Developing an analogical transfer skill assessment tool on momentum and impulse material

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Abstract. This research can be done to assess the analogical transfer skill based on isomorphic problems. The assessment tool in this research contains momentum and impulse material questions consisting of 40 multiple-choice items. Instruments that have been validated by physics education experts, physicists, and educational practitioners. The instrument was piloted on 333 learners. This research used a response model dichotomous. The result of the research shows that there are 40 items of expert judgments that have a “good for use” category. Based on the analysis, the mean INFIT MNSQ, which is 1.00 ± 0.04, means that all items are accord the Rasch Model. The whole item represents the range of capabilities -2.0 to +2.0. Thus, this assessment instrument can be used to measure the analogical transfer skill of senior high school students, especially on the matter of momentum and impulse.

1. Introduction
Assessment is the basis of decision-makers in learning [1–3]. Through the assessment of a teacher can conclude the level of ability of individual learners [3,4]. Therefore, the assessment should go through the process of collecting data to obtain information [1–3]. One of the steps to obtain information in the assessment activity is by using a valid and reliable instrument. The development of an assessment instrument especially in the subject of physics should take into account its cognitive domain [5] following the bloom taxonomy. Assessment in physics learning is generally done to determine the ability of conceptual understanding and problem-solving [6].

Problem-solving is the most important learning outcome in many contexts [7]. One aspect that often becomes the difficulties of learners in physics learning is the analogical transfer. The application of analogical transfer generally involves some concise principles and concepts in the mathematical form [8]. The analogical transfer ability helps learners in studying and solving a physics problem [8,9]. The analogical transfer skill can be enhanced by doing regular problem-solving exercises by comparing isomorphic problems [9].

Isomorphic problems are problem pairs constructed from different backgrounds and surface features (languages) but have similarities in form, principle, problem-solving steps as well as the difficulty and complexity of the problem. This is accord the opinions of previous researchers who expressed the equality of isomorphic problem pairs located in the background of the problem [9], and different surface features [10,11]. The previous researchers’ opinions regarding the different isomorphic questions lie in the form of the problem [12], the principle [9–11,13–15], problem-solving steps [16,17], as well as difficulty levels and complexity of the problem [18].
The purpose of using isomorphic problems in learning to test concepts [13], and similar abilities [18]. Besides, an isomorphic problem can be used to diagnose problem-solving patterns to see the progress of learners [19] and to determine the feedback to be provided [18]. The use of isomorphic problems in addition to measuring certain abilities can also be used to train the ability of learners. One of the benefits to be gained is that learners practice the ability to understand the similarities and differences between problem partners [15]. Lin and Singh also express the benefits of using an isomorphic problem that is, learners can develop knowledge [9], skills [20], and improve the ability to transfer knowledge from one context to another [8,10]. Exercise using an isomorphic problem can make for learners easier to analyze new problems [14] encountered.

The analogical transfer is an ability to transfer familiar problem-solving knowledge to solve new problems [10,21–23]. Transfer activities may continue even though there are differences in features between issues [24]. Although the problem is different, the problem resolution process has the same steps.

The application of analogical transfer requires similarity [22], a connection between problem pairs [23]. The similarities are structural relationships [25,26], in the form of methods or procedures used in solving problems [27,28] in addition, it also uses the same principles and concepts. While the connection between the problems useful as an effective guide to solving new problems [23]. The analogical transfer in physics is interesting because it only uses principles and concepts developed into concise mathematical forms [20].

2. Methods
Respondents in this study came from three state high schools in the East Nusa Tenggara province, Indonesia totaling 333 students. All three schools have high, medium and low categories. Schools are selected based on the results of the National Exam (a test conducted in Indonesia) of physics courses. The research data were obtained from the study sheet and the instrument test. Experimental review results were then analyzed using Aiken's V [29]. The equation is as follows.

\[ V = \sum \frac{s}{n(c - 1)} \]

The purpose of this analysis is to determine the theoretical level of validity of the instrument. Then the criteria are determined [30] as in table 1.

| Coefficient Validity | Interpretation          |
|----------------------|-------------------------|
| > 0.35               | Very useful (Good to use)|
| 0.21 – 0.35          | Can be useful (Can be used)|
| 0.11 – 0.20          | Subject to condition     |
| < 0.11               | Not useful (Unusable)    |

The reliability of the problem was tested by the Alpha-Cronbach method. Interpretation of reliability according to Gliem & Gliem [31] can be seen in table 2.

| Reliability Coefficients | Interpretation         |
|--------------------------|------------------------|
| > 0.9                    | Very good              |
| > 0.8                    | Good                   |
| > 0.7                    | Matches                |
| > 0.6                    | Doubtful               |
| > 0.5                    | Not good               |
| < 0.5                    | Not suitable            |
3. Results and discussions

This study determines the feasibility level of instrument assessment analogical transfer skill based on the isomorphic problem. The instrument assessment of analogical transfer based on the isomorphic problem is developed based on the similarity between isomorphic problem characteristics and the problem can be applied on analogical transfer. The similarity of these two variables can be seen in Table 3.

Table 3. The similarity of the isomorphic problem and analogical transfer

| Isomorphic problem characteristics | Characteristics of problems that can be applied to the analogical transfer |
|-----------------------------------|--------------------------------------------------------------------------------|
|                                   | Have the same method and problem-solving procedures | Have the same principles and concepts | Has a connection between problems |
| The same problem form             | -                                                      | -                                      | -                                    |
| The same problem-solving principle| -                                                      | √                                      | -                                    |
| The same settlement steps         | √                                                      | -                                      | -                                    |
| The same difficulty level problem | -                                                      | -                                      | -                                    |
| The complexity of the same problem| -                                                      | -                                      | -                                    |
| Background of different problems  | -                                                      | -                                      | -                                    |
| Different surface (language) features| -                                                  | -                                      | -                                    |

Assessment instruments are developed based on the similarities of the two variables namely the similarity of methods and procedures for problem-solving, and the similarity of principles and concepts used. The assessment instruments developed are then validated both content and empirical. Also, the specified, the reliability.

Aiken’s V is used to analyze the validity of the contents of the developed assessment instrument. The assessment instruments analyzed form multiple-choice. The result of the analysis of the validity of the contents of the multiple-choice assessment instrument is stated in Table 4.

Table 4. The result of the analysis of the validity of the content of the multiple-choice assessment instrument

| Criteria                  | Number of questions |
|---------------------------|---------------------|
| Good used                 | 40                  |
| Can be used               | 0                   |
| Subject to condition      | 0                   |
| Not useful (Unusable)     | 0                   |

Based on Table 4 it is known that out of all multiple-choice questions developed are ‘good to use’. After testing, multiple-choice instrument data were scored with numbers 0 and 1. The result data of empirical validity test using Quest software can be seen in Table 5.

Table 5. The result of the empirical validity test of the analogical transfer appraisal instrument

| Parameter     | Item Estimation   | Case Estimation  |
|---------------|-------------------|------------------|
| INFIT MNSQ    | 1.00 ± 0.04       | 1.00 ± 0.18      |
| OUTFIT MNSQ   | 0.99 ± 0.17       | 0.98 ± 0.59      |
| Reliability   | 0.94              |                  |
The result data on the difficulty level of the question items that have been made in the graph can be seen in Figure 1.

![Figure 1. Graph of difficulty level item](image)

Based on the analysis of each item, note that all items are declared valid. Empirical validation was conducted in 3 schools in Indonesia, specifically in East Nusa Tenggara province. These three schools represent composed of schools with high, medium and low predicate based on the results of physics exam nationally in Indonesia. Respondents involved in this study consisted of 333 students.

Based on the data of test result using QUEST software (Table 5), it can be concluded that a valid instrument is used to measure analogical transfer skill with INFIT MNSQ value is at 1.00 ± 0.04. These results indicate that the whole item was developed according to Rasch Models. This means that the whole item can measure the analogical transfer skill of the student to impulse and momentum materials.

The classic reliability test using Alpha Cronbach calculated using the QUEST program obtained instrument reliability score of 0.94. This score has a good reliability value used. Based on Figure 1, it is known that the whole item developed represents the range of capabilities between -2 to +2, so the developed instrument is said to be suitable for measuring the analogical transfer skill of the student on the capabilities of -2.0 to +2.0.

4. Conclusion

The application of environmental education as one of the efforts to preserve protected forests in Merauke has been well implemented in schools in Merauke and surrounding areas. This is evidenced by the average percentage results of the application of environmental education questionnaire of 65.21%, which is in the excellent category. Even so, the application of particular environmental subjects has not been carried out to the fullest, plants in school parks are not all equipped with information on types and Latin names, and the use of nature as a learning medium has not been maximized.

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