Validation construct: Confirmatory Factor Analysis (CFA) instruments scientific communication skills students in learning physics

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Abstract. Scientific communication skills into competencies required of students in the 21st century scientific communication must be owned that is orally or in writing. This research aims to develop assessment instruments scientific communication skills of students in physics. Scientific communication skills assessment instrument is a synthesis developed into five indicators. Instruments tested on students of SMAN 6 Yogyakarta. The instrument was developed to test the construct using LISREL. LISREL analysis used in the form Confirmatory Factor Analysis (CFA) to see how the fit between indicators developed models. The results showed that scientific communication instrument had a reliability 0.82. Criteria for each item has a value infit meansquare 1.01 with grain criteria fit with the model of Rasch (meansquare infit ≤ 0.77 ≤ 1.33) with both criteria. Loading factor of each item instrument has a value of > 0.3. The results validate the results obtained construct second order confirmatory factor analysis (CFA) on 17 items results showed that p-value = 0.27505 (p > 0.05) and RMSEA = 0.031 (RMSEA > 0.05). By loading factor > 0.3 and t-value > 1.95 so that the item is valid and thus fit model. Dengan scientific instruments developed communication skills can be used to measure scientific communication skills of students in physics.

1. Introduction

The development of the 21st century brought an emphasis that the student must have special skills. Special skills students need to have in the 21st century include the ability to think critically, problem-solving skills, creativity, metacognitive skills, communication skills-collaboration, digital literacy and technology [1],[2],[3],[4],[5]. Part of the 21st century skills that will be developed is the skill of communication-collaboration. The communication process is important in the learning process. The success is determined by a process of learning good communication between teachers and students [6].

Based on early study results of research show that 76.6% of students admitted to still having difficulty in learning the physics of matter. Furthermore, 88.3% of students rarely (<3 times) asked during the learning activities take place. Initial studies also showed that only 18.9% of students understand the presentation of the concepts of physics in the mathematical representation. Furthermore, as many as 56.8% of students better understand the presentation of the concepts of physics in the form of a picture (visual). Based on the above, further studies need to be done to develop assessment instruments, scientific communication skills in learning physics.
Scientific communication skills of students is part of the 21st century skills students need to have. Direct of scientific communication between students and teachers is part of the learning process. The success of the students in understanding what is presented by the teacher is the success of the learning objectives. Communication failure means the failure of students to accept what is presented by the teacher. This indicates that the message / the teacher is not the same to convey the message / information received by the students [7]. Based on the above explanation, the study aims to (1) generate measurement instruments scientific communication skills in learning physics, (2) to see the results of scientific communication skills of the students on the material impulse and momentum.

2. Methods

This study is a scientific instrument development of communication skills to assist teachers in the evaluation process of scientific communication skills of students. Instruments developed is the result sitesis developed into the grain indicators. The subjects were students of class X at SMAN 6 Yogyakarta. The analysis instrument of scientific communication skills using LISREL program to determine the relationship between the grains fit indicator. Research procedure includes the following activities: (1) The test plan includes test goal setting, preparation of test items and test preparation section, fixing validation by experts, the revision and development instruments. (2) Stage tests include determination of high school, test execution, penskoran, item analysis, and revision of test items which do not meet the criteria. (3) measurement phase includes the development of a test based on the test results, and interpretation of measurement data to see N-Gain scientific communication skills graders X. Test goodness of fit test for construct validation results Confirmatory Factor Analysis (CFA) is determined based on the loading factor (load factor) > 0.3. Model fit (fit statistic) of data obtained with the following provisions:

| Goodness of fit index                     | Criteria               | Status |
|------------------------------------------|------------------------|--------|
| Kai squared empirical                    | Chi square <2dB        | fit    |
| Root Mean Square Approximation (RMSEA)   | ≤ 0:08                 | fit    |
| P-Value                                  | > 0.05                 | fit    |
| GFI                                      | > 0.90                 | fit    |
| AGFI                                     | > 0.90                 | fit    |
| NFI                                      | > 0.90                 | Fit    |
Determination of reliability criteria that the test results should have a reliability of at < 0.90 [8]. The higher the coefficient of reliability of a test, then it is likely the smaller the error occurs at the time of making decisions based on the score obtained in the tests. Formulation of indicators blueprint for scientific communication skills test was developed based on Table 2 [9-11].

**Table 2. Indicators of scientific communication students**

|                              | Coil                        | Divan & Mason               | Spektor                      |
|------------------------------|-----------------------------|-----------------------------|------------------------------|
| **Finding and taking resources** |                             |                             |                              |
| **Evaluate and critique information** |                             |                             |                              |
| **Build argument**          |                             | Written                     | Listening and observing      |
| **Solve the problem**       |                             | Oral presentation           | Scientific writing           |
| **Communicating information** |                             |                             | Data representation          |
|                              |                             |                             | presentation of knowledge    |

Furthermore development grain indicators of scientific communication skills high school physics matter further impulse and momentum are presented in table 3.

**Table 3. Indicators of development of communication skills of scientific instruments**

| Communication skills            | Competence                  | No.  | Indicator                                                                 |
|---------------------------------|-----------------------------|------|---------------------------------------------------------------------------|
| **Seek and receive resources**  | Finding sources of information relevant to a given concept | p1   | Looking for information related to the proposed concept                   |
| **Evaluate and critique the information provided** |                            | p2   | Gather information from various sources available                        |
| **Build argument**              |                             | p3   | Receive and understand the information provided                           |
| **Solve the problem**           |                             | p4   | Mastery of the material provided                                          |
| **Communicating information**   |                             | p5   | Show enthusiasm in asking questions                                        |
|                                  |                             | p6   | Asking the question in accordance with the topic or discussion            |
| **Seek and receive resources**  |                             | p7   | Answering questions with precise and clear                                |
|                                  |                             | p8   | Argues against what were deemed incompatible with the thinking and the reasons apply opinion / argument with clear and easily understandable ability Arguments | p9   |
| **Solve the problem**           |                             | p10  | Provide data to strengthen the opinion / argument                         |
| **Communicating information**   |                             | p11  | Justifying a relationship between an argument with the data that has been written. Providing solutions for solving a given Providing solutions for solving problems relevant to the concept / materials |
|                                  |                             | p12  | Understanding the concept / information provided in various forms of representation |
3. Results and Discussion
This research is the development of an assessment instrument of scientific communication skills of students in physics. Furthermore, researchers analyzed each item indicator using the second order confirmatory factor analysis (CFA) to see whether the indicators are developed valid CONSTRUCTS (construct validity) with a fit model valid assessment criteria refer to Table 1.

| Communication skills | Competence | No. | Indicator |
|----------------------|------------|-----|-----------|
| p15                  |            |     | Using multiple representations in presenting their opinions / arguments |
| p16                  |            |     | Communicating the concept / information received in the form of other representations |
| p17                  |            |     | Concluded by systematic and clear |

Results construct empirical validation of the instrument using the QUEST program is shown in Figure 2. Based on the results of the path diagram Confirmatory Factor Analysis (CFA) obtained the loading factor value of each item indicators > 0.3. It shows that in the grain and declared valid indicator. However, CFA measurement requires a match of models built with the data obtained in the field (fit statistic). To know the results of model fit (fit model). Determination fit model based on p-value and Root Mean Square Approximation (RMSEA). Based on the analysis above, the p-value = 0.00076 and...
Root RMSEA = 0.077. Based on the criteria of Table 1, the results of the analysis are not yet eligible p-value <0.08. Therefore it is necessary to modify the model to create a new path diagram in accordance with the path suggested by the program LISREL. The next stage perform modification indices, results path diagram shown in Figure 3. After modification indices, the analysis result of each item indicator has a loading factor> 0.3, p-value> 0.05 and RMSEA ≤ 0.08. These results indicate that the instrument is declared fit to the data. Results per item indicator analysis are shown in Table 4.

Table 4. Results of second order CFA instrument of scientific communication skills

| item | Loading Factor (λ) | t-value | significance (> 1.95) | Criteria (> 0.5) | result |
|------|---------------------|---------|-----------------------|------------------|--------|
| dimension 1 |                      |         |                       |                  |        |
| p.1  | .38                 | ----    | ----                  | Valid            | reference Item |
| p.2  | .44                 | 3.88    | significant           | Valid            | item Fit |
| p.3  | .51                 | 4.22    | significant           | Valid            | item Fit |
| p.4  | .56                 | 4.62    | significant           | Valid            | item Fit |
| dimension 2 |                      |         |                       |                  |        |
| p.5  | .52                 | ----    | ----                  | Valid            | reference Item |
| p.6  | -1.08               | -3.13   | Not significant        | Invalid          | Item Not Fit |
| p.7  | .51                 | 5.97    | significant           | Valid            | item Fit |
| dimension 3 |                      |         |                       |                  |        |
| P.8  | .47                 | ----    | ----                  | Valid            | reference Item |
| p.9  | .38                 | 2.35    | significant           | Valid            | item Fit |
| p.10 | .49                 | 2.35    | significant           | Valid            | item Fit |
| dimension 4 |                      |         |                       |                  |        |
| p.11 | .59                 | ----    | ----                  | Valid            | reference Item |
| p.12 | .56                 | 8.03    | significant           | Valid            | item Fit |
| p.13 | .49                 | 6.81    | significant           | Valid            | item Fit |
| dimension 5 |                      |         |                       |                  |        |
| p.14 | .53                 | ----    | ----                  | Valid            | reference Item |
| p.15 | .52                 | 6.30    | significant           | Valid            | item Fit |
| p.16 | .50                 | 6.62    | significant           | Valid            | item Fit |
| P.17 | .40                 | 5.91    | significant           | Valid            | item Fit |

Based on the analysis of scientific instruments developed communication skills with models of second order analysis (CFA) on 17 items results showed that p-value = 0.27505 (p > 0.05) and RMSEA = 0.031 (RMSEA > 0.05). These results indicate that the item has been fit indicators developed in accordance with Rasch models. Some items have a loading factor> 0.3 and t-value> 1.95 so that the item is valid and fit model. Based on table 4, item p1, p2, p3 ...., P5 and p7, p8, ...., p17 meet the criteria of fit and can be used for the next stage. But the item has a loading factor p6 - 1:08 with a t-value -3.13 This value shows that the item p6 declared invalid so it can not be used. The results of the analysis of the second order CFA has a value of Chi-Square = 167.55; df = 114; p-value = 0.27505; RMSEA = 0.031; CFI = 0.97; GFI = 0.80; AGFI = 0.73; NFI = 0.92. Based on analysis of 16 of the 17 indicators developed grains have a loading factor (λ) > 0.3. Thus the indicators developed 16 items declared fit models fit the data. Item indicator can not be used / not fit are p.16. So that at a later stage is not used anymore p.16. Furthermore, the test results obtained reliability value of 0.82. Criteria item has a value infit meansquare 1:01 with grain criteria fit with the model of Rasch (meansquare infit ≤ 0.77 ≤ 1.33) with both criteria. Based on the measurement results of the instrument that was developed has memehuni fit the criteria according to Rasch models.

Table 5. The results of the QUEST program analysis

| Results Analysis | Scientific Communication Skills |
|------------------|---------------------------------|
|                  |                                 |

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4. Conclusion
These results indicate that the scientific assessment instruments developed communication skills have value infit meansquare 1:01 with grain criteria fit with the model of Rasch (meansquare infit ≤ 0.77 ≤ 1.33); 0.82 with good reliability criteria. Based on the measurement results of the instrument that was developed has fit the criteria according to Rasch models. The results validate the results obtained construct second order confirmatory factor analysis (CFA) on 17 items results showed that p-value = 0.27505 (p> 0.05) and RMSEA = 0.031 (RMSEA> 0.05). By loading factor> 0.3 and t-value> 1.95 so that the item is valid and fit model. Based on the results of validation constructs and empirical validation of the instrument of scientific communication skills developed can be used to measure students’ skills of scientific communication at a later stage.

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