Succeed or failed: diagnostic of student’s ability to passed basic learning material on liquid pressure, respiratory system and its application based on integrated sciences test in school

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Abstract. This research performed to analyze student’s ability to mastering the liquid pressure and body breathing system materials on integrated science learning. Both of the materials in integrated learning include blood pressure, diffusion of respiratory events, osmotic pressure, fluid pressure at a different depth, buoyancy, and capillarity expressed in a specific test. The study covered 144 students in the Integrated Islamic Junior High School. We organized a student's ability assessment based on midterm semester exam conducted in March 2018. Data analysis applied by Rasch modeling. The results of this study indicated that students have difficulty in understanding the pressure on liquids, notably in bringing water process from root to leaf (capillarity on plants). Conversely, students are qualified to figure out the operation of the mucous membrane in the nasal cavity in the body respiratory system. Other interesting points discussed in this article are quality of the test related to measure students' ability and traces of student misconceptions in learning materials on integrated science. It is prerequisite for teachers to promote the quality of learning in the integrated science, and to develop a quality test for student in the future.

1. Introduction

Integrated Sciences materials in school promote students to seek a precise compilation of knowledge, by building up the learning activities using scientific methods showed through a sequence of scientific work, values and scientific attitudes [1]. In general, these aspects are located in the studies of physics, space earth, biology, and chemistry. In other terms, integrated science in junior high school should be developed in a unified way [2,3]. Furthermore, integrated sciences in school is conducted through a series of concepts that are linked with the concept outlines that have developed as an end of experiment and observation through their application straight with the application of methods and scientific work, which then will have useful for further experimentation and observation activities [4].

The level of students understanding figures out how high they have mastered the integrated sciences concept provided. The student may be said to have mastered the concept if it has been able to (a) think with it, (b) use it in another field other than the one he/she has studied, (c) express it in his own language or way, (d) identify a parable or analogy about it, and (e) establishing a mental and physical model of it [3,5–7]. The material in liquids includes several compound conceptions, one of which is in bringing water from root to leaf (capillarity in plants), so that when applying the concept there are still many obstacles to planting the liquid concept. Understanding concepts for student on the pressure of liquids is still relatively poor [8]. Students even have difficulty in establishing sub-concepts that must be set up
to understand the concept to be studied. Therefore, the difficulties encountered by the students are serious to be dealt with so that they can comprehend the concept well and can communicate the understanding back to achieve the learning objectives [9].

Furthermore, referred to the analysis of integrated sciences materials that also contained in it is the respiratory system in humans [10]. This subject matter is generally viewed problematic by students because many components are not observed. The previous studies proved that students are less concerned to pursue the learning process of human respiratory system because this material is presented to the mechanisms and processes that occur in the body that are complex to interpret by students [11]. The main competence on the respiratory system materials that students are capable to express the respiratory system in humans and its relationship with health [10]. Accorded the importance of learning the respiratory system that provides an understanding of respiratory devices with the function of incorporating oxygen and removing carbon dioxide and water vapor, therefore affecting health [12], it is important to be well understood beforehand on by junior high school students.

Based on the crises practiced by students and the importance of considering the material of liquids and respiratory system, this article puts on the study of the students' ability to deal with the problem of fluid pressure, respiratory system and application based on integrated science in school.

2. Method
The study linked to 144 students in junior high school (Mean Age = 12.3 Years Old). Students who are exposed in this research are students enrolled in integrated sciences subjects. The semester test is held on Friday, March, 9th, 2018. The exam target is a student class VIII. A-F SMP Islam Terpadu Darul Hikmah Bekasi-West Java.

The exam questions consist of 25 multiple-choice items for measuring the two basic of learning competencies, i.e. (1) the student finds out the pressure on the liquid and its application in daily life to point out blood pressure, diffusion of respiratory and osmotic pressure events, and respiratory system, 2) conduct experiments to study fluid pressure at a certain depth, buoyant force, capillarity (investigate the transport of fluids in plant stems and liquid pressure in enclosed spaces). Students are allowed 90 minutes to perform the midterm exam.

We checked student exam results based on answer keys provided by teachers. The test results were evaluated by WINSTEPS 3.73 Computer Program of Rasch Model [13]. These research datasets can be reached through osf.io/fk7j6 Open Science Frameworks [14]. Furthermore, all student actions in this research are a credential and no credit earned by students from the schools where the student works for his/her participation in this research.

3. Result and Discussion

3.1. Integrated Sciences Test in Junior High School: Psychometrics Evaluation
To measure the student’s succeed or failed in mastering the supposed of learning competence, we assess each construct of psychometrics integrated sciences test handed over by the teacher to the midterms student test.

| Table 1. Summary of item measured based on Rasch fit statistics (N item = 25). |
|---------------------------------------------------------------|
| Estimation                      | Values  |
| Item Reliabilities               | .94     |
| Separation Index of Items        | 3.90    |
| Observed average (Label 0)       | .13     |
| Observed average (Label 1)       | 1.53    |

Table 1 displayed excellent reliabilities items (.94). The ability of the items contained in the integrated sciences test is also effective to categorize the items from the most difficult to the easiest to implement with the students (3.90). Furthermore, the choice of answers provided on the integrated sciences test is appropriate. This can be looked at from the movement of specific observed variable values in the
incorrect answer (.13) to the correct answer (1.53). Unfortunately, based on Table 2 the collusion validity of an integrated sciences test is unsatisfactory. This is explained by the value of raw variance explained by measures (23%) which is yet significant below the standard (40%). There are still 77% of collisions that have not covered the integrated sciences tests that teachers have made to students.

**Table 2.** Principal component analysis (PCA) (N item = 25).

| Item No. | Measure | Outfit MNSQ | Outfit ZSTD | Item No. | Measure | Outfit MNSQ | Outfit ZSTD |
|---------|---------|-------------|-------------|---------|---------|-------------|-------------|
| 3       | 1.80    | 1.52        | 3.50        | 15      | -.14    | .95         | -.20        |
| 21      | -.20    | 1.41        | 2.10        | 2       | .25     | .84         | -1.0        |
| 10      | .74     | 1.35        | 2.70        | 18      | .46     | .85         | -1.20       |
| 12      | 1.07    | 1.16        | 1.15        | 23      | -.69    | .92         | -2.0        |
| 7       | .39     | 1.15        | 1.10        | 13      | .14     | .79         | -1.30       |
| 24      | .28     | 1.08        | 0.60        | 20      | .67     | .83         | -1.40       |
| 11      | .78     | 1.07        | 0.70        | 25      | -1.45   | .66         | -0.80       |
| 22      | -.35    | 1.01        | 0.10        | 16      | .46     | .85         | -1.20       |
| 19      | .57     | .97         | -.20        | 17      | .32     | .78         | -1.60       |
| 1       | -.74    | .97         | 0.0         | 6       | -.97    | .72         | -.90        |
| 8       | 1.02    | .99         | -.10        | 4       | -2.34   | .42         | -1.0        |
| 5       | -1.16   | .85         | -.30        | 14      | -.74    | .66         | -1.3        |
| 9       | -.35    | .92         | -.30        |         |         |             |             |

Note: MNSQ = Mean-Square Fit Statistics. ZSTD = Standardized Fit Statistics. Measure in Logits

Furthermore, we also evaluated the accuracy of items in integrated sciences tests through the sensitivity of student response patterns to certain difficulty items (Outfit MNSQ) and data compatibility with Rasch modeling (Outfit ZSTD).

**Table 3.** Outfit MNSQ and outfit ZSTD on integrated sciences test (N items = 25).

Based on Table 3 it is noticed that MNSQ's outfit value for 24 items is in satisfactory condition for measurement because MNSQ outfit values are still within the ideal range of 0.5 - 1.5. The only item that is unsatisfactory for instrument is item no. 3 (outfit MNSQ = 1.52). Nevertheless, item no. 3 can still be included in the test because item No. 3 actually did not reduce the measurement quality (1.5 - 2.0) [15].

Furthermore, another interesting empirical fact in Table 3 is to identify the suitability of data with the model. The parameter used is the ZSTD value. Based on ZSTD value each item is recognized item no. 3 takes a value of ZSTD > 3.0, which means the data did not pair with the model. On the other hand, there are 2 items within the range of 2.0 ≥ ZSTD ≥ 2.9 which means that data cannot be accurately predicted (items 21 & 10). Finally, there are 2 items that are easily predicted by the answer of the student, the item no 5 and no 6. Both items are predictable it becomes ZSTD value ≤ -2.0.

The student difficulty level for answering the questions is indicated by the logit measure value, where the most difficult questions for students have the highest logit measure value among all questions, and the easiest questions for students takes the lowest Logit measure value among all the questions investigated (see Table 3 column measure).
Table 4. The hardest and the easiest items on integrated science mid test.

| Item | Statement | Choice of answers | Measure | Perceived |
|------|-----------|-------------------|---------|-----------|
| 3    | Leaf suction power is one of the processes for transporting water from the roots to the leaves, which can occur due to ... | a. water from the leaves evaporates so that the leaves take water from the vessels | -1.80 | Hardest |
|      |           | b. the leaves have a lot of veins | | |
|      |           | c. there are capillary vessels that make water rise to the leaves | | |
|      |           | d. the pressure from root to leaf | | |
| 4    | The nasal cavity has a mucous membrane that helps the process ... | a. Taking air breathing | -2.34 | Easiest |
|      |           | b. Air filtration from dust | | |
|      |           | c. Respiratory air expenditure | | |
|      |           | d. Pushing the air out | | |

Note: Measure in Logits

Table 4 explains that in the integrated sciences test in general the item no. 3 is the most difficult item to explain by students. On the other hand, the item No. 4 is the easiest material for students to go on. The difficulty level item no 3 is four times more difficult than item no. 4.

Furthermore, the findings in Table 1, 2, and 3 indicate that the quality of integrated sciences tests used by teachers still needs to be reviewed. Why? The reason is that although reliability is highly satisfying, but there are 5 items in the midterm’s test that indicate an obstacle. This proposes that there is insufficient information that teachers and researchers can make associated with integrated sciences materials.

3.2. Student’s Ability on Integrated Sciences Test: Material on Liquid Pressure, Respiratory System and Its Application

Before charting students 'competences in an integrated Sciences exam, we re-evaluate the students' integrity in taking on each integrated sciences question. The evaluation is to measure students' reliabilities when the test is performed.

Table 5. Summary of person (students) measured based on Rasch fit statistics (N person = 144).

| Estimation                                   | Values |
|----------------------------------------------|--------|
| Person Reliabilities                         | .73    |
| Separation Index of person                   | 1.64   |
| Mean Measure                                 | 1.09   |
| Cronbach Alpha (KR-20) Person Raw Score      | .75    |
| "Test" Reliability                           |        |

Based on Table 5 it is noted that global average students' ability in performing the integrated sciences exam is above average (1.09 ≥ 0.00). Person reliabilities also point out if the consistency of the students
in answering the exams was appropriate. Furthermore, the interaction between the students and the items is also acceptable. It also confirmed the value of Cronbach Alpha (KR-20) Person Raw Score "Test" Reliability (.75). Unfortunately, the student's abilities level during the exam can simply be categorized into 2 groups, i.e. students with great and poor ability.

In addition to estimating misfit items, we also go estimate any students as person with misfit indication; which is weighing which students are reacting that is irreconcilable with the material of the integrated sciences exam.

**Table 6. Person misfit on integrated sciences test (N Person = 12 from 144).**

| Student No. | OUTFIT MNSQ | OUTFIT ZSTD | Guttman Scalo gram: Item order from easiest to difficulties |
|-------------|-------------|-------------|---------------------------------------------------------|
| 142P        | 1.81        | 2.4         | 4, 25, 5, 6, 14, 23, 9, 22, 15, 21, 13, 2, 24, 17, 7, 16, 18, 19, 20, 10, 11, 8, 12, 3 |
| 081P        | 1.63        | 2.0         | +010001000011000010100100001 |
| 092P        | 1.61        | 1.3         | +0010000000000000001010 |
| 028L        | 1.56        | 2.3         | +01110101010101011110100 |
| 108P        | 1.56        | 1.6         | +010000000000100100001100 |
| 017L        | 1.55        | 1.50        | +10110000000000000100001 |
| 029L        | -.39        | -.50        | +111111111111111111110 |
| 018L        | .25         | -.3         | +11111111111111111111110 |
| 023L        | .25         | -.3         | +11111111111111111111111 |
| 030L        | .25         | -.3         | +11111111111111111111111 |
| 033L        | .25         | -.3         | +11111111111111111111111 |
| 034L        | .25         | -.3         | +11111111111111111111111 |

Note: L=Laki-laki (Male), P=Perempuan (Female).

Referring to Table 6 we found interesting facts when evaluating misfit students. First, there are 12 students who suffered misfit; the students who responded did not match the expected answers. For example, students 142P and 081P indicate the inconsistency between abilities acquired by the answers permitted. Both students were inadequate to answer the easier questions but managed to answer the most difficult questions (No. 3). This means if the students are guessing the answers on the exam. Furthermore, the 029L students are careless students. Why is that? Student 029L indicates that he is capable of responding to his abilities (prepared to answer the problem from the lowest difficulty level to the level of difficulty on it) but not completely on the last 3 questions (No. 8, 12, and 3).

Secondly, if deeply discovered there are 5 students, i.e. 018L, 023L, 030L, 033L, 034L having MNSQ outfit value, ZSTD outfit, and the same Scalo gram. Despite the strengths of students' ability to explain the easiest questions to the most difficult questions, the five students showed misleading (cheating) during the exam. This is evidenced by the value of MNSQ Outfit ≤ 0.5, which means that students are less productive. Next, relating to the Scalo gram arrangement, it is seen that the response made by the five students is the same. This underlines the students' proof of mutual cooperation (cheating each other) during the test. We didn’t consider to mapping the misfit student in an integrated sciences exam. Totally, there are 12 students didn’t demonstrate substantial abilities. Thus only 132 students can be mapped their competence in integrated sciences exam.

The results of the analysis of abilities on 132 students indicate if there are 7 students, namely 024L, 054P, 060P, 064P, 074P, 075P, and 098P which have the highest ability in integrated science test. In contradiction, student 040L were the lowest performing among all the students who took the exam.

4. Conclusions

In general, students have above average skills in performing integrated test exams. Passing on to the structure of integrated sciences exam, it is known that students are difficulty in understanding the pressure on liquids, particularly in bringing water process from root to leaf (capillarity on plants). Conversely, the students are capable to figure out the operation of the mucous membrane in the nasal cavity in the respiratory body system. Although the diagnosis of students' ability in the exam can be
detected accurately, but on the quality side of the integrated sciences exam requires to got major attention from the teacher. Furthermore, teachers also need to significantly reform supervision when exams are implemented to prevent student cheating behaviour during the exam.

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