Instrument design of students self-regulated learning in statistics course

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Abstract. The purpose of this study was to obtain an appropriate and valid instrument for measuring students self-regulated learning in a statistics course. The first step was reviewing the definitions of self-regulated learning from some relevant references. The second was writing an instrument blueprint. The third was asking some expert judges to examine the instrument validity. The next step was compiling the statement items as the initial instrument design. Then the initial instrument was used to collect the self-regulated learning data from students in higher education. Those data were processed and analysed using exploratory factor analysis. The result was the final instrument which consists of 19-items with nine strategies that were grouped into five factors. The Factor-1 was fit into a goal, planning, and organizing strategies which had 7-items; The Factor-2 was fit into a structuring in physical and mental environment (3-items); The Factor-3 was fit into a seeking information (3-items); The Factor-4 was fit into a seeking assistance and rehearsing (3-items); and The Factor-5 was fit into a self-consequence and self-evaluation (2-items). This final instrument could be used as an appropriate and valid instrument for measuring students self-regulated learning in a statistics course in next study.

1. Introduction

Self-regulated learning is translated into Indonesian as “kemandirian belajar” [1]. Self-regulated learning has been defined by some researchers such as [2-6]. They expressed the definition in different ways but it had the same main term that is the students’ process of self-organizing in academic achieving. Self-regulated learning can be stated as a student’s learning process in terms of managing and controlling themselves in their cognition, emotion, and behaviours as their effort to achieve the optimal academic achievement.

A set of behaviour, value, belief, and personal trait is called a character [7]. Self-regulated learning is closely related to the character or a personal behaviour of students in carrying out the learning process to achieve the maximum target of learning outcomes or academic achievement. Therefore, self-regulated learning is important to be owned by every student at various levels of education, especially by students in higher education [8].

Self-regulated learning is more important to be owned by students of higher education because they have to learn a large quantity and complex subjects. They have to immediately learn the subjects in a relatively short time in each semester. For that reason, they need to have motivation and learning strategies themselves in order to reach their optimal targeted achievement. In addition, the transition
period of the changes in the way of learning from high school to higher education makes they should have the character of self-regulated learning and grow it in higher education.

The importance of self-regulated learning drives the number of researches in self-regulated learning topic. The researchers develop the self-regulated learning concept and its measurement. The concept of self-regulated learning contains three stages, namely forethought and planning, performance and monitoring, and self-reflection [3]. Those stages were explained by [3,5,8-11] as a cyclical stages from one stage to another. The measurement of self-regulated learning was developed from the results of the researcher such as [11] who proposed the self-regulated learning model which contains 14-strategies. Those strategies were referred from previous researchers who observed students’ self-regulated learning strategies in their classes. The researcher [12] used the 11-strategies to measure students’ self-regulated learning by combining three strategies from [11]. One of the authors who used the 11-strategies for measuring self-regulated learning students was [1]. These 11-strategies were self-evaluation, organizing and transforming, goal setting and planning, seeking information, keeping records and monitoring, environment structuring, self-consequence, rehearsing and memorizing, seeking social assistance, reviewing records, and miscellaneous (other) strategy.

The strategy or aspect of students’ self-regulated learning can be seen as a concept or variable which cannot be directly measured but it has to be measured by some indicators. The more variables used to measure self-regulated learning the more indicators or items needed. The more indicators or items are made there are a chance that the items have similarities and correlated. If that condition occurs then the indicators or items need to be selected, reduced, and grouped into one or more factor(s). The exploratory factor analysis techniques can be used for that procedure to produce the appropriate and valid instrument.

This study aims to obtain an appropriate and valid instrument for measuring students’ self-regulated learning in a statistics course. The process of instrument design was making an instrument blueprint, validating, compiling, and applying the factor analysis exploratory.

2. Methods

2.1. Procedure
The instrument of self-regulated learning was designed through some steps. The first was reviewing its definitions from some of relevant references. The definitions from some research were expressed differently but consistently referred to the three stages of self-regulated learning. The first stage is forethought and planning, the second stage is performance monitoring, and the third stage is self-evaluation.

The second step was writing an instrument blueprint of self-regulated learning. The third step was asking some expert judges to meet a valid instrument [13]. The fourth step was compiling the statement items of the instrument for the research subjects, namely students in a statistics course in higher education.

The number of items made in the blueprint step was 61-items then it was reduced to 26-items after being validated by expert judges. These 26 items were then analysed by exploratory factor analysis to be selected and reduced based on the correlation among them. The retained items formed one or more factor(s) that had the similarity item(s).

2.2. Data Collection
The survey was done to the higher education students and was conducted in online survey as long as four days, from 8th to 11th of August 2018 based on the adequacy of the amount of data.

2.3. Respondent
There were 191 respondents who participated in filling out the self-regulated learning instrument. They came from undergraduate, master, and doctoral students. About 11% was non-active students and the rest was active students. For further analysis, the 150 data were taken, namely all active undergraduate students. Based on gender, there were 45 men and 105 women. The age ranges from 18 to 25 years old. The mathematics science and mathematics education study programs more dominant than others study program.
2.4. Data Analysis

The scale data of students self-regulated learning was analysed by exploratory factor analysis that can be referenced from [14,15]. The determined criteria of validity were a KMO value 0.7, the value of loading factor for each item was not less than 0.4, the total variance explained was at least 60%, and the cross-factor value was at least 0.3. Thus, the items with a value of loading factor less than 0.3 or a value of cross factor at least 0.3 were then excluded from the next iteration. This technique was carried out iteratively until the factors met all of the determined criteria.

3. Results and Discussion

3.1. Result

Factor analysis is one of the analytical tools in statistics that widely used to find internal correlation among some variables [15]. In developing instrument designs, the term variable can be applied to the attributes or items instrument. The exploratory factor analysis process is to select, to reduce, and to classify the items which have similarities based on the correlation values among them. The set of items that have similarities would be form into a factor. The process iteratively is done until the determined criteria met.

The result of first iteration of Keiser-Mayer-Otkin (KMO) criteria and the p-value of Bartlett’s test was 0.880 and 0.000 respectively. Those of the two test results indicated that the factor analysis could be used for the next analysis and the items in the instrument design significantly correlate each other. This iteration carried out 6-factors with the total variance explained was 60.63%.

The second iteration, there were three items should be excluded, namely item10, item12, and item19. The next iteration was done in the same manner. Table 1 shows the resume of all iteration results.

| Iteration | Number of Factors | Item(s) Deleted | KMO   | Total Variance Explained (%) |
|-----------|-------------------|-----------------|-------|------------------------------|
| 1         | 6                 | -               | 0.880 | 60.63                        |
| 2         | 6                 | 10, 12, 19      | 0.871 | 63.15                        |
| 3         | 6                 | 17, 25          | 0.878 | 61.44                        |
| 4         | 5                 | 3               | 0.877 | 63.10                        |
| 5         | 5                 | 20              | 0.868 | 63.25                        |

The 5th iteration formed as many as five factors which have KMO value of 0.868 and the total variance explained was 63.25% with the total 7-items deleted. This shows that the rest of 19-items in the instrument design could be explained by the five factors as much as about 63% the information of all items. This met the criteria of the minimal total variance explained that was suggested by [14]. Those five factors could be used to measure students self-regulated learning in statistics course and could be named to facilitate the interpretation. The name of the factor(s) was given based on the similarities of its forming items. For example, Factor-1 had seven forming items which were related to the purpose of learning statistics, arranging learning plans, and implementing them, so that Factor-1 could be named as the represent of the Goal, Planning, and Organizing. Table 2 shows the factor and its forming items, loading factor value, and the factor’s names.
Table 2. The Factor and Its Forming Items, Loading Factor, and Factor’s Names

| Items Number | Item Statement in The Instrument | Loading Factor | Factor’s Name                              |
|--------------|----------------------------------|----------------|--------------------------------------------|
|              |                                  |                |                                            |
| Item5        | Doing 80% of planning in learn   | .755           | Factor-1 Goal, Planning, and Organizing    |
|              | statistics                       |                |                                            |
| Item21       | Happy in doing the statistics    | .750           |                                            |
|              | problem                          |                |                                            |
| Item26       | Reviewing the result of statistics task | .634       |                                            |
| Item4        | Setting a plan to do in learning | .609           |                                            |
|              | statistics                       |                |                                            |
| Item1        | Knowing a goal of learning       | .558           |                                            |
|              | statistics                       |                |                                            |
| Item6        | Rereading statistics note        | .534           |                                            |
| Item11       | Seriously in learning statistics in the class | .530        |                                            |
| Item15       | Need to memorize the statistics  | .708           | Factor-2 Structuring physical and mental   |
|              | material                         |                | environmental                               |
| Item14       | Come in to the statistics class  | .690           |                                            |
|              | early                            |                |                                            |
| Item13       | Avoid a friend who likes make a  | .612           |                                            |
|              | chat in the class                |                |                                            |
| Item8        | Comparing my statistics note     | .800           | Factor-3 Seeking information               |
|              | with a friend’s note for         |                |                                            |
|              | confirming                       |                |                                            |
| Item9        | Looking for the additional       | .654           |                                            |
|              | material more than one to        |                |                                            |
|              | support for doing a statistics   |                |                                            |
|              | task                             |                |                                            |
| Item7        | Routinely checking the           | .556           |                                            |
|              | completion of my statistics note |                |                                            |
| Item2        | Searching the information about  | .540           |                                            |
|              | what is statistics               |                |                                            |
| Item16       | Need of some statistics exercises | .773           | Factor-4 Seeking assistance, rehearsing    |
|              | problem                          |                |                                            |
| Item18       | Help-seeking in doing a hard     | .753           |                                            |
|              | matter in statistics             |                |                                            |
| Item22       | Need of a statistics text book   | .688           |                                            |
| Item24       | Predicting the value of statistics work done | .654       | Factor-5 Self-Consequence, Self-Evaluation |
| Item23       | Reward on my succeed in doing    | .639           |                                            |
|              | statistics problem               |                |                                            |

3.2. Discussion

The analysis result of students’ self-regulated learning instrument design produced nine strategies for the final instrument. Those strategies were in line with some strategies from [11,12]. Those were goal setting, planning, organizing, structuring environment, seeking information, seeking assistance, rehearsing, self-consequence, and self-evaluation. All of the 19-items in the final instrument were grouped into five factors that could be used to measure students self-regulated learning in a statistics course.

Those of five factors could be separated into the stages of self-regulated learning from [3]. The Factor-1 was fit into the forethought and planning stage. This stage could be show at the beginning of the learning process and at the initial implementation.
The combination of Factor-2, Factor-3, and Factor-4 were fit into the performance and monitoring stage. This stage was the effort phase of using some strategies in achieving the goal of learning. The monitoring was done as long as learning process. The students regulate his/her self to achieve the goal of learning based on their strategies.

The last factor, Factor-5 was fit into the self-reflection stage. This stage shows at the end of the learning process. The reflection process occurs after all of the effort phase have been done. In this stage, students try to predict the quality of his/her task that have been done and give the value of it.

Other strategies, namely transforming, keeping records and monitoring, memorizing, reviewing records, and other strategy from [3,12], were not used in the final instrument. Those strategies have been included implicitly in the formed of five factors.

4. Conclusion
The final instrument of students’ self-regulated learning in statistics course consists of 19-items that were grouped into five factors. Factor-1 was the items that described about the goal, planning, and organizing which has 7-items; Factor-2 was the items that expressed about structuring in physical and mental environment (3-items); Factor-3 was the items that described about seeking information (4-items); Factor-4 was the items that described about seeking assistance and rehearsing (3-items); and the last, Factor-5 was the items that expressed about self-consequence and self-evaluation (2-items).

This final instrument has all determined criteria of exploratory factor analysis as a valid instrument. The instrument can be used for measuring students’ self-regulated learning in statistics course for next research.

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