Construct validity and composite reliability of students’ motivation instrument toward science in UNNES

E Rudyatmi* and S Ridlo
Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang

*Corresponding author: elyrudy@mail.unnes.ac.id

Abstract This instrument manuscript was arranged with unstandardized stimulus and would come to a very subjective interpretation. This study aimed to test (1) construct validity and (2) factor reliability of students’ motivation instruments toward Sciences in Mathematics and Natural Sciences Faculty (FMIPA), UNNES. The response approach method was used in the instrument development. This approach would put response categories in points along the defined psychological continuum. The variable of this research is student's motivation toward science. Research respondents were some students of FMIPA, UNNES who were studying in the even semester of academic year 2016/2017. Respondents was taken by proportional random sampling technique. This research was carried out in FMIPA UNNES. Loading factor on each variable in this instrument is significant or valid. That is observed from the p-value of the t-test <0.05. The minimum loading factor in each factor is 0.3, so qualitatively all the loading factors within the instrument are valid. Thus, the instrument of students’ motivation toward science is valid. As factorial, the coefficient of instrument reliability in science is very high. In composite, the coefficient of instrument reliability of students’ motivation toward sciences is also very high. Thus, the instrument of students’ motivation of FMIPA UNNES toward sciences is reliable.

1. Introduction
Stated that many research problems need development of valid and reliable instruments to measure the abstract component such as: intelligence, learning outcome, motivation, attitude, interest and so on. The measurement of different variables demands a different set of instruments as well [1].

An instrument is a tool used in the measurement. A qualified instrument should be validated before being used. Basically, there are two kinds of instruments; test and non–test. The test is a systematic procedure to conduct observation on someone’s attitude and describe it with a numeric scale or category [2]. Attitude indicator explored by the test is a maximum performance since the test is arranged to reveal the individual competence maximally. Meanwhile, indicator explored by the non-test is a typical performance.

This instrument manuscript was arranged by unstandardized stimulus and might make a very subjective interpretation as individual affective aspect at the moment [3]. The quality of the instrument is defined by two main criteria; the validity and reliability [4]. So, the nature of the instrument is a measurement tool with good validity and reliability to collect data in a study.

Described the critical steps in the preparation or development of a test that as follows: (a) clarity of concept or theory used as the basis of measurement work; (b) it should be thoroughly identified the attributes to be measured; (c) it is necessary to operationally define the attributes that have been identified; and (d) it is essential to select the format of the measuring instrument appropriate with the
attributes and with the Indonesian [5]. Explained the steps of instrument development as follows: (a) formulating constructs based on the theoretical underpinning, (b) constructing of dimensions and indicators of variables to be measured, (c) designing the framework of the instrument in a table of specifications representing dimensions, indicators, number and the total items, (d) assigning quantities or parameters in a continuum span, (e) writing instrument items in the statements or questions, (f) performing theoretical validation, (g) revising based on panel results, (h) duplicating the instruments for testing, (i) empirical validation trials, (j) empirical validity testing using internal or external criteria, (k) concluding valid items or set of instruments based on the criteria obtained, (l) issuing, repairing, or reassembling items based on the items analysis, (m) calculating the reliability coefficients, and (n) reassembling the valid items as the instrument [6].

This research focused on the development of students’ motivation instruments for FMIPA, UNNES toward sciences by factor analysis. The objectives of the study could be formulated as follows: (a) to examine the construct validity of the motivation instrument toward sciences for FMIPA students; and (b) to examine the factor and composite reliability of students’ motivation instrument of FMIPA, UNNES toward sciences.

The findings in this study are expected to give significant contributions include: (a) academically, this research results could support construct validity and reliability concept of Cronbach’s α factor and stratified; (b) in practice, produced a standard and valid student motivational instrument on sciences for FMIPA, Unnes; and (c). In practice, it would give empirical data for other researchers to develop the students’ motivation instrument for FMIPA, UNNES on advanced science.

2. Methods

This instrument developmental research was conducted in response approach. The response approach would put response categories at points along a defined psychological continuum. The variable of this research was the targeted area to be measured, which was student’s motivation toward sciences.

The targeted population was all students of FMIPA UNNES, while the population unit was the active students of FMIPA UNNES in the even semester of the academic year 2016/2017. The respondents were some students of FMIPA UNNES who were studying in the even semester of academic year 2016/2017. The respondents were defined by proportional random sampling technique. This research was conducted in FMIPA UNNES in the even semester of 2016/2017.

The measurement or instrument of student motivation of FMIPA UNNES toward science needs to be elaborated into some factors and indicators. The motivational factors of FMIPA UNNES students’ motivation toward science are interpreted as: (a) intrinsic motivation, (b) self-efficacy, (c) self-determination, (d) level of motivation, and (e) career motivation. Each factor is divided into five indicators [7], it was already qualified as described in the SPSS manual.

The response to this research was a typical performance. Therefore the expected response could be explored by an instrument related to a condition, situation, or feeling associated with a student's circumstances when learning in his class. The format of the item selected for this instrument was the restricted response format, which in each item has five response options with a range of values 1 through 5.

According to [8], there are four basic steps for carrying out a factor analysis, i.e. (a) calculating all correlation matrices for each variable, (b) doing factor extraction, (c) rotating, and (d) naming each factor. According to [9], there are two approaches of factors analysis, namely (1) exploratory factor analysis by Principal Component Analysis (PCA), and confirmatory factor analysis by Maximum Likelihood (ML) analysis. This study applied the confirmatory approach because it had the purpose of (a) testing whether the number of factors obtained empirically corresponds to the number of theoretically constructed factors or testing the hypotheses about the existence of constructs; and (b) finding answers to the question of whether the number of extracted factors could be used to explain the relationship among indicators significantly.

Argues that reliability could be measured in several different ways: (a) repeatedly giving tests on the same sample in a short period (reliability test-retest), (b) internal consistency method, associated with
the Cronbach’s alpha coefficients and their variants, (c) split-half method, and (d) parallel-form method [10]. This study used internal alpha consistency reliability by Cronbach. Reliability was calculated by Cronbach’s alpha on every factor presented in this instrument; in addition, the set of instruments was also tested by stratified Cronbach’s alpha.

3. Results and Discussion
The minimum sample size is 5 times of variables studied. This study employed 25 variables; then the minimum sample should be 125 respondents. The number of respondents of this research was 312 students, so theoretically, the sample size of this study is eligible for further factor analysis.

Stated that items in one factor should be at least three variables. This study employed five variables or items in each factor. The minimum requirement of three items for each factor considers information obtained from the factor (not too small or thin) [8].

| Item  | Factor                     | Loading factor | p (t-test) | Category |
|-------|----------------------------|----------------|------------|----------|
| X1    | Intrinsic motivation       | 0.043          | 0.038      | Valid    |
| X2    |                           | 0.059          | 0.038      | Valid    |
| X3    |                           | 0.047          | 0.037      | Valid    |
| X4    |                           | 0.047          | 0.043      | Valid    |
| X5    |                           | 0.056          | 0.037      | Valid    |
| X6    | Self efficacy              | 0.048          | 0.038      | Valid    |
| X7    |                           | 0.041          | 0.040      | Valid    |
| X8    |                           | 0.053          | 0.038      | Valid    |
| X9    |                           | 0.049          | 0.038      | Valid    |
| X10   |                           | 0.042          | 0.037      | Valid    |
| X11   | Self-determination         | 0.049          | 0.037      | Valid    |
| X12   |                           | 0.047          | 0.042      | Valid    |
| X13   |                           | 0.047          | 0.040      | Valid    |
| X14   |                           | 0.055          | 0.040      | Valid    |
| X15   |                           | 0.050          | 0.037      | Valid    |
| X16   | Level of motivation        | 0.040          | 0.040      | Valid    |
| X17   |                           | 0.042361       | 0.039      | Valid    |
| X18   |                           | 0.047917       | 0.039      | Valid    |
| X19   |                           | 0.048          | 0.041      | Valid    |
| X20   |                           | 0.043056       | 0.039      | Valid    |
| X21   | Career motivation          | 0.053          | 0.034      | Valid    |
| X22   |                           | 0.04375        | 0.035      | Valid    |
| X23   |                           | 0.055          | 0.035      | Valid    |
| X24   |                           | 0.053          | 0.039      | Valid    |
| X25   |                           | 0.042          | 0.043      | Valid    |

Source: CFA by Lisrel

Note:
t: students distribution to test the loading factor significance
p: opportunity to be supported or failed to be supported by data
The correlation between intrinsic motivation factor and self-efficacy is 0.55 with a coefficient of <0.7. The correlation between intrinsic motivation factor and self-determination is 0.58 with a coefficient of <0.7. The correlation between intrinsic motivation factor and motivation level is 0.42 with a coefficient of <0.7. The correlation between intrinsic motivation factor and career motivation is 0.48 with a coefficient of <0.7. The correlation between self-efficacy factor and self-determination is 0.60 with a coefficient of <0.7. The correlation between self-efficacy factor and motivation level is 0.51 with a coefficient of <0.7. The correlation between self-efficacy factor and career motivation is 0.39 with a coefficient of <0.7. The correlation between self-determination factor and motivation level is 0.73 with a coefficient of >0.7, which for both of these factors showed an intercorrelation and should be used rotation oblimin assumption. The correlation between self-determination factor and career motivation is 0.43 with a coefficient of <0.7. The correlation between motivation and career motivation is 0.46 with a coefficient of <0.7. Thus, the relationship among independent variables in this instrument is suitable for varimax model rotation, which is done for CFAs using Lisrel.

Loading factor on any variables or items in this instrument is significant or valid. It was found in the p-value of the t-test which is <0.05. According to [8], the minimum loading factor in each item is 0.3. Thus, qualitatively, all the loading factors in this instrument item are valid. It can be said that the construct validity of students’ motivation instruments toward sciences for FMIPA UNNES is valid. A summary of the construct validity analysis of students' motivation instrument toward sciences is presented in Table 1.

**Table 2. Stratified reliability of students’ motivational instrument toward sciences**

| Items  | Factor          | Reliability of Cronbach’s α coefficient | Reliability of stratified Cronbach’s α coefficient |
|--------|-----------------|----------------------------------------|-----------------------------------------------|
| X1     |                 |                                        |                                               |
| X2     |                 |                                        |                                               |
| X3     | Intrinsic Motivation | 0.823                                |                                               |
| X4     |                 |                                        |                                               |
| X5     |                 |                                        |                                               |
| X6     |                 |                                        |                                               |
| X7     |                 |                                        |                                               |
| X8     | Self-efficacy   | 0.799                                  |                                               |
| X9     |                 |                                        |                                               |
| X10    |                 |                                        |                                               |
| X11    |                 |                                        |                                               |
| X12    |                 |                                        |                                               |
| X13    | Self-determination | 0.814                                |                                               |
| X14    |                 |                                        |                                               |
| X15    |                 |                                        |                                               |
| X16    |                 |                                        |                                               |
| X17    |                 |                                        |                                               |
| X18    | Level of motivation | 0.840                                |                                               |
| X19    |                 |                                        |                                               |
| X20    |                 |                                        |                                               |
| X21    |                 |                                        |                                               |
| X22    |                 |                                        |                                               |
| X23    | Career motivation | 0.849                                |                                               |
| X24    |                 |                                        |                                               |
| X25    |                 |                                        |                                               |
| Total  | Student’s motivation toward sciences | 0.937                                |                                               |

*Source: Reliability test by SPSS*
The CFA model for this instrument is valid according to the Root Mean Square Error of Approximation (RMSEA), because 0.070 < 0.08; however, it is not valid for other criteria. Thus, the CFA model of this research instrument could still be improved by modifying the item statements in the instrument. The Lisrel CFA result suggests that some items are transferred to another factor, meaning that the statement declaration or question in the item is less suitable for a particular factor but more suitable for other factors. This indicates that respondents have different perceptions of the researchers.

The reliability of instruments with confirmatory factor analysis demands reliability on each factor followed by stratified reliability [11], [12] often refer it as composite reliability.

The stratified alpha coefficient was introduced by Cronbach as cited by [13] which is useful for estimating the reliability of an instrument consisting of several subtests or factors. This coefficient is similar to the alpha coefficient. Stratified or composite alpha coefficients are internal consistency measurements involving test components. These stratified alpha coefficients are appropriately imposed in the case of multidimensional composite scores such as multidimensional battery tests [13].

The composite reliability analysis as presented in Table 2 above indicates a very high factorial coefficient, in addition to the composite reliability, is also very high. Thus, regarding reliability requirements, the instrument of students’ motivation of FMIPA UNNES toward science is qualified.

4. Conclusion
Loading factor on each variable or item in this instrument is significant or valid. This is supported by the p-value of the t-test which is <0.05. The minimum loading factor in each factor is 0.3, so qualitatively all the loading factors within the instrument are valid. Thus, the instrument of students’ motivation of FMIPA, UNNES toward science is valid. As factorial, the coefficient of instrument reliability is very high. In composite coefficient of instrument, reliability is also very high. Thus, the instrument of students’ motivation for FMIPA UNNES toward science is steady or reliable.

Reference
[1] Mohajan H K 2017 Ann. Spiru Haret Univ., Econ. Ser. 17 58
[2] Taber K S 2017 Res. Sci. Educ. 48 1273
[3] Balasubramanian N 2012 Asian J. Nurs. Edu, Res. 2 65
[4] Erwin P 2014 Attitudes and Persuasion. (Psychology Press: London)
[5] Hudha S A and Mardapi D 2018 REID 4 35
[6] Taherdoost H 2016 Int. J. Acad. Res. Manag. 5 28
[7] Arkkelin D 2014 Using SPSS to Understand Research and Data Analysis (Psychology Curricular Materials. Valparaiso University)
[8] Hadi N U, Abdullah N and Sentosa I 2016 J. Educ. Soc. Res. 6 215
[9] Saptono A, Suparno and Najah S 2018 J. Entrep. Educ. 21 238
[10] Ursachi G, Horodnic I A, and Zait A 2015 Procedia Econ. Finance 20 679
[11] Awang Z, Afthanorhan A, Mohamad, M and Asri M A M 2015 Int. J. Tour. Policy. 6 29
[12] Gajewsk B J, Jiang Y, Yeh H W, C Teel, Choi W S, Greiner K A and Daley C M 2014 CSBIGS 5 88
[13] Mousa S 2016 Glob. Bus. Rev. 17 1125