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Investigating Student Intention to support the Green Laboratory Program Using the Pro-environmental Reasoned Action Model: A case study from Bandung, Indonesia

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Abstract. Industry 4.0 requires the educational sector to enhance its effectiveness and efficiency by considering the environmental factor. The green laboratory concept supports industry 4.0 through its energy-saving and getting more efficient and effective teaching and learning process. The teaching aid that developed regarding the green laboratory program is needed for efficient and effective educational activities. For this reason, a tool is designed, namely the Material Selection Box to facilitate students in reading material selection charts during the product development practicum. This study aimed to investigate the intention to use the Material Selection Box using the Pro-Environmental Reasoned Action Model (PERA). 160 students were surveyed using an online questionnaire. This study uses the Structural Equation Modeling to analyze the data. The result showed that the PERA model was found to represent the willingness to use material selection teaching aids. More importantly, it is found that the laboratory management has strong influence on the students' willingness to use the teaching aid. Thus, it is recommended for laboratory management to motivate students to support the green laboratory program by using the teaching aid.

Introduction

Industry 4.0 that introduced by the Government of Germany is a strategy that adopts new digital technology into the industrial manufacturing sector [1]. It was established to achieve the stability of product distribution towards the customers demand by optimizing the entire system, product quality efficiency, energy optimization and design optimization [2]. Although it originates from manufacturing sector, industry 4.0 proved to increase the performance of the service sector [3]. As one of the service sectors, it is found that the educational sectors need to boost its innovation to face Industry 4.0 for creating future learning [4]. On the other hand, recently, the green concept as the response of environmental problem gains more attention. The green concept needs to be established in the educational sectors for supporting the industry 4.0, thus the environmental performance can be significantly achieved [5]. In addition, the green laboratory program as the implementation of green concept can potentially support the industry 4.0 through its effective and efficient teaching and learning process in the laboratory. The innovation in educational sectors to support industry 4.0 can be established through the development of the teaching aid as the implementation of the green laboratory program.

The green laboratory program has been implemented by many universities to support the green campus [6]. The product development laboratory of the Industrial Management Department, Telkom University implements the green laboratory program through the development of the teaching aid for the material selection practicum. According to the survey conducted among 809 students of Industrial department Telkom University, it was found that the most difficult material during the laboratory practicum is module 6 as presented in Table 1.

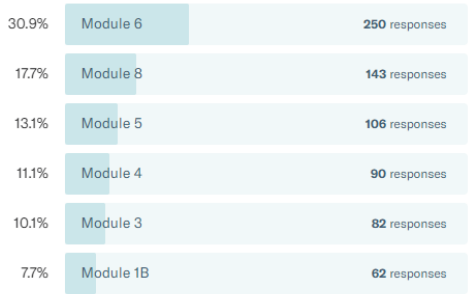

Figure 1 Students Responds to "The most difficult material"

Module 6 discusses the material selection process during the product development practicum. Figure 1 presented the statistic of the most difficult material that delivered during the product development practicum. It showed that 30.9% students agree that module 6 or Material Selection module is the most difficult module among all modules delivered during the product development practicum. It motivates the product development practicum management to develop the teaching aid for the material selection during product development namely the Material Selection Box. According to Latuheru [7] teaching aids are all tools or objects used for teaching and learning activities. This tool aimed at conveying learning information from the source to the recipient. Thus, the Material Selection Box teaching aid is expected to help the laboratory assistant to deliver the material selection module to the students during the product development practicum.

Specifically, the Material Selection Box teaching aid as shown in fig. 2 was developed to simplify the reading of material selection charts. The material selection chart is a graph consists of the materials and the value for material properties. It is used to identify the value for material property, select the material according to needed property, and design the hybrid material. [8]

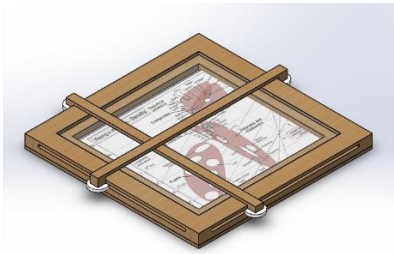

Fig. 2 Design of Material Selection Box Teaching Aid

Once the product developed, it needs to be evaluated to ensure that the product has the expected performance. According to Stufflebeam & Shienfield [9], the product evaluation is the final stage that aimed to measure, interpret and assess program achievements. The product evaluation is conducted carefully and thoroughly because it defines the achievement of the newly developed product towards its predetermined goals. As a new developed product, the Material Selection Box needs to be evaluated. This paper aimed to identify the students' intention to use the Material Selection Box teaching aid during the material selection practicum. By identifying the student's intention to use that teaching aid, the newly developed material selection be teaching aid can be evaluated according to the willingness of the students to use the teaching aid. In addition, through the identification of student intention to use the Material Selection Box teaching aid, the solution for increasing the efficiency and the effectiveness of the teaching aid can be generated.

Theoretical Framework

This research adopted the Pro-Environmental Reasoned Action Model developed by Nadhlifatin et al [10] to identify the factors that influence the intention to use the Material Selection Box teaching aid. The PERA model was expected to represent the intention of students' to use the Material Selection Box teaching aid because the Material Selection Box teaching aid was developed to support green laboratory program and the industry 4.0 era.

The PERA model is the extended TRA (Theory of Reasoned Action). TRA was first introduced by Icek Ajzen and Martin Fishbein [11]. It is mentioned in Hale et al [12] that the aim of the TRA is to explain the volitional behavior. According to Ajzen & Fishbein [11], there are four latent variables of the TRA model: attitude, subjective norms, behavioral intention, and behavior. In the TRA, the behavior is predicted by the behavioral intention and the behavioral intention is predicted by the attitude and the subjective norms. It is mentioned in Ajzen & Fishbein [11] that the attitude is the *Minimal prerequisite for the development of valid measurement procedures*", the subjective norms is "*The totality of the normative pressure*", and the behavioral intention is"*Person's intention to perform specific behavior".*

The Pro-Environmental Reasoned Action (PERA) model was developed according to the TRA model. It is mentioned that PERA model extends the TRA model by putting the environmental consideration into account. The PERA model was firstly developed by Nadhlifatin, et al. [10] and continued by Chin et al [13]. The PERA model consists of PAS (Perceived Authority Support), PEC (Perceived Environmental Concern), SN (Subjective Norm), AT (Attitude), and BI (Behavioral Intention). According to Persada and Lin [14] The Perceived Authority Support is the perception of individual that a person or organization support the person do conduct a specific behavior and the Perceived Environmental Concern is the feeling of individual about the pro-environmental consequence of an activity.

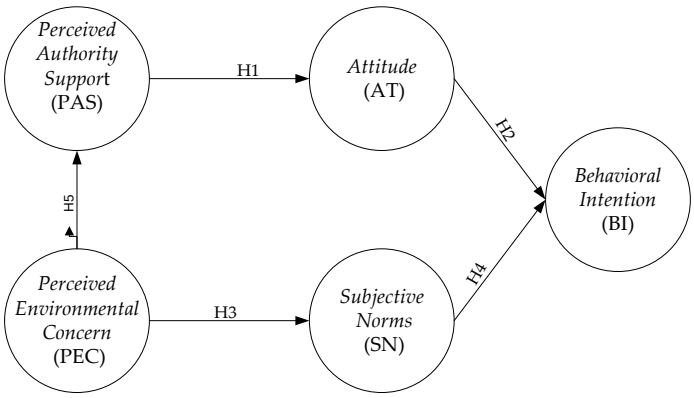

Fig. 3 The pro-environmental reasoned action (PERA) model

While Ajzen and Fisbein [11] initially proved the positive influence of subjective norms and attitude towards the behavioral intention and the behavior, it is proved in several studies that the pro-environmental support for the authority holder influences the intention to conduct specific pro-environmental behavior [10,13]. In addition, it is confirmed in many studies that the pro-environmental perception of individual positively influence the pro-environment acts such as the pro-environmental shares and green purchase [15,16]. Thus, the following hypothesis as shown in fig.3 were proposed

H1: PAS positively influences AT of using Material Selection Box teaching aid
H2: AT positively influences BI of using Material Selection Box teaching aid
H3: PEC positively influences SN of using Material Selection Box teaching aid
H4: SN positively influences BI of using Material Selection Box teaching aid
H5: PAS positively influences PEC of using Material Selection Box teaching aid

Methodology

Participants and procedure. This research conducted by surveying 160 students of Telkom University as the respondents. The respondents were given an online questionnaire. There are three groups of respondents according to their product development practicum experience in the laboratory: 1. Students who have never participated in product development practicum, 2. Students who have participated in product development practicum, 3. the product development laboratory assistants. All student groups were chosen as the respondent to ensure that the research represents all respondent with different experiences.

Questionnaire. The questionnaire used consists of two main parts. The first part is the question about the respondent profile and the second part is the question about the students' intention to use the Material Selection Box teaching aid. The second part of the questionnaire represents the PERA model and consists of 5 subparts: Perceived Authority Support (PAS), Perceived Environmental Concern (PEC), Attitude (AT), Subjective Norms (SN), and the Behaviour Intention (BI). Each of the subparts consists of items as presented in Table 1.

Table 1 Questionaire Items

Factors		Items
Perceived Authority Support (PAS)	**PAS 1**	The laboratory facilitates the Material Selection Box teaching aid
	PAS 2	The laboratory initiates the design of the Material Selection Box teaching aid
Perceived Environmental Concern (PEC)	**PEC 1**	I really care about the environment and my future, so I have to use the Material Selection Box teaching aid to support the green laboratory program to save the environment
	PEC 2	Humans tend to damage the environment, so I have to use the Material Selection Box teaching aid to support the green laboratory program to safe the environment
	PEC 3	Human and environment interactions lead to some damages, so I have to participate in protecting the environment by using the Material Selection Box teaching aid to support the green laboratory
Attitude (AT)	**AT 1**	I think that the use of the Material Selection Box teaching aid to support the green laboratory program is really good
	AT 2	I think that the use of the Material Selection Box teaching aid to support the green laboratory program is really wise
	AT 3	I think that the use of the Material Selection Box teaching aid to support the green laboratory program is really liked by all students
Subjective Norms (SN)	**SN 1**	Many people who important for me think that I have to use the learning tool to support the green lab
	SN 2	Many people who important for me ask me to use the Material Selection Box teaching aid to support the green laboratory program
	SN 3	Many people who important for me want me to use the Material Selection Box teaching aid to support the green laboratory program
Behavior Intention (BI)	**BI 1**	I want to use the Material Selection Box teaching aid to support the green laboratory program
	BI 2	I plan to use Material Selection Box teaching aid to support the green laboratory program

The item about the student's intention to use the Material Selection Box teaching aid was answered using the five-points Likert Scale, from 1 (strongly disagree) to 5 (strongly agree).

Statistical analysis. In this research, the questionnaire result reliability was measured using the cronbach alpha reliability test. The Confirmatory Factor Analysis was conducted to ensure the validity of the hypothesized PERA model using the Analysis of Moment Structure (AMOS) software. Thus, the relationship between the latent (observed) variable in the PERA model can be confirmed.

Result and Discussion

With regard to age, from totally 260 students as the respondent, the majority were 20-22 years old (98.7%) and the remaining are older than 22 years old (1.3%). Besides, half respondents are male student (46.9%) and the other half (53.1%) are females students. The reliability of the model was shown by the minimum Cronbach alpha for each construct 0.675 and the most constructs have the Cronbach alpha value more than 0.7 which considered reliable [17,18]. It confirms the internal consistency of the measures. The item loadings are ideal as shown most scores are above 0.7, indicated the high loading of items in the specifics construct [17,18].

Table 2 Reliability and Construct validity test

Factors	Item	Mean	SD	Factor Loading	Cronbach Alpha
PAS	PAS2	4.0763	0.75057	0.703	0.765
	PAS3	4.0382	0.86295	0.653	
PEC	PEC1	4.3588	0.70240	0.706	0.729
	PEC2	4.3511	0.73300	0.703	
	PEC3	4.2443	0.69162	0.560	
AT	AT1	4.2214	0.65972	0.736	0.784
	AT2	4.2672	0.72137	0.817	
	AT3	4.1221	0.75471	0.675	
SN	SN1	4.1221	0.75471	0.729	0.83
	SN2	3.9618	0.75859	0.830	
	SN3	4.0840	0.73420	0.806	
BI	BI2	4.1756	0.75936	0.724	0.675
	BI3	4.2290	0.72922	0.683	

The overall fit scores of the model showed a good fit. All the scores X^2/df, CFI, TLI were acceptable: below 3 (1.894), above 0.9 (0.925), and approach 1 (0.901) for each measure respectively [19]. The X^2/df shows that the model fits the data [20]. The acceptable CFI and TLI showed the high fit improvement compared to baseline model and the higher normed chi-square value for the null model compared to the specified model respectively [19,20]

Table 3 Model fit test

Statistic	Value	
	The proposed model	**Recommended** Hair, et al 2006)
1. X^2/df,	2.110	≤ 3
2. CFI	0.906	>=0.9

Note. X^2 = chi-square, df – degrees of freedom, X^2/df = relative/normed chi-square, CFI – comparative fit index

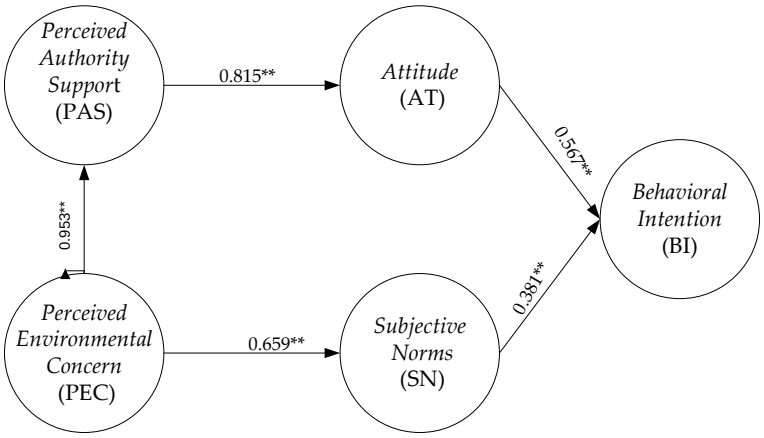

Fig. 4 The pro-environmental reasoned action (PERA) model

Table 4 Correlation and Significant result

Correlation between factors			β	Hypothesis
PAS	→	AT	0.815**	H1: Accepted
AT	→	BI	0.567**	H2: Accepted
PEC	→	SN	0.659**	H3: Accepted
SN	→	BI	0.381**	H4: Accepted
PEC	→	PAS	0.953**	H5: Accepted

*p≤0.1; **p≤0.05; ***p≤0.01

According to Table 4 and figure 3, it was found that the PAS has positive and significant influence towards AT. The correlation score of 0.815 shows that the PAS has strong influence towards the AT. Thus, it proves that the laboratory support influences the attitude towards using the Material Selection Box teaching aid with regards to implement the green laboratory concept. In addition, the AT found to have significant and positive correlation towards BI. The correlation score of 0.567 shows that the AT has fairly strong influence towards the BI. It shows that the attitude towards using the Material Selection Box teaching aid with regards to implementing the green laboratory concept influence the willingness to use the Material Selection Box teaching aid. Further, it was found that PEC has significant positive influence towards the SN. The PEC correlation score of 0.6 shows that environmental awareness has fairly strong influence towards other people suggestion of using the Material Selection Box teaching aid. Moreover, SN was found to have significant positive influence towards the BI. The SN correlation score of 0.381 towards BI shows that SN fairly influences the BI. It means that other people suggestion of using the Material Selection Box teaching aids influences the willingness to use the Material Selection Box teaching aid. Lastly, the PEC was found to have significant positive correlation towards PAS. The PEC correlation score of 0.953 towards PAS shows that PEC has very strong influence towards PAS. The relationship of the PAS, PEC, AT, SN, and BI shows partial support of Nadhlifatin [10] and Chin et al [13]. It proves that environmental awareness strongly influences the laboratory to supports the use of the Material Selection Box teaching aids. According to the Squared multiple correlation score (R^2) of 0.686 shows that the five factors that construct the proposed model represent the 68.6% intention to use the material selection teaching box aid as the implementation of green laboratory. The remaining 21.4% might originate beyond the proposed PERA model. This result is comparable with the previous research result of Nadhlifatin [10] and Chin et al [13].

Overall, the model showed that the strongest correlation occurred between the PEC and the PAS. The PEC has a strong positive influence towards the PAS. The more the environmental awareness of the authority holder, the more the support of the authority holder on the

pro-environmental behavior of using the Material Selection Box teaching aid. On the other hand, the weakest correlation occurred between the SN and the BI. The SN found to positively influence the BI. However, the effect of SN towards the BI was not stronger compared to the effect of AT towards BI. It showed that other people suggestion may have a low power to motivate individual to conduct the pro-environmental behavior of using the Material Selection Box teaching aid, compared to the attitude of that individual themselves.

Conclusions

According to the proposed PERA model, it can be concluded that the strongest relationship occurred between the PEC and the PAS in which the PEC was found to strongly influence the PAS positively. Thus, it can be proved that environmental awareness is a strong trigger for the authority holder to create programs that support the environment. Moreover, it is found that the PAS has strong positive influence towards the AT. This finding shows that the authority holder has power to motivate individuals to do certain attitude. Furthermore, the AT was found to positively influence the Behavior. According to those findings, the laboratory management was strongly suggested to motivate the students to use the Material Selection Box teaching aid because the management has strong influence on the students' attitude. In addition, more awareness of the laboratory management as the authority holder to motivate students to use the Material Selection Box teaching aid can be achieved by increasing the environmental concern of the laboratory management. Thus, the more optimal use of the Material Selection Box teaching aid can be achieved to better support the industry 4.0 on the educational sector.

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