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LEARNING ENVIRONMENT, STUDENTS' BELIEFS, AND SELF-REGULATION IN LEARNING PHYSICS: STRUCTURAL EQUATION MODELING

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Abstract. *Studies of correlations between students' beliefs and various aspects of student learning become one of the fastest growing research areas in the field of education and psychology. The aim of the current research was to analyze the correlations between learning environments, students' beliefs, and self-regulation in learning physics through structural equation modeling (SEM). There were 1010 students from the existing five public high schools in Jambi city, Indonesia, participating in the research. Three self-report questionnaires including (1) WIHIC, (2) CLASS, and (3) MSLQ were used to collect the research data. The data analysis showed that students' beliefs were significantly and positively correlated with multiple dimension of self-regulation in learning physics (critical thinking and peer learning); while the dimension of sense-making and problem-solving ability significantly related to the affective component of self-regulation (test anxiety). However, the dimension of students' beliefs did not have any significant effect on all of the self-regulation components. Additionally, learning environment dimensions were significantly related to students' beliefs about physics on the dimension of conceptual connection and related to all of the self-regulation dimensions.*
Keywords: *learning environment, self-regulation, students' beliefs, structural equation modeling.*

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Introduction

Physics is a branch of science that has its uniqueness and characteristics. The uniqueness of physics lies in the existence of concepts that are abstract and require idealization through mathematical modeling. This makes physics conceptually justified as a difficult subject, both to be learned and taught (Hofer & Pintrich, 1997; Mulhall & Gunstone, 2012). Some of the main obstacles faced by students in learning physics include: the low ability to explain the principles of physics qualitatively (McDermott, 1993), misconception (Duit, Niedderer, & Schecker, 2007), the low ability in solving physics problems (May & Etkina, 2002), low conceptual understanding (McDermott, 1993; Osborne, Simon, & Collins, 2003), and low motivation as well as low active involvement in learning physics (Tran, 2012).

Researchers in the field of science education try to explore the factors that affect students' learning process, especially in the field of physics by not only submitting observational evidence, but also involving a multi-perspective framework to understand, describe, and convey the role of a social and individual aspect on students' learning process (Otero, 2003). One of the individual aspects that plays an important role in the process of knowledge construction is a set of beliefs that students have about the characteristics of knowledge and how to acquire that knowledge (May & Etkina, 2002). Youn (2000) defined beliefs as implicit assumptions held by students about the source and certainty of knowledge and how to obtain it. This means that beliefs can be identified as a reference to learning, whereby knowledge acquired by students is generated from the cognitive process. Fishbein and Ajzen (2010) explained that these beliefs have a significant impact on individuals' attitudes, and finally, these attitudes influence individuals' behaviors.

Hammer (1994b) categorized students' beliefs about physics and physics learning in a continuum on three aspects, namely (1) beliefs about the structure of physical knowledge (pieces - coherence), (2) beliefs about

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the content of physics knowledge (conceptual understanding - formula), and (3) beliefs about the physics learning process (authority - independent). Hammer (1994a) described that students with beliefs that the structure of physics knowledge is coherent, emphasizing on conceptual understanding, and learning as a process of applying and modifying knowledge itself, tended to have better performance in solving physics problems. Contrary to that, students who have beliefs that physics is a collection of facts and formulas that must be memorized tend to fail to replace misconceptions with scientific ideas and have the low reasoning ability (Qian & Alvermann, 2000). Similarly, Sahin (2010) noted that students with sophisticated beliefs at the beginning of the semester tend to obtain higher concept comprehension scores at the end of the semester than students with negative beliefs.

Research Problems

Students' beliefs can be constructed, changed and strengthened. According to Tsai (2000) how the teacher explains the scientific concept and organizes information plays a vital role in the construction of students' beliefs. Furthermore, Tsai (2000) explained that students desire a learning environment which provides opportunities to interact with one another, integrate their prior knowledge and experience in the learning process, think independently and solve problems related to everyday life. In the same vein, Madsen, McKagan, and Sayre (2015) stated that teaching method and strategies which explicitly focus on developing models from the world of physics, including instructional strategies centered on inquiry activities, modeling instruction, physics, and everyday thinking resulted in a positive shift on students' beliefs in pre-test and post-test. This learning model involves students working in small groups to experiment and obtain evidence to build models from the world of physics.

Previous studies report that students' beliefs will influence academic performance (Cano, 2005), motivation (Lin, Deng, Chai, & Tsai, 2013), self-efficacy and attitude (Kapucu & Bahçivan, 2015), and learning strategies (Dahl, Bals, & Turi, 2005). Research findings by Dahl et al. (2005) showed that the less students believe knowledge is organized in a complex system (naive beliefs), the more they tend to report using rehearsal strategies, and the less they tend to report using organization and metacognitive strategies. Although all of the previous studies have explored the correlation between students' beliefs with various learning outcomes, none of these studies have explored the correlation between learning environment, students' beliefs, and self-regulation simultaneously. Therefore, the main purpose of this research was to study about the correlation between learning environment, students' beliefs, and self-regulation (motivation and cognitive and metacognitive component) in learning physics.

Based on the aforementioned research, it can be concluded that beliefs are a determining factor for students' success in understanding and applying physics in everyday life. As Kortemeyer (2007) said students with positive beliefs were students who understood the characteristics and process of construction of physics knowledge, and were able to monitor, evaluate, and improve the learning process. Nevertheless, students' beliefs could be constructed, changed, and strengthened. Research in education showed the pivotal key that played an important role in beliefs construction was the learning environment (Madsen et al., 2015; Ozkal, Tekkaya, Cakiroglu, & Sungur, 2009; Tsai, 2000). In addition, research has proven that students' beliefs influenced their motivation and their learning approach (Cano, 2005; Kapucu & Bahçivan, 2015; Ozkal et al., 2009; Tsai, Jessie Ho, Liang, & Lin, 2011).

Research Focus

Although the relation between learning environment, students' beliefs, and learning approaches has been analyzed in a wealth of studies, few studies have been done to explore the interaction between these variables in the physics domain. Moreover, no research about which psychosocial factors of learning environment have the most influence on beliefs' construction and students' self-regulation, as well as how these beliefs influence students' self-regulation (motivation component and cognitive and metacognitive component) in learning physics has been conducted. Therefore, the aim of this research was to explore a model of structural correlations between the learning environment, students' beliefs and self-regulation in learning physics, as guided by the following research questions:

1. Which psychosocial factors of the learning environment have the most salient influence on students' beliefs about physics and learning physics?
2. Which psychosocial factors of the learning environment have the most salient influence on students' regulation in learning physics, both in motivation and learning strategy aspects?
3. Which dimensions of student' beliefs have the most prominent influence on students' self-regulation in learning physics?

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Research Methodology

General Background

The conceptual framework of this research is based on the cognitive social theory that forms the basis for the development of constructive and cooperative learning models. According to the cognitive social theory, learning process occurs due to the reciprocal triadic between personal factors (students' beliefs), external factors (learning environment), and behaviors (self-regulation). Based on this existing theoretical framework, the researchers recommended a research model as seen in Figure 1.

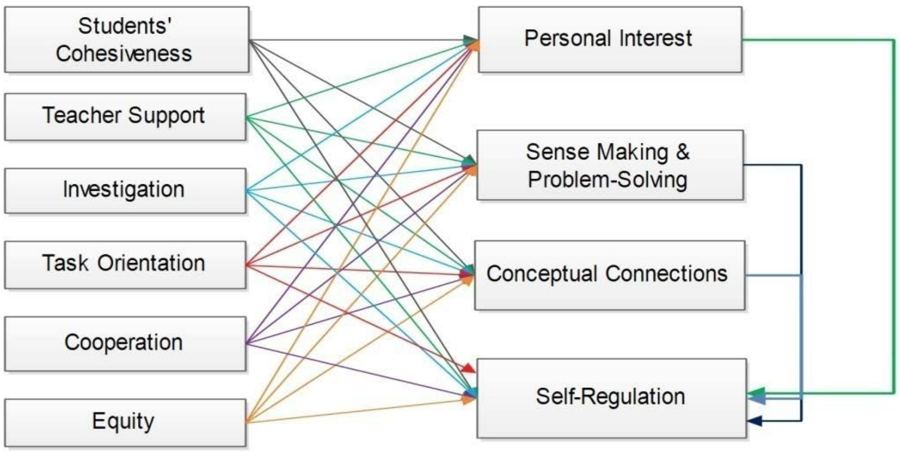

Figure 1. Research model.

The researcher's assumptions in this research were as follows: (1) psychosocial factors of classroom learning environment positively correlate with students' beliefs about physics; (2) students' beliefs positively correlate with the use of self-regulation in learning physics, (3) learning environment positively correlates with students' self-regulation in learning physics.

The researchers used the What is Happening in This Class (WIHIC) questionnaire to assess students' perception of the classroom learning environment (Aldridge, Fraser, & Huang, 1999; Fraser, Fisher, & McRobbie, 1996). The WIHIC consists of seven dimensions of psychosocial factors of the learning environment (cohesiveness, teacher support, investigation, involvement, task orientation, cooperation, and equity) that are developed based on human environmental theory initiated by Moos and Trickett (1987). In the theory, Moos et al. (1987) divided the human environment into three dimensions, namely relationship, personal development, and system maintenance and change. Students' cohesiveness, teacher support, and involvement fell into the relationship dimension according to Moos' scheme. While investigation, task orientation, and cooperation are parts of the personal development dimension. The last component, equity was a part of the system maintenance and change dimension.

Students' beliefs about physics and learning physics were assessed using The Colorado Learning Attitudes about Science Survey (CLASS) which was developed by Adams, Perkins, Dubson, Finkelstein, and Wieman (2005). The CLASS is developed based on the other established instruments that measure students' attitudes and beliefs about physics, such as the Maryland Physics Expectation Survey (MPEX), the Views about Science Survey (VASS), the Epistemological Beliefs Assessment, and Fishbein's theory of attitudes (Ajzen & Fishbein, 1977). The original version of CLASS consists of eight categories, namely: real-world connection, personal interest, sense-making/effort, conceptual connections, applied conceptual understanding, problem-solving (general), problem-solving (confidence), and problem-solving (sophistication). In the current research, the researchers used CLASS in *Bahasa Indonesia* version which was adapted and modified by Tanti et al. (2018). The Indonesian version of CLASS questionnaire comprises three categories, namely personal interests, sense-making & problem-solving, and conceptual connections.

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The Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich, Smith, Garcia, and McKeachie (1991) was used to assess students' self-regulation in learning physics. The MSLQ is based on a general social-cognitive view of motivations and learning strategies, in which students represent as active agents of knowledge construction. The MSLQ consists of two categories, namely motivations which are divided into six components (intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self-efficacy, and test anxiety) and learning strategies which are divided into nine components (rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, and help-seeking).

Based on Figure 1, the researchers predicted that the seven components of the psychosocial learning environment (cohesiveness, teacher support, investigation, task orientation, cooperation, equity, and involvement) are positively and significantly related to students' beliefs component (personal interest, sense-making & problem-solving skills, conceptual connection). In addition, the researchers predicted that each component of the learning environment is positively and significantly related to the self-regulation in learning physics, both in the motivation components (intrinsic goal orientation, goal orientation, task value, control of learning beliefs, self-efficacy, anxiety test), as well as cognitive and metacognitive strategy components (rehearsal, elaboration, organization, critical thinking, metacognitive, time & research environment, effort regulation, peer learning, and help-seeking).

Sample

The respondents of this research involved 1,010 students from grade XI of the existing five public high schools in Jambi City, Indonesia. All students registered in grades XI participated in the survey. Before the data analysis, the researchers "cleaned and accounted" the data from errors and those of uncompleted ones (Creswell, 2012). The process of the data cleaning included checking the students' responses on each item in the research instrument to make sure that all statements were completed by the respondents; the process of re-ranking of each negative statement was also conducted simultaneously. As a result, 1,003 respondents were considered eligible for the following data analysis phase. Table 1 summarizes the number of respondents based on genders:

Table 1. Respondents' demography based on genders.

Gender	Number	Percentage
Male	346	34.5
Female	657	65.5
Total	1003	100

Instruments, Procedures, and Data Analysis

The researchers used three self-report instruments: CLASS to assess students' beliefs about physics and learning physics (Adams et al., 2006), WIHIC to assess students' perception about the learning environment (Aldridge et al., 1999) and MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991) to assess students' self-regulation. The CLASS and MSLQ questionnaires were originally developed in English language. To obtain a valid and reliable measurement used in the context of learning in Indonesia, the CLASS and MSLQ questionnaires were first adapted into the Indonesian version. The translation process of these both questionnaires was conducted through standard translation methodology, which includes translation, verification, and modification. All of the items were translated into Bahasa Indonesia. The result was then validated qualitatively by two lecturers from the Department of Physics Education (bilingual). The feedbacks provided by the validators were adopted as the basis for improving the translation versions of the questionnaires.

For this research, the researchers conducted two stages of the data analysis, exploratory factor analysis (EFA), and confirmatory factor analysis (CFA). Hair Jr, Hult, Ringle, and Sarstedt (2017) explained that EFA and CFA tests cannot be done by using the same data-set as it would amount to mere data fitting rather than testing theoretical constructs. Hence, the researchers divided the data into two parts, namely "odd" and "even" data. The odd data-

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set was used for factor analysis (EFA) test using SPSS version 21.0, while even data-set was used for confirmatory factor analysis (CFA) test using PLS-based SEM (PLS-SEM). Table 2 summarizes the "odd" and the "even" research data based on the respondents' genders.

Table 2. Odd and even data based on genders.

Gender	Odd		Even	
	Number	Percentage	Number	Percentage
Male	167	33.2	179	35.80
Female	336	68.8	321	64.20
Total	503	100	500	100

The EFA was conducted on the CLASS questionnaire to measure students' beliefs about physics and learning physics. The EFA test on the CLASS questionnaire was performed for several reasons. First, the original version of the CLASS questionnaire consists of 41 statement items, in which 26 of the 41 are grouped into eight overlapping dimensions. The eight dimensions are real-world connections, personal interest, sense-making and effort, conceptual connections, applied conceptual understanding, problem-solving general, problem-solving confidence, and problem-solving sophistication. This means one item can fit into two or more dimensions. For example, item #11: "I am not satisfied until I understand why something works the way it does". This item falls into two dimensions, namely personal interest and sense-making / efforts. The same tendency occurs in other items, indicating that the resulting constructs are not unidimensional. While the remaining 16 items are not categorized into the previous eight dimensions, because they have not received a response from experts. Second, the evaluation of the psychometric characteristics of the CLASS questionnaire was only performed by one researcher (Douglas, Yale, Bennett, Haugan, & Bryan, 2014). Douglas et al. (2014) stated that based on EFA and CFA analysis, there are 15 items of validity statement and 26 categories of the CLASS questionnaire which are categorized into three dimensions, namely personal application and relation to the real world, problem-solving/ learning, and effort/sense-making. Based on these reasons, the researchers decided to conduct an analysis with the same stages as to the CLASS questionnaire to obtain a valid and reliable instrument, which is used to measure students' beliefs on physics and physics learning by the context of socio-cultural conditions of Indonesia.

The second test conducted in this research was Confirmatory Factor Analysis (CFA). The CFA test was performed to analyze the convergent validity of beliefs dimension produced through the EFA test, as well as to evaluate the internal reliability of the MSLQ questionnaire used to measure the students' self-regulation in learning physics. The CFA test was also conducted to analyze the structural model of the correlation between the three latent variables of the research, i.e., learning environment, beliefs, and self-regulation of students in researching physics.

The researchers also conducted EFA and CFA instrument validation. Cronbach's alpha and composite reliability for each instrument were examined. Finally, the researchers performed structural equation modeling (SEM), which is based on variance (PLS-SEM) to analyze the fit of the proposed model in Figure 1. The PLS approach is Asymptotic Distribution Free (ADF), meaning that the analyzed data do not possess a certain distribution pattern, it can be nominal, category, ordinal, interval, and ratio.

Research Results

The initial assumption tests showed that the value of Kaiser-Meyer-Olkin was .862 and of Bartlett's Test of Sphericity was 2916.252, which was statistically significant ($p<.001$). Both values indicated that initial requirements for factor analysis were fulfilled; since the value of KMO was >.5 and that of Bartlet's Test of Sphericity was < .05 (Pallant, 2011). Principal component analysis with orthogonal rotation (varimax) on 26 items of the CLASS questionnaire resulted in 5 factors of students' beliefs with Eigen value of >1 and total variance of 46.259%. However, the analysis of the scree plot showed fractures over the three dimensions, as shown in Figure 2:

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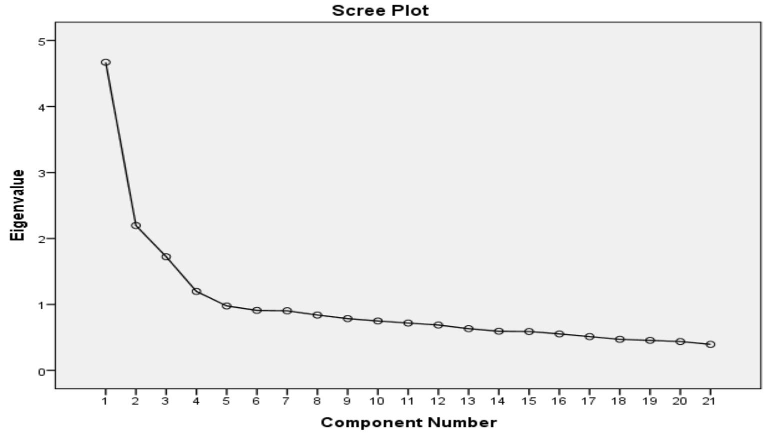

Figure 2. Screeplot of students' beliefs.

Based on Figure 2 above, it was decided to take the three factors of students' beliefs with a total variance of 40.896%. The examination of communalities indicated that there were five items that had a value of < 0.3; those were items #1, #5, #10, #25, and #37. According to Cabrera-Nguyen (2010) communalities value of < 0.3 shows the low relation between the items with the dimensions formed and should be excluded from the test; the remaining 21 items were included in the retest of factor analysis. Loading factors and reliability of each dimension can be seen in Table 2.

Table 2. Loading factor and reliability of items from class questionnaire.

Items	Component		
	Personal Interest	Sense-Making & Problem Solving	Conceptual Connection
23	.649		
33	.642		
35	.635		
13	.611		
21	.585		
32	.570		
12	.558		
3	.554		
30	.540		
14	.529		
25	.482		
22		.681	
15		.641	
7		.603	
20		.574	
24		.460	

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Items	Component		
	Personal Interest	Sense-Making & Problem Solving	Conceptual Connection
28			.680
31			.641
36			.592
19			.568
6			.564
Eigenvalue	4.670	2.196	1.723
% Variance	22.236	10.457	8.203
Cumulative %	22.236	32.694	40.896
Reliability values	.813	.643	.619

The next step was to analyze the convergence and discriminant validity on the 21 items of CLASS resulting from EFA. The researchers also checked the convergence validity of MSLQ items. Convergent validity measures the magnitude of the correlation between constructs with latent variables, including individual item reliability, internal consistency, and average variance extracted (AVE). Individual item reliability was seen from the value of standardized loading factor. According to Hair Jr et al. (2017) the loading factor value of ≥ .7 is said to be ideal, meaning that the indicator validly measures the constructs it establishes. Another opinion is put forward by Haryono (2017), based on empirical research, that the value of loading factor ≥ .5 is acceptable. Thus, the loading factor value of ≤ .5 must be dropped from the research model. The CFA test result showed that out of the total of 21 items of the CLASS questionnaire, there were several items that had a loading factor value of ≤ .5 so that they were dropped from the model (item #3, #12, #13, #14, #19, #20, #21, #23, #27, #33, and #36) — resulted in ten valid items of the CLASS questionnaire, which were categorized into three dimensions, namely personal interests (3 items), sense-making & problem solving (4 items), and conceptual connection (3 items). Table 4 shows the item loadings, composite variance, and average variance extracted of each of the CLASS and MSLQ dimensions.

Table 3. Item loadings, composite variance, and average variance extracted.

Latent Variable	Item	Loading Factor	Average Variance Extracted (AVE)	Composite Reliability
Personal Interest	13	.861	.502	.746
	25	.658		
	33	.577		
Sense Making &Problem Solving	7	.655	.517	.810
	15	.735		
	22	.757		
	24	.715		
Effort & Real-World Connection	6	.657	.564	.794
	28	.817		
	31	.769		
Intrinsic Goal Orientation	1	.707	.545	.827
	16	.749		
	22	.734		
	24	.763		
Extrinsic Goal Orientation	7	.725	.559	.835
	11	.747		
	13	.800		
	30	.715		

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Latent Variable	Item	Loading Factor	Average Variance Extracted (AVE)	Composite Reliability
Task Value	10	.659	.544	.856
	17	.670		
	23	.752		
	26	.808		
	27	.786		
Control of Learning	2	.750	.515	.808
	9	.640		
	18	.761		
	25	.712		
Self-Efficacy for Learning & Performance	12	.726	.507	.860
	15	.736		
	20	.675		
	29	.719		
	31	.717		
	6	.698		
Test Anxiety	8	.894	.522	.754
	14	.743		
	28	.463		
Rehearsal	39	.711	.519	.811
	46	.715		
	59	.709		
	72	.683		
Elaboration	53	.669	.507	.837
	64	.741		
	67	.736		
	69	.754		
	81	.655		
Organization	32	.731	.546	.826
	42	.854		
	49	.669		
	63	.688		
Critical Thinking	38	.710	.507	.804
	47	.778		
	51	.681		
	71	.676		
Metacognitive	36	.723	.502	.876
	41	.705		
	44	.733		
	54	.662		
	55	.739		
	56	.735		
	61	.659		
Time & Research Environment	35	.734	.557	.790
	43	.793		
	73	.709		
Effort Regulation	48	.858	.688	.815
	74	.800		
Peer Learning	34	.685	.547	.783
	45	.761		
	50	.769		
Help-Seeking	58	.693	.520	.764
	68	.766		
	75	.702		

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Based on Table 3, all values of loading factors are ≥ .5, so it can be concluded that the validity of the CLASS questionnaire is good at the item level. Furthermore, at the level of construction, the composite value of reliability is high with values ranging from .74 to .86. According to Hulland (1999), the value of the composite reliability limit is the same as Cronbach's alpha ≥ .7. The higher the composite reliability (CR) value, the higher the contribution of the construct in the measurement model. The final criterion of convergent validity is the measurement of the average variance extracted (AVE) for each construct. The AVE value describes the variance or variability of the manifest variables that the latent construct can have (Haryono, 2017). Hair Jr et al. (2017) recommends a minimum of 0.5 AVE to indicate an excellent convergent validity measure. Based on Table 4 above, AVE values for all components are above the minimum value, ranging from 0.5 to 0.6. So, based on the value of loading factor, composite reliability, and AVE, it can be concluded that both CLASS and MSLQ have good convergence validity. Discriminant validity measures the extent to which latent variable constructs are empirically different (Aldridge, Afari, & Fraser, 2013). Table 4 and 5 show that the square root of the average variance (AVE) for each construct is larger than inter-construct correlation.

Table 4. Discriminant validity of CLASS questionnaire.

Latent Variable	*CC*	*PI*	*SM & PS*
CC	.751		
PI	-.080	.709	
SP&PS	-.213	.416	.719

Table 5. Discriminant validity of MSLQ questionnaire.

Lat. Var	CL	CT	ER	Ela	EG	HS	IG	Met	Org	PL	Reh	SE	TO	TV	TA	TSE
CL	.717															
CT	.419	.712														
ER	.419	.551	.829													
Ela	.423	.692	.581	.712												
EG	.632	.330	.429	.328	.748											
HS	.418	.549	.611	.628	.402	.721										
IG	.587	.593	.414	.565	.387	.397	.738									
Met	.440	.726	.533	.735	.283	.553	.616	.709								
Org	.408	.690	.529	.725	.336	.528	.626	.739	.771							
PL	.448	.640	.515	.608	.369	.546	.578	.694	.684	.739						
Reh	.417	.707	.568	.703	.333	.605	.569	.713	.691	.628	.720					
SE	.569	.611	.454	.599	.478	.419	.723	.623	.650	.628	.593	.712				
TO	.276	.313	.245	.303	.282	.266	.361	.309	.346	.259	.306	.397	.712			
TV	.647	.599	.467	.599	.439	.431	.781	.627	.635	.629	.593	.738	.353	.737		
TA	.527	.353	.314	.310	.571	.375	.405	.335	.321	.343	.321	.448	.226	.402	.722	
TSE	.485	.588	.621	.601	.455	.603	.524	.627	.636	.635	.644	.591	.364	.562	.388	.746

Note: the bold value in the diagonal are the square roots of average variance extracted, cc=conceptual connection, pi=personal interest, sm &ps = sense-making & problem-solving ability, cl=control of learning, CT=critical thinking, ER=Effort Regulation, Ela=Elaboration, EG=Extrinsic Goal, HS=Help Seeking, IG=Intrinsic Goal, Met=Metacognitive, Org=Organization, PL=Peer Learning, Reh=Rehearsal, SE=Self Efficacy, TO=Task Orientation, TV=Task Value, TSE=Time & Research Environment

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The amount of influence between constructs and interaction effects (moderation) is measured by the value of the coefficient path (path coefficient). Path coefficient that has statistic value of ≥ 1.96 or has p-value of ≤ .05 expresses significance. The results indicate that 30 of the 168 possible correlation are statistically significant ($p < .05$) and all of the statistically significant correlation are positive in direction. The Path coefficient and t-value for each hypothesis are positive and significantly related in the research model, as shown in Table 6 below:

Table 6. Path coefficient.

Hypotheses	*t* -values	*p* values	Conclusion
Cohesiveness -> Conceptual Connection	2.391	.017	Significant
Cooperation ->Peer Learning	2.642	.008	Significant
Cooperation -> Self Efficacy	1.993	.047	Significant
Equity -> Conceptual Connection	2.379	.018	Significant
Investigation ->Critical Thinking	1.995	.046	Significant
Investigation -> Elaboration	2.175	.030	Significant
Investigation ->Intrinsic Goal	3.904	.001	Significant
Investigation ->Metacognitive	3.178	.002	Significant
Investigation -> Organization	2.195	.028	Significant
Investigation ->Self Efficacy	1.999	.046	Significant
Involvement ->Peer Learning	1.984	.050	Significant
Involvement ->Time & Research Environment	2.172	.030	Significant
Personal Interest->Critical Thinking	2.249	.025	Significant
Personal Interest->Peer Learning	1.906	.057	Significant
Sense-Making & Problem-Solving ability->Test Anxiety	1.921	.055	Significant
Task Orientation -> Control of Learning	2.388	.017	Significant
Task Orientation -> Critical Thinking	3.312	.001	Significant
Task Orientation -> Effort Regulation	2.505	.012	Significant
Task Orientation -> Elaboration	3.103	.002	Significant
Task Orientation -> Extrinsic Goal	2.789	.005	Significant
Task Orientation -> Help-Seeking	2.879	.004	Significant
Task Orientation ->Intrinsic Goal	4.653	.000	Significant
Task Orientation -> Metacognitive	2.851	.004	Significant
Task Orientation -> Organization	3.837	.000	Significant
Task Orientation -> Rehearsal	3.219	.001	Significant
Task Orientation -> Self Efficacy	5.183	.001	Significant
Task Orientation -> Task Value	4.975	.000	Significant
Task Orientation -> Test Anxiety	2.327	.020	Significant
Task Orientation -> Time & Research Environment	4.345	.001	Significant
Teacher Support -> Conceptual Connection	2.211	.018	Significant
Teacher Support -> Control of Learning	1.980	.050	Significant
Teacher Support ->Extrinsic Goal	2.249	.025	Significant
Teacher Support ->Test Anxiety	2.407	.016	Significant

From Table 6, the researchers can conclude that three out of seven learning environment scales (cohesiveness, equity, and teacher support) most likely influence students' beliefs, especially on conceptual connection dimension. While, the learning environment scales that are closely related to students' self-regulation in learning physics is investigation, task orientation, and teacher support. The findings also indicate that teacher support is likely to correlate both students' beliefs and self-regulation in learning physics. Additionally, all dimensions of students' beliefs significantly correlate with both motivation scale (test anxiety) and learning strategy scales (critical thinking and peer learning) of students' self-regulation in learning physics. All these statistically significant correlations are represented in the model as in Figure 3.

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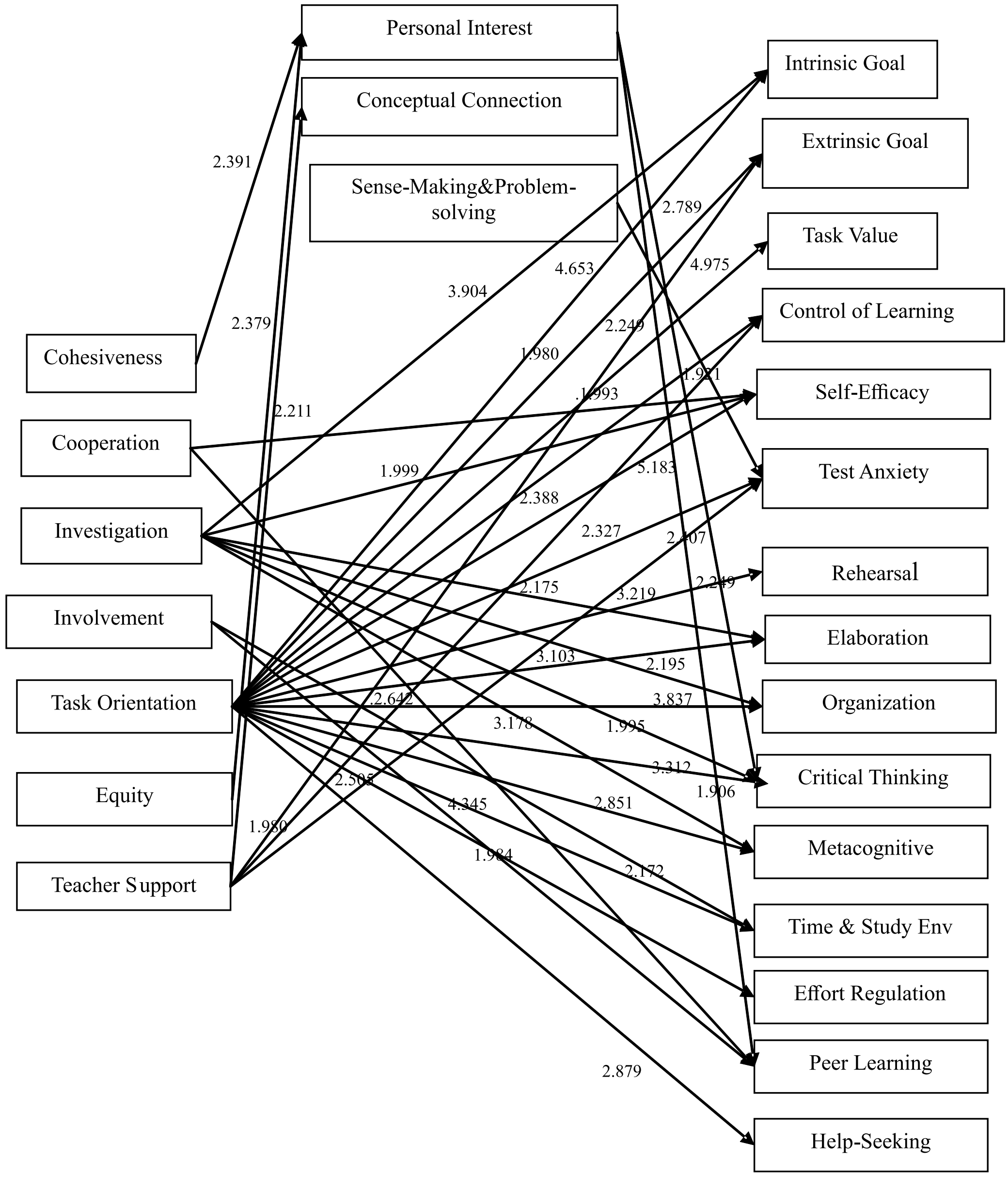

Figure 3. The *t*-value of the Structured Model (*t* > 1.96).

Discussion

This research aimed to analyze the structural correlations between the learning environment, students' beliefs, and self-regulation in learning physics. The CLASS questionnaire developed by Adams et al. (2006) is used to measure student beliefs about physics and learning physics. Before using, the CLASS questionnaire was adapted into the Indonesian version. The validation process through the EFA and CFA obtained three factors of students' beliefs, namely problem-solving abilities (4 items), conceptual understanding (3 items), and effort & real-world connection (3 items). The values of composite reliability for the three dimensions of the beliefs were .812, .805 and .754 respectively for the factors of problem-solving ability, conceptual understanding, and effort & real-world connection. The result of the validation of the Indonesian version of the CLASS questionnaire was in line with the analysis conducted by Douglas et al. (2014). The evaluation of the psychometric factor of the CLASS questionnaire conducted by Douglas et al. (2014) resulted in 15 valid items categorized into 3 dimensions, namely personal ap-

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plication and relation to real world (6 items), problem-solving (5 items), and effort/sense-making (4 items), with Cronbach alpha reliability values of .80, .73, and .69, respectively. The difference in naming the constructs and the number of valid items were more due to the different cultural contexts that could have been understood differently.

The MSLQ questionnaires were used to measure students' self-regulation in learning physics. The researchers adopted 15 self-regulatory scales of The Motivated Strategies for Learning Questionnaires (MSLQ) developed by Pintrich et al. (1991). The 15 scales are categorized into two major components of self-regulation, namely the components of motivation (6 scales) and components of cognitive and metacognitive strategies (9 scales). The CFA test revealed the values of the composite reliability of 15 self-regulation scale ranging from 0.719 - 0.876. Similar results were reported by Pintrich et al. (1991), with internal Cronbach's alpha reliability values ranging from 0.52 to 0.93. Based on the findings, it was concluded that the Indonesian versions of CLASS and MSLQ were valid and reliable to be used to measure beliefs and students' self-regulation in learning physics.

The relation between the learning environment, students' beliefs, and self-regulation in learning physics were analyzed using structural equation-based variance modeling (PLS-SEM). The evaluation of the structural model showed that there was a positive and significant correlation between learning environment, students' beliefs, and self-regulation, although this positive and significant relationship did not occur in all scales of research variables. The scales of the learning environment that has a positive and significant influence on the formation or construction of beliefs were cohesiveness, equity, and teacher support. These three scales of the learning environment had a positive and significant effect on the formation of beliefs, especially in the conceptual connection dimension. The conceptual connection measures the extent to which the beliefs the students have for the coherence of a physics topic with other physics topics.

Hammer (1994a) explained that students who believe of physics knowledge structures are coherent, will emphasize their learning on conceptual understanding, and thus tend to have better performance in solving physics problems. Based on the result of structural relationship analysis, it can be concluded that students' perceptions toward the three aspects of the psychosocial learning environment, namely cohesiveness, equity, and teacher support, have a positive and significant effect on their beliefs about the conceptual connection structure. It means that students will be encouraged to be actively involved in the learning process when they feel there is good social acceptance by peers, help from each other, and teachers' support in their learning process. Students will not be embarrassed to be laughed at by their classmates when they make mistakes in working on questions or tasks assigned by teachers; besides, students will not hesitate to ask teachers when they encounter challenges in understanding the concepts of physics.

The results of this research are in line with the studies conducted by Ozkal et al. (2009) and Tsai (2000). From the results of their research, Ozkal et al. (2009) found that students who have students' perceptions of the classroom environments (including personal relevance, uncertainty, critical voice, and student negotiation) are positively correlated with students' beliefs that scientific knowledge is tentative. Further Ozkal et al. (2009) explained that the classroom learning environment, which connects the learning process of science with the daily experiences of students, provides opportunities for students to share their science ideas with others, as well as to provide hands-on experience to students through inquiry activities in laboratories closely with the formation of tentative beliefs, i.e. beliefs that scientific knowledge is tentative or evolving. The same thing was stated by Tsai (2000), that students with perceptions of the classroom learning environment are constructivist, giving students the opportunity to discuss with peers and integrate the students' initial knowledge with new knowledge taught by teachers, tend to have beliefs that science knowledge is constructivist.

Concerning with the relationship between students' beliefs and self-regulation in learning physics, the current research demonstrated that there is a positive relationship between students' beliefs (personal interest and sense-making/ problem-solving ability) and self-regulation both in learning strategy components (critical thinking and peer learning) and motivation component (test anxiety). The dimension of students' beliefs, i.e. "personal interest" has a positive and significant effect on the learning strategy components of self-regulation, namely critical thinking, and peer learning. Critical thinking describes the extent to which students apply prior knowledge to new situations in order to solve problems, while peer learning describes students' perceptions of learning experience where students share knowledge and discuss ideas (Pintrich et al., 1991).

According to Redish (1997) and Halloun and Hestenes (1998), because beliefs are closely related to students' perceptions about the characteristics of knowledge and how to obtain that knowledge, personal interest is an important part that will shape students' beliefs about physics and the physics learning process. In other words, students will have strong beliefs if they realize that studying physics provides benefits for them, because it is relevant to what they experience in everyday life, and the skills needed to understand physical concepts such

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as reasoning abilities which will be useful in their lives; while students will have naïve beliefs, if they believe that studying physics is not related to what they experience in everyday life.

The research findings above explain if students have sturdy beliefs on personal interests, they tend to feel more challenging and have the confidence to understand and solve complicated physics problems. These findings are consistent with the results of the previous research in which tentative beliefs were related to meaningful learning strategies, and they were mainly motivated by their interests and curiosity about science (Tsai, 1998). Additionally Chan, Ho, and Ku (2011), on their research about the relationship between epistemic beliefs and critical thinking of Chinese students showed that epistemic beliefs had specific effects on critical thinking and cognitive ability. Further, Chan et al. (2011) explained that students having beliefs that knowledge is being fixed and absolute (certain knowledge) tend to have poor performance in everyday evaluative thinking and reduced cognitive ability.

The research findings also show that the task orientation and investigation are the components of the learning environment which contribute the most significant influence to the students' self-regulation in learning physics, both in the motivation and learning strategy component. Task orientation assesses the extent to which students perceive that it is crucial to complete the subject tasks and understand the goals of the subject. According to human environment theory proposed by Moos et al. (1987), task orientation is part of the dimension of "personal growth" which emphasizes the accessibility (opportunity) of students to develop themselves and improve self-quality (self-enhancement) through various aspects such as achievement, competition, autonomy, and personal status (Velayutham, Aldridge, & Afari, 2013). These results indicate that teachers should pay attention to students' learning objectives and ensure that students understand what is needed to complete the task. The findings support Velayutham et al. (2013) the suggestion that students need to be aware of the importance of completing planned activities and stay focus on the subject matter.

Finally, the findings of the current research have also revealed that there are three learning environment scales that are significantly related to students' beliefs about physics. These factors are students' cohesiveness, equity, and teacher's support. The findings also show that students' beliefs correlate with their self-regulation in learning physics. Another important result from the current research is that learning environment directly correlates with students' self-regulation in learning physics both in motivational and learning strategies component.

Conclusions

The purpose of the research was to study about the structural correlations between learning environment, students' beliefs, and self-regulation in physics learning. The findings show that three out of the seven psychosocial factors in the learning environment (cohesiveness, equity, and teacher support) have a positive and significant impact on students' beliefs about physics and learning physics. The implication of these findings is that teachers need to pay attention to how to create a conducive learning environment that facilitates students to be able to work together and respect each other's opinions. Also, the teacher must provide equal attention to students, not to discriminate students, and support students to be successful in learning. The results revealed are significant in that the current study is one of the few studies conducted in Indonesia applying structural equation modeling (SEM) based on variance (PLS-SEM) which has commonly been used to develop a comprehensive model of correlation between individual aspects of students (student trust), learning environment, and self-regulation in physics learning. This research will contribute positively to all education stakeholders, curriculum developers, teacher educators, teachers, and students. The results provide new insights to understand why a curriculum designed to address students' difficulties in understanding the concept of learning is not effective for some students. Information obtained from this research can be a theoretical foundation for curriculum developers in designing and developing science education curricula, especially in the field of physics so that the implementation of teaching and learning can facilitate students to gain direct, contextual, and student-centered experience. Finally, the current research will provide an important insight for physics teachers to explore students' prior knowledge as a representation of their beliefs about physics so that teachers can design learning processes that can facilitate shifting of students' beliefs from naive beliefs to expert beliefs.

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