PSYCHOLOGY AND EDUCATION (2021) ISSN: 0033-3077 Volume: 58(3): Pages: 2972-2979
Article Received: 13th September, 2020; Article Revised: 25th January, 2021; Article Accepted: 12th February, 2021

The Measurement of Science Teaching Efficacy Belief Instrument (STEBI): Sustaining Teacher's Quality

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ABSTRACT

The teachers take the role as the important human resources in creating effective learning conditions. Teacher's self-efficacy is one of the significant factors that determine how they carry out the process of learning and teaching in schools. Teacher's self-efficacy refers to their beliefs towards their abilities in managing and carrying out existing tasks and challenges which in accordance with their goals. This study aims to develop and validate *Science Teaching Efficacy Belief Instrument* (STEBI) in science teachers. The number of respondents involved was 223 science teachers who were selected using the purposive sampling technique. The results showed that the validity test using exploratory factor analysis produced four major factors that explained the concept of the measuring instrument. These major factors included positive pedagogical in motivating students (4 items), coping with changes and challenges (4 items), teacher's perception on ideal pedagogy (3 items), and enthusiasm (4 items). In addition, the confirmatory factor analysis test showed that each factor that appeared in the instrument fulfilled the model fit criteria (*P-value* > .05 and *RMSEA* < .05). Thus, it can be concluded that STEBI is a psychometrically valid instrument so that it can be used in measuring and exploring science teacher's self-efficacy.

Keywords
Confirmatory Factor Analysis; Exploratory Factor Analysis; Science Teacher; Self-Efficacy; STEBI; Sustaining Teacher's Quality

Introduction

Basically, self-efficacy is defined as a person's believe towards his ability in organizing and carrying out tasks to achieve a goal (Bandura, 1997; Bandura, 1982, 2010). Self-efficacy in a teacher is related to how a teacher assesses his own ability in managing and executing the learning process. Therefore, it can be concluded that self-efficacy in a science teacher is related to the level of confidence a science teacher has about his ability in conducting science teaching practices (Riggs et al., 1994). This ability is considered to determine how the teachers perform, not only in the pedagogical and personality aspects, but also in their roles as the agents of change to create better education.

Research on teacher's self-efficacy is essential to be conducted because it is one of the determinants of teacher's quality in the classroom. Previous studies have found that self-efficacy could act either as the mediator variable or moderator variable in determining the teacher's quality in the classroom (Huang et al., 2020; Perera & John, 2020). Self-efficacy can predict how a teacher establishes his aspirations and learning goals (Burić & Moè, 2020), including choosing the appropriate teaching methods (Allinder, 1995; Woolfolk et al., 1990). A teacher with good self-efficacy tends to make the innovation in the teaching and learning process (Van Gasse et al., 2020). Self-efficacy could also influences the positive attitudes possessed by the teacher (Huang et al., 2018). In addition, self-efficacy could also predict the likelihood of a teacher to persevere in his profession which ultimately could affect the job satisfaction (Perera & John, 2020; Skaalvik & Skaalvik, 2010).

Considering the significant role of self-efficacy in the teaching and learning process, it is necessary to conduct research that could examine and develop an instrument that could measure the level of teacher's self-efficacy especially for science teachers. One of the most popular self-efficacy instrument for science teachers is STEBI (Science Teaching Efficacy Belief Instrument), which was first developed by (Enochs & Riggs, 1990; Riggs et al., 1994). Initially, STEBI was developed based on 2 scales namely the Personal Science Teaching Efficacy Belief scale and the Science Teaching Outcome Expectancy which was later combined into STEBI. The combination of these two scales resulted in a total of 50 items which were subsequently discussed by some experts for further study. STEBI consisted of a Likert Scale that was first tested on 71 respondents. By using a factor analysis test, it was found that there were 24 items from the Personal

Science Teaching Efficacy Belief scale and 19 items from the Science Teaching Outcome Expectancy scale. Finally, STEBI was tested on a larger sample of 331 elementary science teachers in urban and rural areas in America who had diverse teaching experiences (Enochs & Riggs, 1990; Riggs et al., 1994). A series of statistical tests including the item analysis were then carried out which eventually resulted in 25 items on STEBI as the final version (Enochs & Riggs, 1990; Riggs et al., 1994).

Some research has tried to develop and adapt STEBI in different cultural and language conditions from various regions. Several studies have tried to develop this instrument in a more adaptive context with different characteristic of target respondents. As argued by (Cobern, 1996; Cobern & Aikenhead, 1997; Cobern & Loving, 2001) cultural viewpoint should be taken into account when learning science in which science teaching and learning should be in accordance with the cultures where the schools are located. For example, the research conducted by Coben and Loving (2001) has tried to develop self-efficacy instrument for Art learning and examine its relationship with the teacher's competencies. There are also some researchers who has generated self-efficacy instrument by designing mixed methodologies to obtain more specific information about teacher's self-efficacy (Thomson et al., 2019) . Meanwhile, Coben (1996) developed STEBI in Turkey which focused on classroom management in schools. In Indonesia, the previous researchers have tried to adapt the STEBI into Indonesian language and culture, which has been validated by appropriate expert judgment that has produced a new Indonesian version of the STEBI instrument (Morris et al., 2017).

This study aims to test and develop the STEBI (Science Teaching Efficacy Belief Instrument) to be applied in the context of science teachers in Indonesia. In the previous stage, STEBI had gone through a process of adaptation in language and culture in the context of science teachers from Indonesia (Morris et al., 2017). The adaptation process of language and culture in Indonesia then produced 16 STEBI items, which initially consisted of 25 items in the original version. This research needs to be done in order to produce a valid and reliable instrument in measuring the level of science teacher's self-efficacy owned in a particular country. In addition, teacher's self-efficacy is important to be studied more deeply because it relates to teacher's sustainability and teacher's quality.

Methods

This study employed a descriptive quantitative approach that aimed to explore and confirm the number of factors arise from STEBI during the research. Besides, this study also aimed to test this instrument so that it could become an instrument that has good psychometric properties (Ramdani, 2018; Ramdani et al., 2019). The population in this study was all science teachers who teach physics, biology, chemistry in Indonesia that have been selected using purposive sampling techniques (Tae et al., 2019). This sampling was used to gain the respondents who have the characteristics determined by the researchers in this study.

The instrument used in this study is the Indonesian version of the STEBI which was adapted by previous researchers that has generated 16 final items to measure the concept of self-efficacy in science teachers (Tae et al., 2019). This instrument has a uni-dimensional theoretical character, meaning that it does not have dimensions or factors in it. Therefore, the other purpose of this study is also to categorize the factors that may be formed from the instrument as the result of statistical analysis. STEBI has discrimination powers that ranges from .31 – .52 (d > .3, considered to be good) for all 16 items. The result also showed that STEBI has a good reliability coefficient of .78 (r > .7, considered to be reliable) (Salsabila et al., 2019). STEBI has been adapted using a systematic guideline, so that the researchers in this study can guarantee that the adaptation results are in accordance to the language and cultural context in which the instrument will be used (Morris et al., 2017).

The researchers then distributed the STEBI questionnaire via online to the respondents who fit the characteristics of the criteria determined in this study previously. The online questionnaire consisted of an informed consent section containing respondents' willingness to fill out and be involved in the research. Consequently, the next sections comprised of respondents' identities, the instructions to fill out the questionnaire, and 16 STEBI items that were equipped with the

answer choices. This instrument used the Likert Scaling that ranges from 1 to 5 (from Strongly Disagree to Strongly Agree). The questionnaires were distributed during 2 months from February to March 2020. The steps then followed by tabulating the data (scoring), selecting the data to choose the data that was categorized as complete, and analyzing the data. The research used SPSS software to analyze descriptive and exploratory factors analysis and LISREL software to test the fit model and confirmatory factor analysis.

Results

The total of respondents involved in this study was 223 science teachers with a composition of 147 females (65.92%) and 76 males (34.08%). The process of developing STEBI begins with conducting the reliability testing that aimed to seeing whether this instrument has reliable characteristics to support the psychometric property of the instrument (see table 1).

Table 1. Reliability Coefficient of STEBI

Variables	Cronbach's Alpha	N of Items
STEBI	.778	16

Table 1 explains the reliability coefficient of STEBI which was .778 ($r > .7$), for the total of 16 items. After ensuring that the instrument has adequate reliability criteria, the researchers then conducted an exploratory factor analysis to find out the number of factors that could be emerged from this instrument. The results of exploratory factor analysis can be seen in table 2.

Table 2. Exploratory Factor Analysis of STEBI

Number of Item STEBI	Component 1	2	3	4
Item 3	.774			
Item 7	.728			
Item 1	.620			
Item 11	.531			
Item 15		.785		
Item 13		.722		
Item 12		.603		
Item 5	.597			
Item 9		.774		
Item 10		.601		
Item 2		.556		
Item 14			.664	
Item 8			.575	
Item 4			.490	
Item 16			-.449	
Item 6			.377	

Based on the results in table 2, the number of factors emerged in this instrument was found to be 4 factors. All factors have items with a loading factor value above .3. But there was only 1 item (item 16) in factor 4 that had the negative value. This item appeared to be overlap with other items so that the item would be removed later and would not used again in the next confirmatory factor analysis. The results of the confirmatory factor analysis for each dimension can be seen in Figures 1 to 4 which explain the fit model criteria for each component.

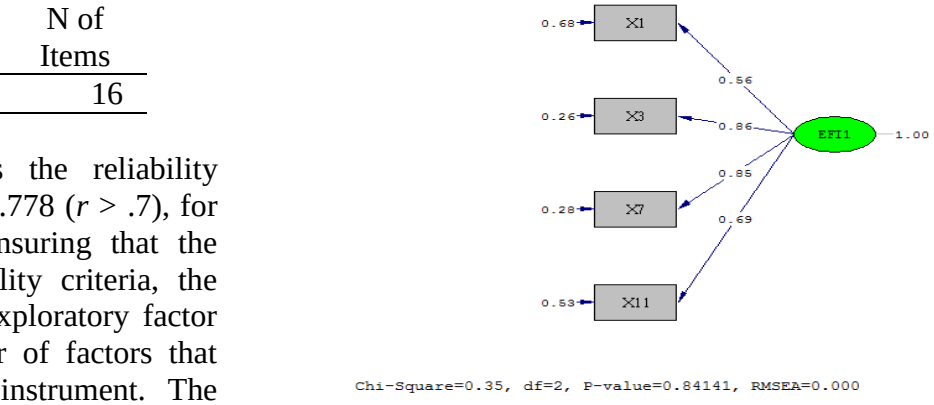

Figure 1. Model fit factor 1

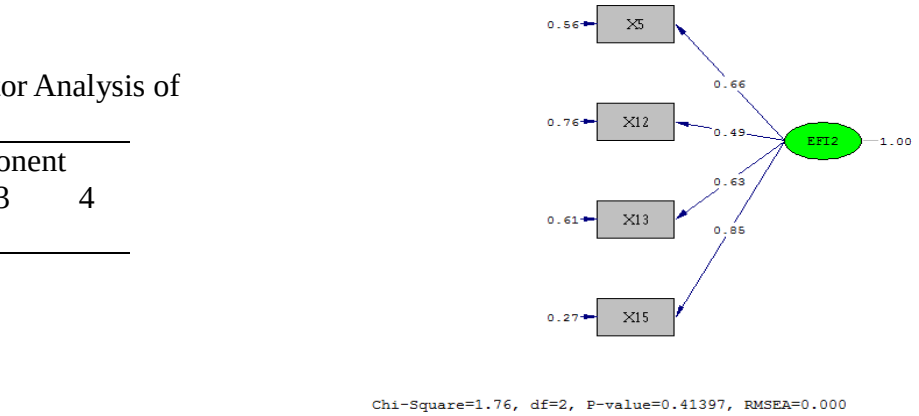

Figure 2. Model fit factor 2

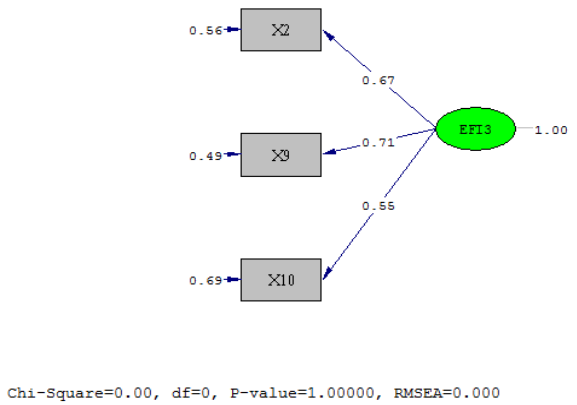

Figure 3. Model fit factor 3

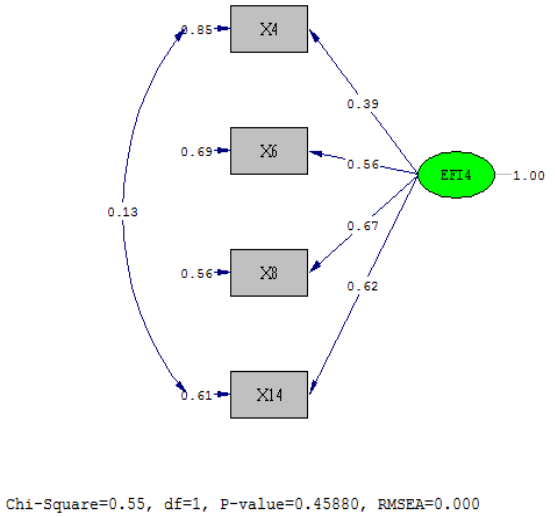

Figure 4. Model fit factor 4

The information from figures 1-4 show the model fit criteria of each factor that has been analyzed using confirmatory factor analysis. All models meet the fit criteria with P-Value reference standard that was above .05 and RMSEA below .05. The result of the validity score for each item can be seen in table 3.

Table 3. Validity Score for Each Item

Factor	Number of Item	V
1	Item 3	.86
	Item 7	.85
	Item 1	.56
	Item 11	.69
2	Item 15	.85
	Item 13	.63
	Item 12	.49
3	Item 5	.66
	Item 9	.71
	Item 10	.55
	Item 2	.67
4	Item 14	.62
	Item 8	.67
	Item 4	.39
	Item 6	.56

Note. V is Validity Score

Table 3 explains the validity for each item in every factor. Item 16 was removed from factor 4 because statistically, it has the validity below .3 which is considered not suitable enough to become a good item. Furthermore, the researchers used the second order model from STEBI which were taken into account as the most perfect model based on the result of exploratory and confirmatory factor analysis (see figure 5).

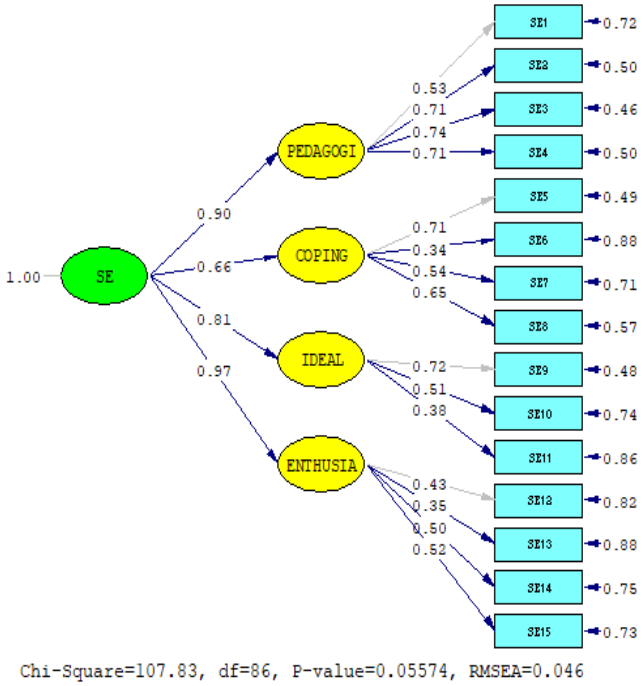

Figure 5. Structural Model of STEBI

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Discussions

The STEBI instrument in this study was developed using a structured methodology in which the researchers used a psychometric approach model that was considered as an appropriate procedure in developing an instrument (Ramdani, 2018). The reliability scores of the 16 items showed that the score reaches more than .7, which can be concluded that this instrument has satisfactory level of reliability (Ramdani et al., 2019). An instrument with satisfactory reliability coefficients means that STEBI can be used in any

context and any characteristic of science teachers as the respondents. Theoretically, the items in STEBI were specifically devoted to measuring the concept of science teacher's self-efficacy, so that it can be assumed that result of this study should be in accordance with previous studies (Enochs & Riggs, 1990).

The factor analysis in this study employed two large approaches that are statistically able to be the appropriate and good examiners for the instrument. The result of the first factor analysis shown by an exploratory approach has categorized this instrument into four factors. Basically, the original version of STEBI was not assumed as the concept of self-efficacy that could be categorized into several factors yet just a unidimensional concept (Enochs & Riggs, 1990). On the contrary, the majority of other experts have categorized the concept of self-efficacy into several factors that can be explained proportionally. For example, Bandura (2010), the founder of the basic theory of self-efficacy, divided self-efficacy into three main aspects namely generality, strength, and level. These three aspects represent the concept of self-efficacy which is considered as a complex concept to explain the individual conditions. Although Enochs and Riggs (1990) did not explicitly explain the number of factors presented in the STEBI, the researchers in this study assumed that the descriptions and examples provided by them in explaining the concept of self-efficacy in STEBI would be easier to understand by dividing it into several operational factors. Thus, based on these theoretical and practical reasons, the researchers in this study decided to categorize the factors of STEBI.

The categorization of factors described in this study, of course, must take into account many indicators so that they can be considered as the valid categorization. First, the results of exploratory factor analysis has brought up the factors into four categories, each of which was then represented by several items that have a loading factor value above .3. The loading factor itself shows that the item is considered sufficient to be the part of a particular category and independently able to explain its contribution to that factor. The result of loading factor was distributed from a range of .3 to .7. Psychometrically, these results are sufficient to explain that the items are suitable to be the part of certain factors (Ramdani, 2017). Second, the results of the confirmatory factor analysis that aim to corroborate the previous results, apparently also support the results of the exploratory. Each aspect factually has a good fit model with the criteria of *P-value* > .05 and *RMSEA* < .05 (Salsabila et al., 2019). These results certainly indicate that the factor model that developed by the researchers in this research is in accordance with existing data and theoretical concepts. Moreover, if it is viewed from Second Order Model (see figure 5), STEBI showed the suitable result which in accordance with the empirical data. Therefore, it can be concluded that STEBI has the suitable concept that could be utilised as the good instrument. Over more, STEBI also has 4 factors which can become the representation of 15 items as the final instrument.

The four factors generated in this research were then given a naming in order to further explain about the factors included in this instrument. Some theoretical considerations were used by the researchers to name the factors that emerged. The process of naming the factors were concepted based on initial theoretical sources that explain self-efficacy (Bandura, 1982). These two experts have examined self-efficacy based on several perspectives and factors such as the power of individuals to achieve the goals, the ability to invite others to achieve the goals, the ability to face challenges, the ability to manage the problems, and the ability to adapt to certain situations. Furthermore, the process of giving the names to the factor was also determined by the important points in formulating sentences used in the instrument. Each sentence has significant points that need to be achieved in measuring the concept of self-efficacy. When conducting further analysis, the researchers found that these important points could be grouped into particular factor based on the similarity of the measurement. The researchers then used these indicators to name the factors into four factors, namely; (1) positive pedagogical in motivating students, (2) coping with changes and challenges, (3) teacher's perception on ideal pedagogy, and (4) enthusiasm.

The first factor describes the basic abilities that must be possessed by a science teacher in accordance with the competencies and content knowledge that he has mastered in science teaching. In addition, this ability could also affect the positive energy not only for him in maintaining his work to remain optimal, but also

in motivating his students to progress and solve the scientific problems properly. The second factor is considered as the basic ability that is usually possessed by almost every science teacher, namely persisting in problems and challenges that may arise during the learning and teaching process. Meanwhile, the third factor focuses on the realm of perception that is directly related to the ability of science teachers to make an ideal figures about themselves in teaching science. Moreover, the last factor focuses more on the ability of science teacher to maintain the optimal conditions that is accompanied by positive emotions and enthusiasm to achieve satisfying results in teaching science. Thus, hollistically, these four factors could explain the concept of science teachers' self-efficacy in which each factor is strongly related each other.

Referring to the results of the confirmatory analysis, the four factors tested could fulfill a good psychometric principle where each aspect is represented by the items that have been translated based on Indonesian context and culture (Morris et al., 2017). Aspect 1 consists of 4 items that represent positive pedagogical in motivating students while aspect 2 consists of 4 items that represent coping with changes and challenges. Furthermore, aspect 3 consists of 3 items that represent teacher's perception on ideal pedagogy while aspect 4 consists of 4 items that represents enthusiasm. In total there are 15 final items that will become the Indonesian version of STEBI. There was a reduction of 1 item that initially was the part of aspect 4, namely item number 16. From the beginning, this item has been the only item that overlapped with other items so that the value of this item was negative (see table 1). When the data analysis was carried out using both exploratory and confirmatory, the item still had negative value and a tendency to interfere with other validity. Therefore, item 16 was finally removed from aspect 4. The results showed that after omitting item 16, the existing model gets better and there is no overlap among the items anymore. In conclusion, the final results of the study showed that there are 15 final items that can be used as a reliable and valid Indonesian version of STEBI.

Acknowledgement

This research is a routine collaboration among the researchers as the form of collaborative network between FKIP Universitas Terbuka Jakarta, Faculty of Psychology, UIN Sunan Gunung Djati Bandung, and Fakultas Ilmu Pendidikan, Universitas Timor. Our thanks go to all of the respondents that have participated in this research.

Conclusion

The result of this study showed that STEBI has good psychometric properties. This can be seen from the reliability coefficient that meets the reliable standards and items that have high level of validation. Meanwhile, the concept of STEBI in this study has produced four factors namely positive pedagogical in motivating students, coping with changes and challenges, teacher's perception on ideal pedagogy, and enthusiasm. Psychometrically, this study has generated a good instrument of STEBI to be used in Indonesian context. Practically, STEBI could also be used in other countries specifically for those who want to focus more on psychological assessment in science teachers. This is because STEBI is not only good from the viewpoint of psychometric and procedural but also from the viewpoint of theoritical framework and the general characteristic the instrument possesses. However, in its development, the researchers recommend future research to use more respondents with more varied backgrounds of science teachers (e.g. the length of teaching experiences, type of schools and ages). The further study should also involve other related variables that have a direct causal relationship to the concept of self-efficacy.

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