between pre-service science teachers' beliefs and self-regulated strategies in studying physics?

Hypothesis

As seen in Figure 1, the current study hypothesized that students' beliefs would contribute to their self-regulated strategies in learning physics (rehearsal, organization, elaboration, critical thinking, and metacognitive).

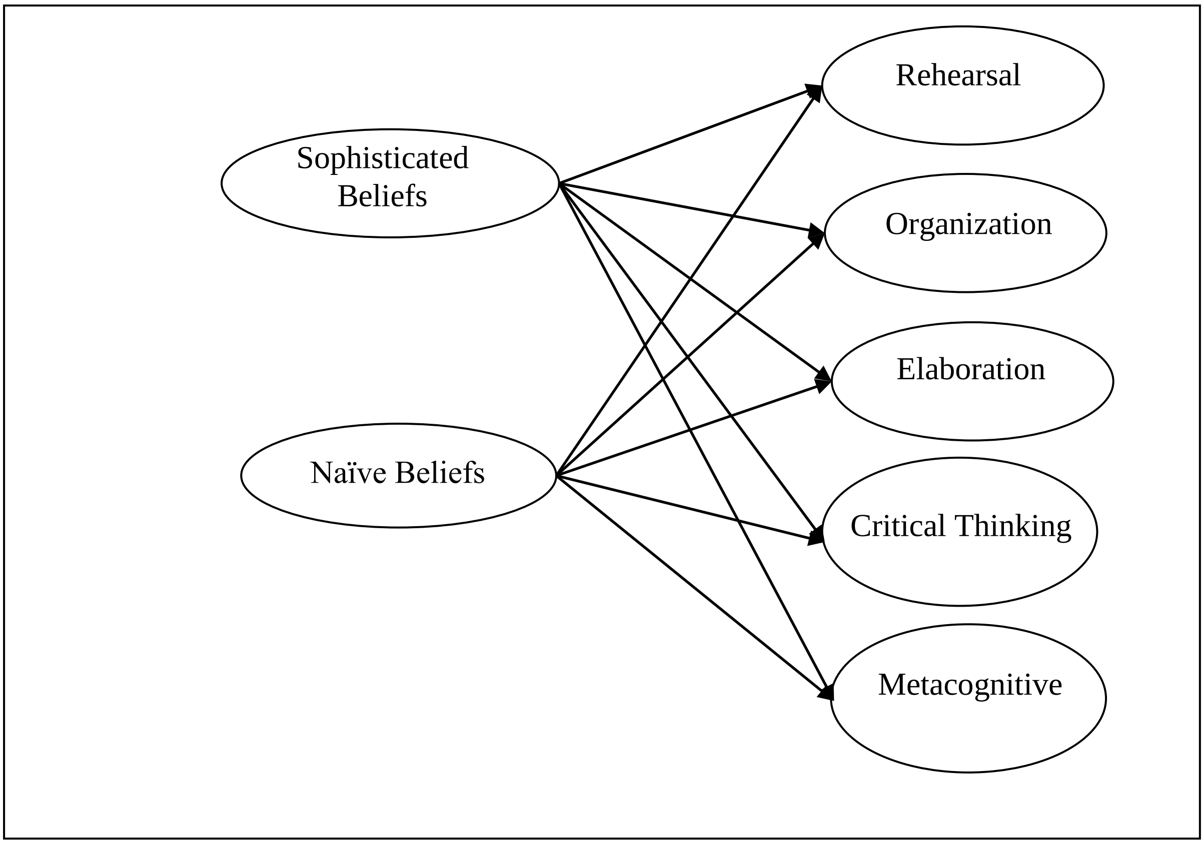

Figure 1. *Research Model on Students' Beliefs and Self-regulated Strategies in Studying Physics*

LITERATURE REVIEW

a) Student Beliefs on Physics and Physics Learning

Psychology researchers define students' beliefs of learning as the nature of knowledge and/or knowing. Two theoretical frameworks scrutinize students' beliefs: developmental and multidimensional (Hofer & Pintrich, 1997). Developmental framework sees beliefs as a pattern sequence of cognitive development. Five major models under the framework are avaiable: "Perry scheme" (Perry, 1970), "women's ways of knowing" (Belenky, Clinchy, Goldberger, & Tarule, 1986), epistemological reflection (Baxter Magolda, 2004), reflective judgement (King & Kitchener, 1994), and argumentative reasoning (Kuhn, 1991). Although each model has a different label for each developmental stage, they possess several common characteristics. Specifically, absolutism, multiplism, and evaluatism are considered as important features in describing students' beliefs (Muis, 2007). Schommer (1990) proposes different perspectives in describing students' beliefs: structure, certainty, source of knowledge, and control and speed knowledge acquisition (Hofer & Pintrich, 1997). Multidimensional framework which has initiated an important research line, links epistemological beliefs to various aspects of student's learning, for example, student performance and classroom learning environment. In line with Schommer (1990), Hammer and Elby (2002) also offer another model for multidimensional framework (called epistemological resources) and view epistemological beliefs as a more context dependent (i.e., a particular physics course) (Hammer, 1994b).

In the last few decades, several researches of students' beliefs have practically tested the characteristics of knowledge. Most of them has analyzed the interrelationships between beliefs and various aspects of student learning, such as conceptual understanding (Cano, 2005; Chu, Treagust, & Chandrasegaran, 2008; Rebello, Siegel, Witzig, Freyermuth, & McClure, 2012; Sahin, 2010), and the use of self-regulated strategies and metacognitive (Bråten & Strømsø, 2005; Yilmaz-Tüzün & Topcu, 2010), attitude (Kapucu & Bahçivan, 2015) and academic achievement (Lin et al., 2013). Nevertheless, how students' beliefs interact with their self-regulated strategies in studying physics has never been explored yet for the Indonesian context. In view of Hofer and Bendixen (2012), further studies on students' beliefs within and across cultures are needed to illuminate the constructs of personal epistemologies.

Some questionnaires are specially developed to measure students' beliefs about physics and physics learning. These are: the Maryland Physics Expectation Survey (MPEX), Views about Science Survey (VASS) (Halloun and Hestenes, 1998), Epistemological Beliefs Assessment for Physics Science (EBAPS) (Elby, Frederiksen, Schwarz, and White, 2001), and The Colorado Learning Attitudes About Science Survey (CLASS) (Adams et al., 2006). The CLASS, which is the last one, was developed by taking earlier instruments (MPEX, VASS, and EBAPS) into account. A 27-item CLASS questionnaire includes Likert scale statements within 8 sub-dimensions: a real world connection, personal interest, sense of effort, conceptual connections, applied conceptual understanding, problem solving (general), problem solving (confidence), and problem solving (sophistication). There are some principal differences between the CLASS and other instruments (Adams et al., 2006). For example, the CLASS instrument addresses various important issues of physics learning and concisely constructs all phrases in each item. By avoiding double interpretations for students or experts, the CLASS categorizes each item into the category or scale for rigorous statistical analysis. Overall, each category or scale characterizes important aspects of the student's mindset. Despite its advantages vis-a-vis other instruments, several researchers have criticized some overlapp items.

Douglas, Yale, Bennett, Haugan, and Bryan (2014) reported that the CLASS questionnaire with eight belief dimensions (a total of 26 items) are highly complex. In addition, they implied that several items were categorized under more than one dimension. For example; the item "If I get stuck on a physics problem, there is no chance I'll figure it out on my own" fell into the dimensions of the applied conceptual understanding, problem solving in general, problem solving confidence, and problem solving satisfaction. This indicated that the construct of the CLASS questionnaire was not unidimensional. exploratory and confirmatory factor analysis by Douglas et al. (2014) pointed to three belief dimensions; personal application and real world relation, problem solving/ learning, and effort/ sense making. The current study ensured the validity and reliablity of the questionnaire measuring Indonesian university students' beliefs through exploratory and confirmatory factor analysis .

b) Self-Regulated Learning

Understanding students' capacities or abilitiesy of students to direct their formal and informal learning has become a central and debatable topic for educators, policymakers, and educational researchers. Given various models of self-regulated learning, Puustinen and Pulkinen (2001) referred to two types of self-regulated learning, namely goal-oriented and metacognitive-oriented self-regulated learning. A goal-oriented definition views self-regulated learning as a result–oriented process emphasizing the constructive or self-generated character of self-regulation (Muis, 2007). This definition asserts that monitoring, regulating, and controlling in the learning process involves not only cognitive, but also motivational, emotional, and social factors (Pintrich & De Groot, 1990; Zimmerman, 2000; Zimmerman & Schunk, 2001). Metacognitive-oriented one emphasizes metacognitive abilities as a significant part of self-regulation. Although these two models have the different foci on the components of self-regulated learning, all authors have the same assumption regarding SRL. Indeed, all models assume that students actively construct knowledge, set goals, and strategies from internal and external contexts by controlling cognitive, motivational, and behaviorial aspects of the learning environment during the learning process (Muis, 2007).

The goal-oriented SRL is rooted by social cognitive theory by Bandura (1997). That is, self-regulated learning is a result of the interaction between personal, behavioral, and environmental factors. Also, social cognitive perspective views the quality of self-regulated learning as the dependent of metacognitive ability (Zimmerman, 2000). For example, Learning process includes to choose cognitive strategies and emphasize personal aspects, namely beliefs and motivation. Furthermore, Zimmerman (2000) draws self-regulation as a triadic cycle process (see Figure 2).

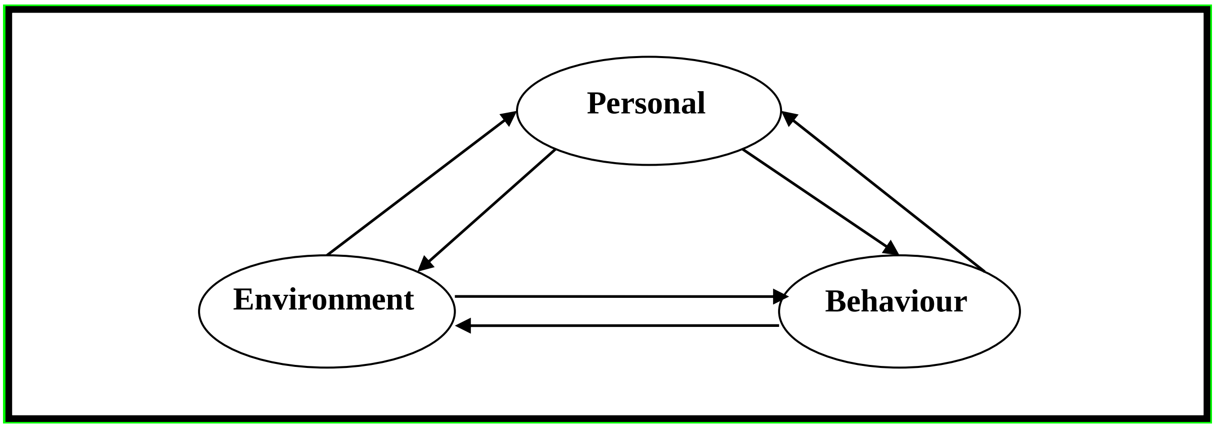

Figure 2. *Triadic Process of Self-Regulation* (Zimmerman, 2000)

As seen in Figure 2, human being is the result of an interdependent causal structure of the personal (e.g., beliefs, motivation), environmental (e.g., classroom), and behaviorial (e.g., self-regulation) factors. These three aspects are the determinants of self-regulated learning. Bandura (1986) explains that these aspects are causally interrelated. Namely, when a person attempts to self-regulate, the result is his performance or behavior, and this behavior affects his environmental change.

Although there is no simple and straightforward definition of self-regulation, the theory of educational psychology has narrowed the scope of students' self-regulated abilities to the academic side of education, i.e., learning objectives and academic achievement (Boekaerts & Corno, 2005). Researchers, in particular, argue that self-regulated ability is central to the educational assumptions of learning, decision-making, problem-solving, and resource management. Furthermore, Carver and Scheier (1990) depict that self-regulation is a complex system, a set of superodinic functions located at the crossroads of several psychological studies on cognition, problem solving, decision making, metacognition, conceptual change, motivation, and volition. Additionally, Zimmerman (2002) defines self-regulated learning as the degree of metacognition, intrinsic motivation and individual behaviors in the learning process. Wolters (2003) states that self-regulated learning, which engage students in actively constructing their learning processes, fosters them to to monitor, organize, and control their cognitive, motivational, and behaviorial issues. In fact, goals direct and drive these issues to prioritize the environmental context. To sum up, self regulation requires students to actively engage in learning process by monitoring, controlling, and evaluating the use of cognition, motivation, and behavior through learning goals.

c) Students' Beliefs and Self-Regulated Strategies in Physics Learning

As mentioned above, beliefs as a multidimensional system (Schommer, 1990) initiate the development of research exploring the relationship(s) between epistemological beliefs and various aspects of student learning, i.e., academic achievement (Muis, 2007; Savoji, Niusha, & Boreiri, 2013), learning environment (Velayutham, Aldridge, & Afari, 2013), and self-regulation (Bråten & Strømsø, 2005; Greene, Muis, & Pieschl, 2010). Meanwhile, Hammer and Elby (2002) also developed a model called the epistemological belief resources given Schommer's (1990) framework. This model explains that students' beliefs of learning are highly dependent on the context (e. g., physics, mathematics, social, etc.). Hammer (1994) classified students' beliefs of physics and physics learning into three dimensions, namely beliefs about the structure of physics, the content of physics knowledge, and the learning process in physics.

A few studies have attempted to analyze the correlations between students' beliefs of learning and self-regulation. Muis and Franco (2009) found that epistemic beliefs influenced the types of learning strategies used by students in the introductory educational psychology course, and achievement goals mediated relations between epistemic beliefs and learning strategies. Dahl, Bals, and Turi (2005) analyzed the relationship between students' beliefs of knowledge and learning with the use of learning strategies in understanding text. Their results proved that students' beliefs of knowledge structure and innate ability significantly contributed to the use of learning strategies. Students, who believed that knowledge was a collection of facts isolated from each other (simple knowledge), tended to use rehearsal learning strategies (repeat) rather than organizational strategies. While students, who believed that learning was an innate ability, tended to rarely use elaboration strategies and critical thinking. Students with naïve belief tended to learn with superficial strategies (e.g., rehearsals) and failed to connect their prior knowledge with new learned one. Also, these students were reluctant to use critical thinking skills in processing information. On the other hand, Bråten and Strømsø (2005) elicited that preservice teachers' beliefs of knowledge construction and modification were a better predictor for self-regulated learning, while business administration students'beliefs of the certainty of knowledge played an crucial role in self-regulated learning. However, none of these studies has investigated the relationship(s) between students' beliefs and their self-regulated learning of physics learning. Therefore, this study purposed to fill in an important gap in the related literature, especially physics education. This study aimed to explore preservice science teachers' beliefs of physics and physics learning, and to examine the relationship(s) between their beliefs and self-regulated strategies (rehearsal, elaboration, organization, critical thinking, and metacognitve) in studying physics.

METHODOLOGY

a) The sample of the study and instruments

A total of 248 students were drawn from physics education at one state and one state Islamic universities in Jambi, Indonesia. All participants were asked to sign a consent form to participate in this study. Hence, only partipants who signed the consent form and were willing to take part in the current study, involved in the sample of the study. Prior to the analysis, the researchers firstly performed cleanup data. The researchers reviewed students' responses on each item to check any unfilled one and re-rank any negative item. This preliminary process finally generated 244 valid responses for running the next analysis stage. Table 1 summarizes the sample's demographic information.

Table 1. *Participants' Demographic Information*

Datasetting	Gender		Age
	Male	Female	
Department of Physics Education -A	57	89	18 to 21
Department of Physics Education -B	39	63	

The researchers followed a-two-stage test. The first test was the exploratory factor analysis (EFA) to measure students' beliefs of physics and physics learning using the Colorado Learning Attitudes about Science Survey (CLASS). The second test was the confirmatory factor analysis (CFA)to analyze the convergent validity of each sub-factor in the EFA test and examine the structural equation model on the relationship(s) between students' beliefs variables and self-regulated learning in studying physics. Since these analysis cannot use the same dataset (DeCoster, 1998), the researchers randomly split the data into two parts, named "odd" (for the exploratory factor analysis) and 'even" data (for the confirmatory factor analysis).

In collecting quantitative data, the researchers used two questionnaires; (1) Motivated Strategies for Learning Questionnaire (MSLQ) to measure students' self-regulated strategies in learning (Pintrich, 1991), and (2) The Colorado Learning Attitudes About Science Survey (CLASS) to measure students' beliefs of physics and physics learning (Adams et al., 2006). To ensure the validity and reliablity of the instruments for the Indonesian context, the CLASS and MSLQ questionnaires were firstly adapted into the Indonesian versions by means of several stages. In the first stage, the CLASS and MSLQ questionnaires were translated into Indonesian by two bilingual lecturers from the Department of Physics Education. Also, their feedbacks were employed to improve the translation procedure.

The next stage tested the obtained data using the factor analysis test within SPSS 22.0^{TM}. Factor analysis allowed the researchers to determine whether multiple variables could be explained by several factors (Fraenkel, Wallen, & Hyun, 2011). The exploratory factor analysis was exploited in the current study with the main component analysis, varimax rotation for Eigen value> 1. Figure 3 outlines the flowchart of validation process of the CLASS and MSLQ questionnaires.

Figure 3. *Flowchart Validation Process of the CLASS and MSLQ Questionnaires*

b) Data Analysis

This study used data analysis with Partial Least Square-Structural Equation Modeling (PLS-SEM model) through SmartPLS version 3.0 software. SEM, which is a multivariate analysis, combines factor analysis with simultaneous path analysis. The SEM model integrates empirical data analysis into theoretical constructs. In this study, the ultimate goal of SEM was to obtain a structural equation model on the relationship(s) amongst students' learning environment, self-regulated strategies, and beliefs of studying physics.

FINDINGS

a) Measurement of Data Quality

This study used the Structural Equation Model (SEM) based variance (VB-SEM) with the Partial Least Square Path Model (PLS-SEM) technique. The PLS approach, which is an Asymptotic Distribution Free (ADF), means that the data do not have a certain distribution pattern, and are nominal, category, ordinal, interval, and ratio. The minimum number of the sample for PLS-SEM is ten times, and the largest number of structural paths directed at specific latent constructs in the research model (Chin, Marcolin, and Newsted, 2003). Based on these rules, the number of the sample was 50 respondents for the present study. The sample of the present study (248 respondents) was more than the number suggested by Chin et al. (2003) and met the PLS model.

b) CLASS Questionnaire Validation Using Exploratory Factor Analysis

The results of the CLASS' factor analysis using the principal component analysis with the orthogonal rotation (varimax) yielded into two factors of their beliefs with the total variance of 31.003%. The initial assumption test showed the value of Kaiser-Meyer-Olkin of 0.693 with a significance value of 0.00. Both values (KMO > 0.5 and significance of Bartlet's Test of Sphericity < 0.05) met the initial requirements for the factor analysis (Pallant, 2013). The screenplot analysis shows the fractures after two factors (see Figure 4).

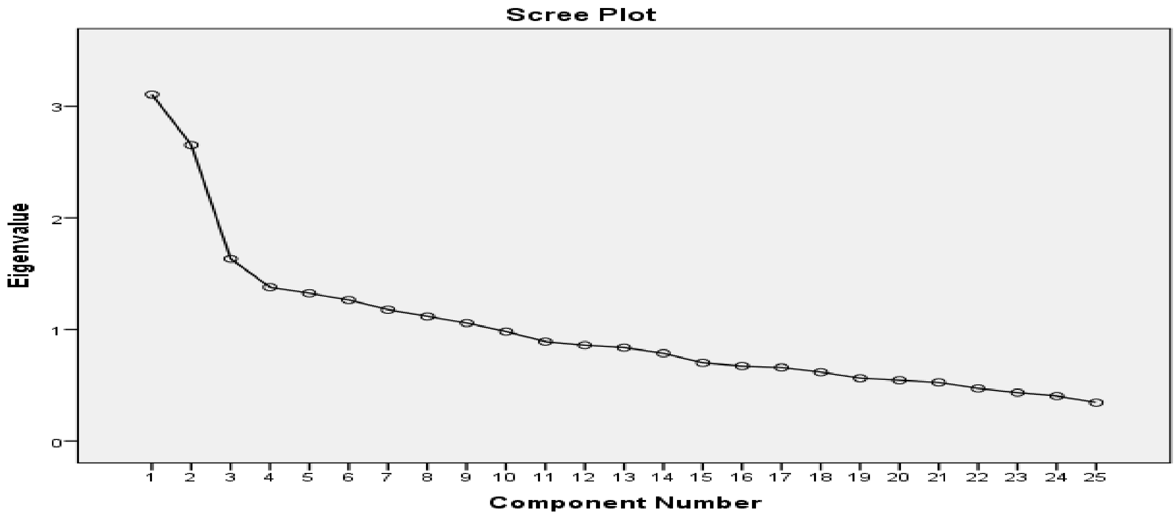

Figure 4. *Screen Plot Data*

As can be seen from Figure 4, the researchers decided two factors. The first factor consisted of items 9, 15-17, 23-25, while the second one comprised of items 4, 14, 15, 19, 21 and 26. Loading factor and reliability components are presented in Table 2.

Table 2. *Summary of Exploratory Factor Analysis and the Reliability of the CLASS Questionnaire for 2 Components*

Items	Components			
	1		2	
23		0.544		
16		0.540		
17		0.534		
9		0.497		
24		0.478		
15		0.469		
25		0.467		
26				0.660
21				0.623
19				0.541
14				0.537
15				0.514
4				0.514
Eigenvalue	3.104		2.651	
% Variance	12.417		10.602	
Cumulative %	12.417		23.019	
Reliablity	0.631		0.598	

c) Convergent Validity Using Confirmatory Factor Analysis (CFA)

The next step analyzed the convergence and discriminant validities of the CLASS questionnaire using 13 items from EFA. The researchers also checked the convergence validity of the MSLQ. Item reliability can be seen from the standardized loading factor, which describes the magnitude of the correlation between each item (indicator) and its latent construct. The loading factor value ≥ 0.7 is an ideal indicator for the construct validity (Chin, 1998; Hulland, 1999). Siswoyo (2015) views the loading factor value ≥ 0.5 as an acceptable value. Thus, the loading factor value ≤ 0.5 must be dropped from the research model. The CFA results showed that several items had lower loading factor values than 0.5 based on a total of 13 items in the CLASS questionnaire. Hence, Because items 3, 12-14, 19-21, 23, 27, and 36 were dropped from the model, six valid items of the CLASS questionnaire were categorized into two dimensions, namely problem solving (3 items), and personal interest (3 items). Item loadings, composite variance, and average variance extracted of each dimension of the CLASS and MSLQ are shown in Table 3.

Table 3. *Item Loading Factors for the CLASS dan MSLQ Questionnaires*

Construct	Item	Loading Factor
Sophisticated Beliefs	SB19	0.814
	SB21	0.776
	SB26	0.738
Naïve Beliefs	SB15	0.894
	SB17	0.642
	SB23	0.654
Rehearsal	RH39	0.796

	RH46	0.632
	RH59	0.719
Elaboratiom	EL53	0.661
	EL64	0.787
	EL67	0.693
Organization	OR32	0.738
	OR42	0.875
	OR63	0.518
Critical Thinking	CT38	0.669
	CT47	0.806
	CT51	0.717
	CT71	0.662
Metacognitive Self Regulation	MT41	0.728
	MT78	0.679
	MT79	0.777

The internal consistency in PLS-SEM analysis can be seen from Croncbach's alpha and composite reliability (CR) values. The composite reliability to measure internal consistency is better than Croncbach's Alpha because CR does not assume the boot similarity of each indicator. The composite reliability boundary value is equal to Croncbach's Aplha ≥ 0.7. The higher CR value means the higher construct contribution to the measurement model. The composite reliability of each latent construction of this study is displayed in Table 4.

Table 4. *Internal Consistency Values of the CLASS dan MSLQ Questionnaires*

Construct	Internal Consistency Values
Sophisticated Beliefs	0.820
Naïve Beliefs	0.779
Rehearsal	0.761
Elaboration	0.758
Organization	0.762
Critical Thinking	0.807
Metacognitive Self Regulation	0.772

The last criterion of convergent validity is the average variance extracted (AVE) measurement for each construct. The AVE value describes the variant or diversity of the manifest variables that the latent construct can have possesses (Siswoyo, 2015). Fornel and Lecker (1981, cited in Ghozali, 2008) recommend a minimum of 0.5 AVE for a good convergent validity.

Table 5. *Average Variance Extracted (AVE) Value*

Constructs	Average Variance Extracted (AVE) Values
Sophisticated Beliefs	0.603
Naïve Beliefs	0.546
Rehearsal	0.517
Elaboration	0.512
Organization	0.526
Critical Thinking	0.512
Metacognitive Self Regulation	0.531

d) Evaluation of Structural Model

Gefen, Straub, and Boudreau (2000) define two non-parametric methods for testing the relationship between the latent variables (boostrap and jacknife). In this study, the researchers used the boostrap method by evaluating the value of R2 and t statistic generated from calculating output of PLS Boostrapping. The influence between construct (s) and interaction effect (s) (moderation) was measured by the value of the coefficient path (path coefficient). Path coeficient, which has a t statistic value ≥ 1.96 or p-value ≤ 0.05, indicates a statistical significancy. The coefficient and t-value path for each hypothesis of relationship ways are shown in Table 6.

Table 6. *Coefficient Path Values*

Hyphothesis of relationship way	Original Sample (O)	T Statistics (|O/STDEV|)	P Values	Conclusion
Naïve Beliefs -> Critial Thinking	-0.184	1.308	0.191	Not significant
Naïve Beliefs -> Elaboration	-0.258	2.522	0.012	Significant
Naïve Beliefs -> Metacognitive	-0.193	1.957	0.051	Not significant
Naïve Beliefs -> Organization	-0.154	0.920	0.358	Not significant
Naïve Beliefs -> Rehearsal	-0.233	2.188	0.029	Significant
Sophisticated Beliefs -> Rehearsal	0.214	1.859	0.064	Not significant
Sophisticated Beliefs -> Organization	0.246	2.405	0.017	Significant
Sophisticated Beliefs -> Elaboration	0.296	3.092	0.002	Significant
Sophisticated Beliefs -> Critical Thinking	0.163	1.302	0.193	Not Significant
Sophisticated Beliefs-> Metacognitive	0.264	2.368	0.018	Significant

DISCUSSION

This study aimed at analyzing the structural relationship between students' beliefs and self-regulated strategies in physics learning. The CLASS questionnaire by Adams, Perkins, Dubson, Finkelstein, and Wieman (2004) was used to measure their beliefs of physics and learning physics. The CLASS questionnaire was adapted into the Indonesian version. The results of the EFA and CFA emerged six valid items categorized under two dimensions, namely sophisticated beliefs (3 items), and naïve beliefs (3 items). Sophisticated beliefs, which highlight students' views about the content and process of physics learning, emphasize conceptual understanding and the importance of re-constructing knowledge. Naïve beliefs viewphysics as a collection of formula. In view of naïve beliefs, the best way to learn physics is to memorize many formulaes.The composite reliability values for these belief dimensions (problem-solving ability and personal interest) were 0.820, and 0.779 respectively. The Indonesian version of the CLASS questionnaire was different from its original version by Douglas et al. (2014). As a matter of fact, Douglas et al. (2004) obtained three components from the explanatory factor analysis (EFA); personal application and real-life relation, problem-solving/learning, and effort/sense-making. Such a difference may result from different cultures and the number of varied samples. For instance; Douglas et al. (2014) studied with 3,844 students, who completed basic physics courses at Purdue University, while the present study involved in only 248 students. That is, the number of the sample might affect the reliability values of each belief components. An increase in the number of the sample might result in the better reliability value of the instrument.

The Motivated Strategies for Learning Questionnaire (MSLQ) was conducted by using the confirmatory factor analysis (CFA). The MSLQ consists of 5 components measuring students' self-regulated strategies in learning (rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation). Each component consists of 4-8 items. Based on the convergent and discriminant validities of the MSLQ, several items were dropped from the model. The CFA results yielded 15 items that are divided into five components (3 for each component). The other items, which had a loading factor value of ≤ 0.5, were excluded from the model. The five components of self-regulated strategies in the current study are consistent with Pintrich's (1991) ones.

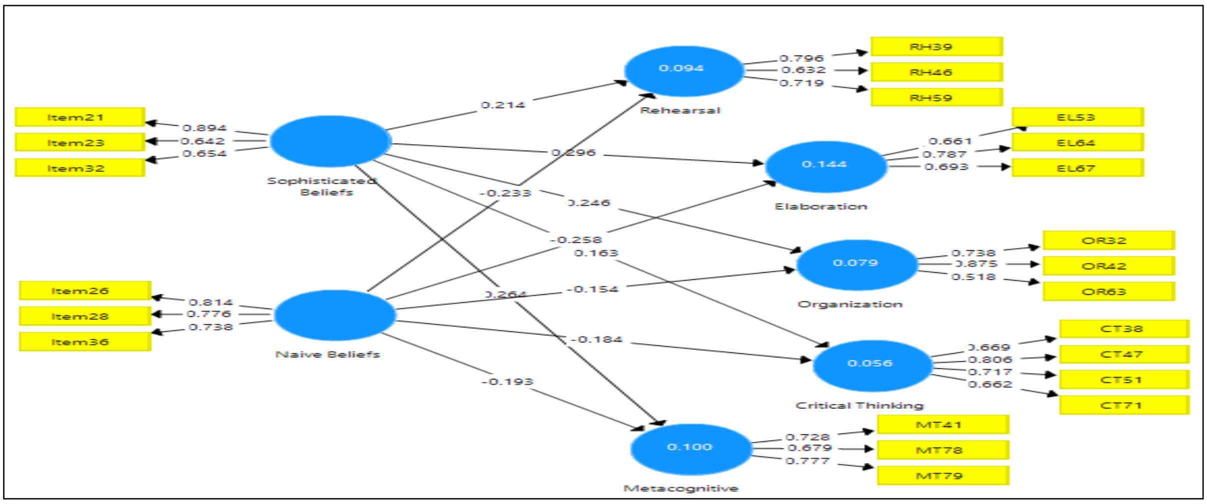

Figure 5. *Structural Equation Model on Students' Structural Beliefs and Self-regulated Strategies*

The structural equation model on the relationship(s) between students' beliefs, and self-regulated strategies in physics learning looked at the significance of the relationship between constructs shown by the value of t statistic output of bootstrapping if the value of t statistic ≥ 1.96 and the value of p value ≤0.05 exists. The structural equation model showed a positive and significant correlation between students' beliefs and self-regulated strategies in physcis learning although these positive and significant correlations were not available for all scales of research variables. The results showed that sophisticated beliefs were positively correlated with the use of elaboration, organization, and metacognitive strategies, whereas the naïve beliefs were related with the use of rehearsal and elaboration strategies. These findings are a paralel with those of earlier studies. Students with the sophisticated belifs, who understand the characteristic and construction process of physical knowledge, are able to monitor, evaluate, and improve the learning process. Previous researches indicate that students with the naïve beliefs, who fix, unchange, and hand down knowledge, are negatively related to their self-regulatory use (Bråten & Strømsø, 2005; Kortemeyer, 2007). Otherwise, students with the sophisticated beliefs realize that the best way to understand physics is to stress learning process on the conceptual understanding instead of memorizing the formulaes (Hammer, 1994a).

To sum up, belief, which is one of the internal factors, plays an important role in knowledge construction. How to use self-regulated strategies will, in turn, be used for learning process will be determined. Physics needs to be taught through the nature of physics. Physics is often taught as a memorizable collection of facts and formulaes, so that students' strategies of learning physics pay more attention to only memorize formulaes and problem solving algorithms. A meta-analysis by Madsen (2015) states that the physics teachers' teaching techniques have a positive impact on their students' beliefs from the naïve to the sophisticated ones.

CONCLUSION

This study aimed to explore the structural equation model of the relationship between preservice teachers' beliefs and self-regulated strategies of studying physics. 248 respondents were drawn from physics education at one state and one Islamic universities in Jambi, Indonesia. This study showed that sophisticated beliefs were positively correlated to the use of elaboration, organization, and metacognitive strategies. In contrast, naïve beliefs were positively correlated with the use of rehearsal and elaboration methods. In particular, the findings of this study revealed that belief was one of the inside factors playing an essential role in constructing knowledge, and governing students'self-regulated strategies for learning process of physics.This study not only carried out to achieve predetermined goals, but also offered an important contribution for science education, especially physics education. This study theoretically contributed to the literature that examines the role of student beliefs on acquiring knowledge and their relevance to the use of self-regulated strategies of studying physics. further, the current study methodologically used the structural equation model via the variance analysis or SEM with PLS to create a significant contribution to future researches. In brief, this study practically provided insights to educators, especially lecturers how to plan, design, and practice appropriate and effective pedagogical strategies to improve students' beliefs and self-regulated strategies in studying physics. The current study suggests that appropriate and effective self-regulated strategies affect students' academic achievement in studying physics.

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