The analysis of IRS-7 using the Rasch model on material elasticity

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Abstract. IRS-7 is the abbreviation of 7 (seven) indicators of representing information skills. This study aims to analyze the students’ scientific communication skills regarding the ability to represent information consisting of 7 indicators: 1) schemes to graphs, 2) verbal to the scheme, 3) verbal to mathematical, 4) schemes to diagrams, 5) schemes to mathematical, 6) graphs to verbal, 7) graphs to mathematical. The skill of representing information is essential in the fourth revolution era and globalization era. This study used a case study approach with a post-test group research design. The sample of this study was high school students in grade XI, as many as 6 male students and 19 female students with an average age of 17 years old. Data were analyzed using Rasch model with the Software Ministeps assistance Version 4.4.1. The results showed that the students had some weaknesses in representing information from graphs into mathematical form 3.4 logits, graphs into verbal forms 3.8 logits, and from images into mathematical forms 5.2 logit. IRS-7 analysis of students on material elasticity can be analyzed properly using the Rasch model.

1. Introduction
The ability to represent information is one of the indicators in scientific communication skills [1]. Scientific communication skills are cross-disciplinary and complex processes that describe several cognitive areas, including science, communication, education, psychology, and sociology [2]. Scientific communication is used to describe how a scientist communicates with the public [3-5]. Communication skills are significant for scientists, students, and also all citizens since they can get involved in dialogue and decision-making processes in the community [6]. Scientific communication skills consist of several indicators, namely the ability to obtain information, read and observe, write scientifically, represent information in the form of images, graphics, schematics and mathematics, and present their knowledge [1]. Communication skills are one of the skills needed in the 21st century. Today, the digital age is increasingly opening up opportunities for everyone to be able to establish oral and written communication. The lack of communication skills will have an impact on intellectual progress, career, and social relations. Based on various surveys, communication skills are one of the skills that are highly required in the world of work. Good communication skills will give someone more opportunities in building social relationships in a wide network. Thus, it is necessary to improve scientific communication skills through the learning process.

Scientific communication in learning physics is the students’ skills in receiving and conveying knowledge or information based on facts and observational results. Data analysis of scientific communication skills has been done by previous research. Data on scientific communication skills of
students were analyzed using histograms and Spearman rank correlation tests [6], while the Classical Theory Test (CTT) was used to know the reliability, validity, average values of each class, and standard deviations [7]. The research analysis’ conclusion was obtained through the dependent and independent t-test scores. [8] The study conducted using three indicators of scientific communication skills which included: 1) scientific writing, 2) information representation, and 3) knowledge presentation. Data analysis was performed by calculating the percentage of total scores on each indicator. The results of data analysis were presented in the form of bar charts for the two groups of research samples.

Other studies conducted data analysis using a classic technique by displaying a measurement score diagram for each indicator on the direct current material [9]. [10] Data analysis was conducted by calculating the measurement of total scores for each scientific communication sub-skill. The results of the score calculation were reported in the form of a percentage score (%) diagram. [11] The calculation of the calculation of total scores was used in analyzing scientific communication skills data on presentation knowledge indicators. [12] The students’ scientific communication skills data in writing reports were analyzed by calculating the percentage of total scores. The limitations of conventional analysis include the level of difficulty and problem bounding on the result of the characteristics of the student group being put to the test. The pure score depended heavily on the measurement taken. Crude and pure scores basically fluctuate depending on the difficulty of what is given. The Rasch model was used on data analysis techniques of seven information representation skills.

George Rasch developed an analysis model of Item Response Theory for dichotomous data [13]. The Rasch model continued to develop into several forms of data analysis such as ranking scale and political data [14], partial credit Rasch model [15], and facets models for analyzing multi-rater scale data and analyzing the relationship between difficulty and ease of measuring items. Rasch model was used in analyzing the students’ skills by linking items and the students’ skills based on the dichotomous data answered by respondents. Rasch model was used as a measurement tool for assessment test items in the learning process [16]. In this study, the authors proposed other alternatives in analyzing students’ scientific communication skills data on aspects of the ability to represent information.

The sub-skill indicators representing information in this study were broken down into 7 (seven) indicators as in Figure 1.

![IRS-7](image)

**Figure 1. IRS-7**

Indicators of information representation sub-skill consist of representing: 1) schemes to graphs, 2) verbal to the scheme, 3) verbal to mathematical, 4) schemes to diagrams, 5) schemes to mathematical, 6) graphs to verbal, 7) graphs to mathematical. The analysis of the skill to represent information was carried out in Physics subject, specifically at the material elasticity.

The material elasticity that was evaluated includes sub material about the relationship of force to the increase in spring length, springs circuit in series and parallel, and to determine the coefficient of the springs. The equations analyzed in this material are as follows.

\[ F = -Kx \] (1)
\[ k = \frac{1}{k_1} + \frac{1}{k_2} + \ldots + \frac{1}{k_n} \quad \text{(series)} \tag{2} \]
\[ k = k_1 + k_2 + \ldots + k_n \quad \text{(parallel)} \tag{3} \]

In general, this sub material was evaluated by looking at the final score of the students' skills in one representation. This research tried to evaluate various forms of representations. The students' accuracy in answering questions in various forms of representation is an indication of good concept understanding [17]. The results of data analysis are expected to be able to describe the students' understanding in each form of representation skill on the elasticity of the material. The skill of the seven information representation indicators is essential to be developed and applied in the learning process. This study aims to find out deeply about student achievement in representing information. This study also aims to analyze student achievement on each indicator of the ability to represent information.

2. Methods

This study used the one-shot case study approach with post-test only group research design [18, 19]. The research sample was obtained through a purposive sampling technique on six classes of grade XI students. The study was conducted in the midterm of the odd semester of 2018 after the students studied the material. The study was conducted at one of the A-accredited private high schools in Cimahi. The sample was students of grade XI with a total of 5 male students and 19 female students. The instrument used was in the form of an essay test with seven sets of questions. The example of the instrument can be seen in Figure 2.

![Figure 2. Example of an IRS-7 instrument](image)

The instrument above is an example of representing information from images to graphical form. The validity of the instrument’s construction was analyzed using the Wright map with the help of software Ministeps Version 4.4.1. Analysis of the validity of this instrument showed that the instruments’ items have varying degrees of difficulty. There are two items that have the same degree of difficulty, namely item E5 and E6, while item E4 has a decent distinction level. The reliability of items 0.98 logit was included in the special category [16]. Thus, the quality of items on the instrument used was very good. The students’ special reliability can be seen through the logit person reliability of 0.70. The logit shows that the reliability of students is included in the sufficient category [16]. The students’ overall reliability can be seen on Cronbach’s alpha scores. The results of the analysis of the instrument showed a Cronbach alpha value of 0.74 which was included in the good category. The results of this analysis can provide information on the quality of instruments in identifying the students’ knowledge. This item's reliability...
is very supportive of the quality of the measurement results. The instrument test results were analyzed using the Rasch model on software Ministeps-assisted Version 4.4.1.

3. Result and Discussion

3.1. The level of difficulty analysis in IRS-7 items
The results of data analysis on the students’ skills on seven information representations (IRS-7) through essay tests can be seen in Figure 3.

![Figure 3. IRS-7 item measuring achievement](image)

The data in Figure 3 provides information about the students’ ability to represent information through the logit values in the measure column. The item E5, E6, and E7 have a positive logit scale (+) which means that the problem has a degree of difficulty above the standard (logit 0.0). Based on the logit scale, it can be inferred that the students are still having difficulties with several indicators to represent information. The students were still having trouble representing information from images into mathematical form (item E5). In item E5, the students were asked to write mathematical equations to calculate spring constant values (K) based on the spring drawings arranged in series and parallel circuit.

In item E6, the students still tended to have difficulty in representing information from a graphic in the form of verbal sentences. On the graph, the students were asked to write an explanation related to the relationship of force to the increase in spring length. This difficulty can be sought by using graphs to explain the learning material. The highest degree of difficulty that the students found lies in representing the graph in mathematical form (item E7). In this item, the students were asked to write a mathematical equation for the relationship of force (F) to the increase in spring length (x) based on the shape of the curve on the graph. This finding is in accordance with the results of the previous research pre-test which found that the students’ ability in representing mathematical indicators, images, graphics, and verbal were in the low category [8]. Based on this analysis, the teachers may improve the learning process of material elasticity to optimize the IRS indicators.

The negative logit scale (-) provides information on the degree of difficulty of the questions that are in the category below the 0.0 standard logit. Based on the results of data analysis, it can be seen that the degree of difficulty for items E4, E3, E2, and E1 below 0.0 logit. The results of this data analysis can provide information that these four items are not too difficult for the students to understand. Item E4 required the students to represent the spring’s drawings in series and parallel circuit in a bar chart. In Item E3, the students were required to represent (verbal) sentences about the arrangement of springs in series and parallel circuits into mathematical equations of spring coefficients. Item E2 is about representing verbal information about a spring arrangement design, where the students were then asked to draw it. In item E1, the students were asked to graph the length of the spring based on three drawings. The previous research also found that the congruence of the students’ verbal communication skills tended to be easier for the students in the moderate category [8,20,21]. Thus, the students’ degree of difficulty on representing information can be used to develop new interventions or further research.
3.2. analysis of IRS-7 student ability
The Rasch analysis model can be used to see the students’ abilities after working on seven IRS-7 items. The results of this analysis can provide information about the potential of IRS-7 as one of the findings to continue research on students’ scientific communication skills. In this section, the author used a scalogram as part of a feature on the Ministep that can show each students’ ability in achieving the IRS-7. Besides, a scalogram can also show the consistency of students’ answers on each item and see the same student’s response patterns. This additional information can be used as one source of the depth of analysis and information. The results of data analysis using a scalogram can be seen in Figure 4.

![Scalogram](image)

The data in Figure 4 can provide some important information on the student's ability of IRS-7. The highest ability was obtained by a female student, 22P. However, 22P’s answers were inconsistent because she scored low on easier questions (item E5) while more difficult questions were answered well (E6, and E7). The scores 22P achieved provides other information that overall students had difficulty in answering questions Item E5 about representing information from spring arrangement drawings into mathematical equations of spring coefficients. It can be presumed that so far the students are accustomed to using existing formulas in solving spring arrangement problems. Inconsistent responses were also found in student 12P, 03P, and 21P. The three students could not answer item E5, but they could answer more difficult questions (item E6). Student 03P and 21P had the same response pattern of answers, it can be indicated both students have the same ability or both students collaborated in answering questions. Item 7, Item E6, and Item E5 were the most difficult questions to answer. It shows the students' limitation to represent information from graphs to mathematical form (7), graph to verbal form (6), and from images to mathematical form (5).

The lowest ability was found in male students, 02L, with a logit scale of -5. Student 02L’s answers were very consistent and comparable to the degree of difficulty of the questions. The highest male student’s ability was obtained by 10L on a scale of -1.5 logit. However, his answer was not consistent at E3. Overall, it was found that the female students tended to have higher ability than male students. Thus, the teacher can obtain information that male students need more attention in the Physics learning process. The same response pattern were found in many female students, this response can identify the similarity of the students' abilities or can indicate the opportunity of cheating when working on the problems. Based on this possibility, the writer recommends the teacher to do collaborative activities in
the learning process. The effectiveness in improving learning outcomes through collaborative-based learning should be obtained by considering the gender factors [22].

4. Conclusion
There are some weaknesses found regarding the students’ skills in representing information on the material elasticity. The students' scientific communication skills in representing information are still low on three indicators, namely from graphs into mathematical form, graphs into verbal form, and images into mathematical form. The results of this study can evaluate the achievement of IRS-7 on each student. The results of this study have a limited number of instruments for each indicator. Thus, for further research, the research can add the number of instrument questions to identify the consistency of student’s answers.

5. References
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