Differential Item Functioning on Physics items based on Computer Based Test in Junior High School Science Learning

by Purwo Susongko 18042022

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Abstract

Learning in the era of the COVID-19 pandemic is carried out using media that can help, especially in the assessment section, learning can be done using a variety of assistive media such as the quizizz application. This study aims to determine the Differerential Item Functioning (DIF) contained in the physics questions used for tests at SMP Al-Irsyad City of Tegal and SMP Muhammadiyah 1 Tegal City in class VIII of the material pressure on substances. This study uses an approach quantitative with primary data taken through quizizz. The population of this research is the answer sheets of the eighth grade students of SMP in the city of Tegal. The sampling technique used purposive sampling. The sample of students taken was 200 respondents from SMP Muhamadiyah 1 in Tegal City and SMP Al-Irsyad in Tegal City. The analysis technique uses the Rasch modeling with the Wald test. The results of the study concluded that the items detected by DIF in the eighth grade science test set were substance pressure, namely items number 1 and 17 and benefited male students, while items 11, 12 and 15 benefited female students..

Keywords: Differerential Item Functioning; physics items; Rasch Model

INTRODUCTION

Online learning is a learning that is done remotely through internet media and other supporting tools such as mobile phones and computers (Putria, Maula, & Uswatun, 2020, p.862). The use of online learning media can facilitate the delivery of learning and evaluation of learning, with good application and qualified teachers' human resources, online learning can run smoothly, including evaluation processes such as tests.

The learning process also has several inhibitory factors both internally and externally. Internal inhibitory factors can be from the students themselves such as lack of learning motivation (Mekka Madaina Jamil, 2019, p.7-8). This condition must be addressed immediately by teachers especially during pandemics like this.

The educational tethering factors arising from the COVID-19 pandemic can be addressed by modification of the learning process. The model of learning during the pandemic should be modified so that students are not saturated with the learning provided by teachers (Walid, Putra, & Asiyah, 2019, p.3-4).

The use of modified learning models can significantly improve students' morale and learning outcomes (Mariana, 2019, p.126). Students' learning outcomes are also influenced by the media used by teachers when teaching such as the use of 3-dimensional media when learning offline (Julaila, 2019, p.52).

Student learning outcomes can be obtained by conducting a learning evaluation using a test device. According to Susongko (2014), tests can be distinguished into two forms, namely contructed response test and objective test (selected response test). The difference between the two is that in the description test the learner is asked to find, organize, write down the answers to the questions in the test, while on the objective test the learner is asked to choose the right answer that has been provided by the test compiler. Objective tests are often used by teachers to test students' skills for daily, midterm and final semester tests.

Tests can be done in 2 ways, namely paper based test and computer based test. Both types of tests have their own advantages. Computer based test (CBT) is very useful to help remote learning evaluation activities. Many software supports to conduct learning evaluation activities using computer based test (CBT) such as quizizz application. The use of quizizz application can facilitate a test or evaluation of learning, in addition computer based test (CBT) is an environmentally friendly test and very relevant during the pandemic (Iwan Permana Suwarna, 2018, p.336).

Tests are conducted to measure the ability of learners and analyze the level of ability of the learner. Male learners and female learners have different abilities. Gender is a sociocultural dimension in male and female psychology. The term gender is distinguished from sex. Sex relates to the dimensions of men and women. Gender roles are social expectations that formulate how men and women should think, feel and do (Triyatno & Ngazizah, 2013, p.35). Gender in learners affects learning outcomes because male and female learners have different innate individual abilities.

Male learners have thoroughness, conscientiousness, accuracy, and equality thinking better than women (Wardani, 2014, p.100). According to Krutetski Research (1976), gender differences between men and women in learning where men are superior in thinking according to reason and women excel in the field of thoroughness, conscientiousness, accuracy, and likeness of thinking.

The ability of male students in terms of thinking using logic and numeric is better than that of female students. Gender can also affect students' learning motivation where female students tend to be lower in motivation than male students (Nisa, 2018, p.43). Good motivation can improve students' way of thinking to be more creative. From the internal factors that exist can improve the creative thinking of learners who have a big influence on the test results in each gender (Cahyono, 2017, p.51).

Student learning outcomes taken through the test kit also need to be considered. The question items tested in the test become external factors that affect the student's own learning outcomes. Based on differences in gender ability, it is necessary to consider whether butis about containing DIF. DIF in the test item can benefit one gender party (Sudaryono, 2011, p.723).

Based on the existing problems, this study aims to determine the existence of DIF in the physics test items, especially on the theme of stress on learning science at Al-Irsyad Junior High School in Tegal City and SMP Muhammadiyah 1 Tegal City.

METHOD

Quantitative approach is used in research conducted, quantitative approach itself is an approach by relying on data such as numbers and using statistical programs to answer research problems (Wahidmurni, 2017, p.3-4). Descriptive research is used in conducting this research to strengthen the results to be delivered.

According to Susongko (2014), descriptive research is research that aims to describe, explain and interpret current or actual conditions. Descriptive research has the purpose of testing phenomena that occur in a certain place and time. In this study is also explorative which is usually used to solve problems that affect the whole event. Explorative research aims to find widely about the cause of influencing the occurrence of an event by looking at the causes and facts that occur in the field.

This research was conducted on January 19 to 27, 2021 at Al-Irsyad Junior High School tegal city and SMP 1 Muhammadiyah Tegal City. The target in this study was a grade VIII junior high school student in Tegal City Area. Research generally has variables that go hand in hand, free variables and bound variables. In this study, there was only 1 variable, namely the gender of the students.

In this study, the population was the answer sheet of grade VIII junior high school students in Tegal city area both female and male gender. This research also has sampling techniques, the technique used is purposive sampling. Purposive sampling itself is a sampling technique based on certain considerations and reasons. Sempel retrieval techniques with purposive sampling are considered necessary for this study, where researchers have a goal at SMP Muhammadiyah 1 Tegal city and SMP Al-Irsyad Tegal city with a sample number of 200 students (male learners as many as 100 people and female learners as many as 100 people). This was done by researchers taking into account the number of junior high schools in Tegal City Area is very large, as well as time constraints in sampling.

The subject of this study is the answer sheet of Junior High School Grade VIII students with physics field test materials in Tegal City Area that will be tested to answer 20 questions through CBT (computer basic test) by using a supporting application in the form of quizizz. At this time the number of male learner population is less or 1:2 between men and women, then the research sample will be adjusted to the criteria of the study.

Sampling techniques in the form of purposive sampling to facilitate researchers and avoid too long research time.

The instrument used in this study was science questions in the field of physics in class VIII SMP using the theme of pressure and its application in everyday life.. There are 20 items that must be done by students using learning evaluation media, namely quizizz based on smartphones. Quizizz is used in this study to support the ease in data retrieval as well as the activity of students in answering test questions. Student activity is obtained because quizizz perpacks game-based evaluation media (Agung, Sri, & Dwi, 2020, p.168).

The data collection technique in this study is to use the student's answer sheet recorded on quizizz after working on the problem. Data analysis used in this study is the approach of Rasch Model. The estimation difficulty level using Rasch model in R programming version 4.0.0 contained in ltm package. DIF detection using the Wald test will result in p-value output and z value. This DIF measurement is done to find out which items benefit one gender party (Retnawati, 2013, p.276). R Programming version 4.0.0 is included in the eRm package. Wald's test was conducted on an eRm package to detect DIF using a confidence plot. The DIF that has been obtained will be analyzed further to determine gender bias on the question tested using the Maple 16 application.

RESULTS AND DISCUSSION

Analysis of the difficulty of the test item is done using r-programe software version 4.0.0 using summary script. The data from quizizz was changed in scoring the correct answer with a score of 1 and the wrong answer with a score of 0 written in microsoft excel and after that was moved into notepad. The difficulty parameter of the problem item can be seen if it is located in $b_i < -2$ is a problem item that is too easy, $-2 \leq b_i \leq 0$ is categorized as an easy problem item, $0 \leq b_i \leq 2$ is categorized as a difficult question item and $b_i > 2$ is categorized as a question item that is too difficult. Data on the difficulty of the data of the test of male learners and female learners can be seen in table 1.

Table 1. Analyze item difficulties

Item	Value	Description
1	-0,158	Easy
2	-0,672	Easy
3	0,115	Difficult
4	-0,420	Easy
5	-0,481	Easy
6	-0,301	Easy
7	-0,390	Easy
8	-0,301	Easy
9	1,383	Difficult
10	0,035	Difficult
11	0,115	Difficult
12	0,550	Difficult
13	-1,403	Easy
14	-0,330	Easy
15	-0,607	Easy
16	0,035	Difficult
17	0,917	Difficult
18	-0,544	Easy
19	1,908	Difficult
20	0,550	Difficult

In Table 1. showed the results of an analysis of the difficulty level of the problem based on the results of 200 respondents, 100 male learners and 100 female learners. There are several categories of test questions based on measure values that are very easy, easy, difficult and very difficult.

Points of test questions with easy categories there are 11 points of the question, namely at number 1, 2, 4, 5, 6, 7, 8, 13, 14, 15 and 18 with a percentage of 55%. Points of test questions with difficult categories there are 9

points of the question, namely on the numbers 3, 9, 10, 11, 12, 16, 17, 19 and 20 with a percentage of 45%. The test question item that has the lowest score is number 13 with a value of -1,403 and the test question item that has the highest score is at number 19 with a score of 1,908.

The value of the difficulty is also proven by looking for items or items that are not fit to detect a question worthy or not. Itemfit parameters P>1, 0.5<MNSQ<1.5, -2,0<ZSTD<2.0 with the results of the test item match analysis in Table 2.

Table 2. Match analysis (itemfit) of items

Item	Value	Description
1	0,017	Fit with model
2	1,000	Fit with model
3	0,020	Fit with model
4	0,958	Fit with model
5	0,834	Fit with model
6	0,997	Fit with model
7	0,689	Fit with model
8	0,000	Non Fit
9	0,000	Non Fit
10	1,000	Fit with model
11	1,000	Fit with model
12	0,763	Fit with model
13	0,999	Fit with model
14	1,000	Fit with model
15	0,676	Fit with model
16	0,994	Fit with model
17	0,665	Fit with model
18	1,000	Fit with model
19	0,000	Non Fit
20	0,439	Fit with model

Differentisl Item Functioning (DIF) detection with Wald Test, DIF plot, and characteristic curves. Here are the results of DIF detection.

DIF detection is performed by looking at the value of opportunities with a degree of significance. The level of significance used in this study was 1% or 0.01. The hypotheses used in the Wald test are as follows:

H0 : there is no simultaneous influence of gender on the proportion of answering the correct question

H1 : there is a simultaneous influence of gender on the proportion of answering the correct question

H0 will be rejected if the p-value < 0.01. The results of the analysis with wald test can be seen in Table 3.

Table 3. Analysis results using Wald test

Item	z-statistic	p-value	Description	Those who benefit
1	-4.059	0.000	DIF	Male
2	-2.219	0.033	Non DIF	-
3	1.979	0.048	Non DIF	-
4	-1.470	0.142	Non DIF	-
5	1.095	0.274	Non DIF	-
6	-0.088	0.930	Non DIF	-
7	-1.655	0.098	Non DIF	-
8	3.073	0.002	Non Fit	-
9	-5.519	0.000	Non Fit	-
10	1.841	0.066	Non DIF	-
11	3.956	0.000	DIF	Female
12	4.929	0.000	DIF	Female
13	0.994	0.320	Non DIF	-
14	-2.020	0.043	Non DIF	-
15	2.662	0.008	DIF	Female
16	2.177	0.029	Non DIF	-
17	-4.941	0.000	DIF	Male
18	1.509	0.639	Non DIF	-
19	-4.193	0.000	Non Fit	-
20	0.468	0.639	Non DIF	-

Based on dif analysis using Wald test obtained DIF value in the test question points in table 4.3. The wald test conducted with a significance level of 0.01 obtained the detected item DIF as many as 5 questions. The point of the test field of physics study subjects IPA Class VIII semester 2 pressure material that has DIF more favorable male learners in the point of questions 1 and 17 while the point of question number 11, 12 and 15.

In the analysis using R Programming version 4.0.0, the resulting DIF plot is a Confidence plot. The confidence plot determines which items the DIF detects can be seen in figure 1.
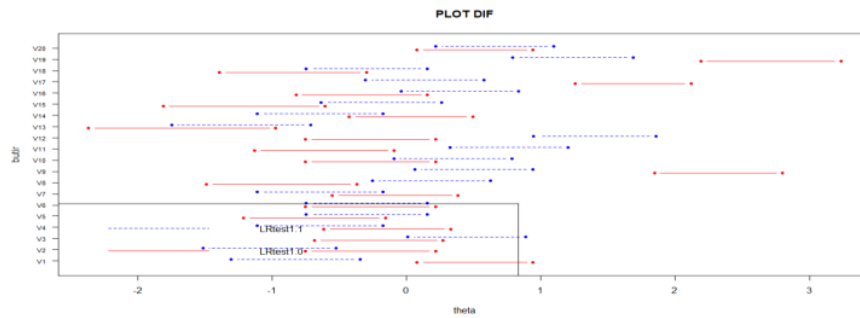
Figure 1. Plot DIF

Theta (θ) shows the interval at each item with a significance level of 0.001. The results of the analysis used DIF plots for 20 test questions as follows:

The LRtest1.1 line shows male learners, while the LRtest1.0 line indicates female learners. DIF is detected when the LRtest 1.1 line with the LRtest1.0 line is not squeezed while when the LRtest1.1 line with the LRtest1.0 line is clustered then dif is not detected. Based on figure 1. visible test questions that contain DIF and do not contain DIF as a whole. The functioning of an item or DIF can be observed in more detail through the PLOT OF DIF per item item of the test question.
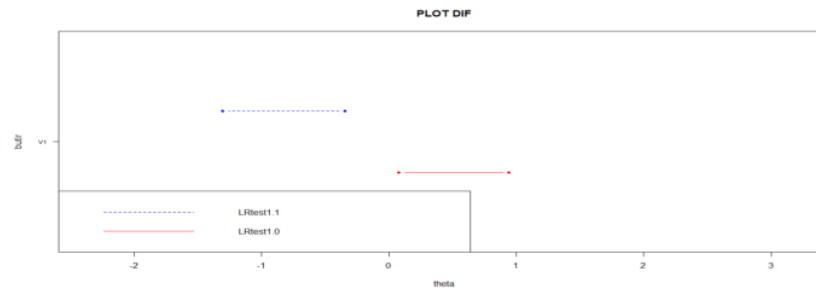
Figure 2. PLOT DIF Item 1

In figure 2. test item shows DIF in point number 1 test. The number 1 test question points favor male learners at levels of -0.5 to -1.3 and benefit female learners at intervals of 0.1 to 0.9. The interval of male and female learners not huddled together this shows the item of this question contains DIF.
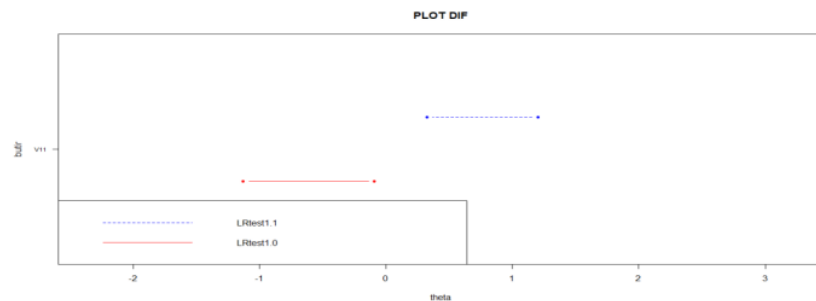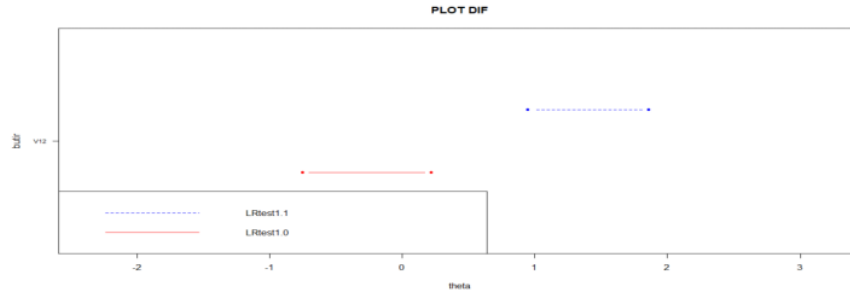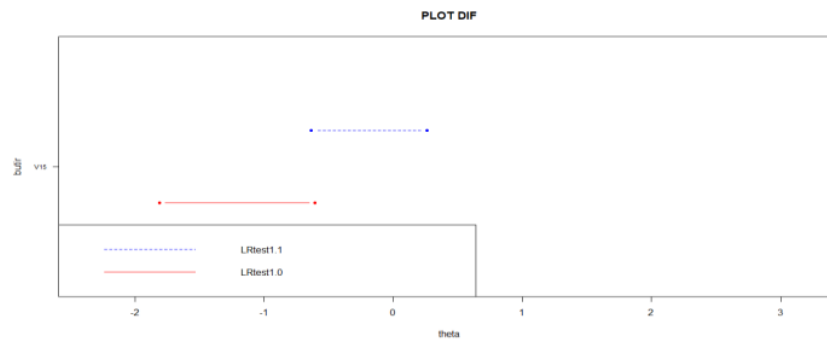
Figure 3. PLOT DIF Point 11

In figure 3. test item shows DIF on the point of test number 11. The number 11 test question points favored male learners at 0.3 to 1.3 ability level intervals and benefited female learners at intervals of -0.1 to -1.2. The interval of male and female learners not huddled together this shows the item of this question contains DIF.

Figure 4. Plot DIF Point 12

In figure 4. test item shows DIF on the point of test number 12. The item of test number 12 is more favorable to male learners at skill level intervals of 0.9 to 1.9 and benefits female learners at intervals of 0.2 to -0.8. The interval of male and female learners not huddled together this shows the item of this question contains DIF.
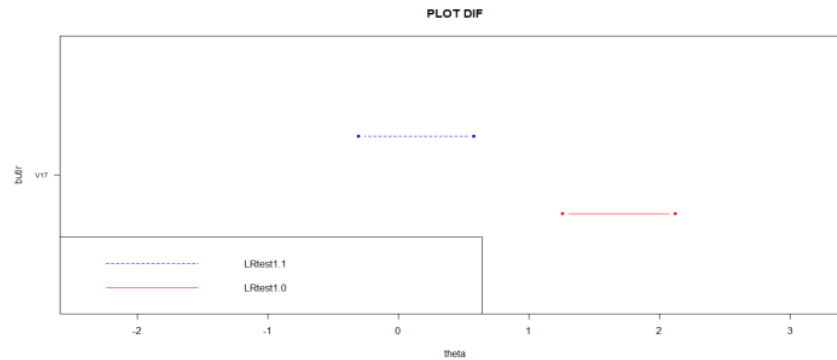

Figure 5. Plot DIF Item 15

In figure 5. test item shows DIF on the point of test number 15. The number 15 test question points favored male learners at skill level intervals of 0.4 to -0.6 and benefited female learners at intervals of -0.6 to -1.8. The interval of male and female learners not huddled together this shows the item of this question contains DIF.

Figure 6. Plot DIF Item 17

In figure 6. test item shows DIF on the point of test number 17. The number 17 test question points favored male learners at levels of -0.4 to 0.6 and benefited female learners at intervals of 1.3 to 2.2. The interval of male and female learners not huddled together this shows the item of this question contains DIF.

Dif detection using characteristic curves is to compare differences in the characteristic curves of the two groups studied. A grain shows a DIF when the item characteristic curve in two groups of learners who have the same ability shows no squeezing, and on the contrary a grain does not show DIF when the curve of the item characteristics of two groups of learners who have the same ability shows clustering. The definition of huddled is that two groups have the same line pattern and are aligned with the ability of the student who answers the test item.

Before creating a characteristic curve, it is necessary to do an equalization test (equating test). Equalization of the test is done so that the details of the question have the same scale. The equalization method of the test used is a simple regression method. Simple regression method performed by paying attention to the response of learners on both test devices X and Y. X is the level of difficulty of women and Y is the level of difficulty of men, resulting in the degree of difficulty of equalization results or Y can be seen in table 4. With the regression equation as follows:

$$\hat{Y} = b_0 + b_1 X$$

Description:

X : Female difficulty level

Y : Male difficulty level

Table 4. Test equalization calculation results

No	X	Y	XY	X²	Ȳ
1	0,511	-0,825	-0,422	0,261	0,144
2	-0,268	-1,020	0,273	0,072	-0,076
3	-0,205	0,450	-0,092	0,042	-0,058
4	-0,143	-0,642	0,092	0,020	-0,040
5	-0,685	-0,297	0,203	0,469	-0,193
6	-0,268	-0,297	0,080	0,072	-0,076
7	-0,083	-0,642	0,053	0,007	-0,023
8	-0,928	0,188	-0,174	0,861	-0,261
9	2,323	0,502	1,166	5,396	0,654
10	-0,268	0,345	-0,092	0,072	-0,076
11	-0,610	0,762	-0,465	0,372	-0,172
12	-0,268	1,402	-0,376	0,072	-0,076
13	-1,669	-1,230	2,053	2,786	-0,470
14	0,033	-0,642	-0,021	0,001	0,009
15	-1,207	-0,187	0,226	1,457	-0,340
16	-0,332	0,397	-0,132	0,110	-0,094
17	1,687	0,135	0,228	2,846	0,475
18	-0,844	-0,297	0,251	0,712	-0,238
19	2,712	1,238	3,357	7,355	0,763
20	0,511	0,658	0,336	0,261	0,144
Σ	-0,001	-0,002	6,544	23,245	
b_1	0,282				
b_0	-0,000086				

To draw the characteristic curve of the grain using the Maple 16 program is to enter the results of the test equalization output into the. Rasch equation with the value of the student's difficulty parameter ranged from $-4 \leq \theta \leq 4$.

The following is an image of the characteristic curve of the grains on the maple 16 grains number 1,11,12,15 and 17.

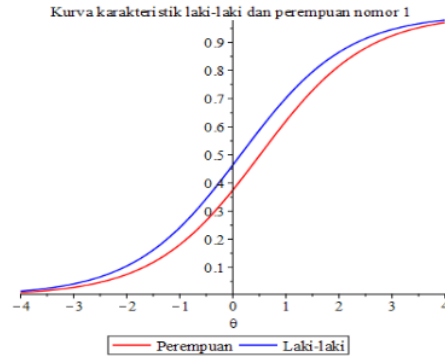Kurva karakteristik laki-laki dan perempuan nomor 1

Figure 7. characteristic curves of male and female number 1

In figure 7. the point of test number 1 contains DIF uniform that benefits male learners, because in the point of question number 1 with the same ability that is on the ability 0. Male and female learners have different opportunities. The chances of answering the item can be seen on the characteristic curve, male learners gained 0.458 while female learners gained 0.364.
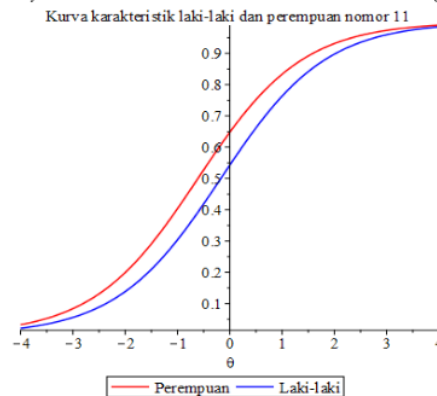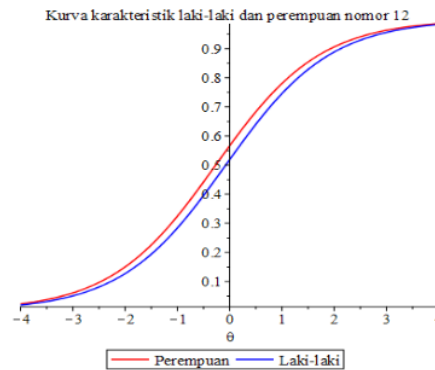
Kurva karakteristik laki-laki dan perempuan nomor 11

Figure 8. characteristic curves of male and female number 11

In figure 8. the point of test number 11 contains DIF uniform that benefits female learners, because in the point of question number 11 with the same ability that is on the ability 0. Male and female learners have different hugs. The chances of answering different items can be seen on the characteristic curve, male learners gained 0.548 while female learners gained 0.657.

Figure 9. characteristic curves of male and female number 12

In figure 9. the point of test number 12 contains DIF uniform that benefits female learners, because in point number 12 with the same ability that is on the ability 0. Male and female learners have different hugs. Different odds of answering items can be seen on the characteristic curve, male learners gained 0.534 while female learners gained 0.562.
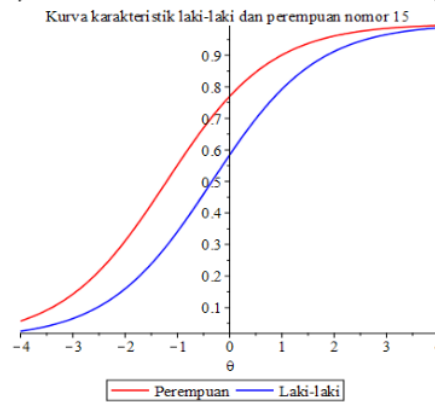

Figure 10. characteristic curves of male and female number 15

In figure 4.10 the question of test number 15 contains DIF uniform that benefits female learners, because in point number 15 with the same ability that is on the ability 0. Male and female learners have different hugs. Different opportunities to answer items can be seen on the characteristic curve, male learners gained 0.596 while female learners gained 0.769.
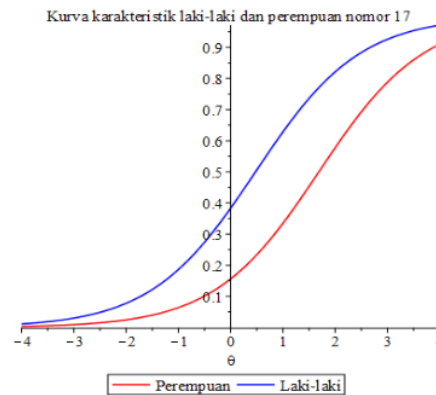
Figure 11. characteristic curves of male and female number 17

In figure 11. item test number 17 contains DIF uniform that benefits male learners, because in point number 17 with the same ability that is on the ability 0. Male and female learners have different hugs. The chances of answering the item can be seen on the characteristic curve, male learners gained 0.494 while female learners gained 0.167.

The construction of test item used in the study has the level of bloom taxonomy type C2 and C3. Test questions of type C2 are found in question numbers 5,6,7,8,10, and 19 with text constructs classifying, exemplifying, predicting and interpreting. In the question with type C3 is found in the question numbers 1, 2, 3, 4, 9, 11, 12, 13, 14, 15, 16, 17, 18 and 20 with the construction of text counting, implementing and determining.

The test questions used in the study had a degree of difficulty based on the response given by the students. In male learners there are categories of questions very easily there are 11 questions on the number 1, 2, 4, 5, 6, 7, 8, 13, 14, 15, and 18. Category 9 difficult questions on numbers 3, 9, 10, 11, 12, 16, 17, 19 and 20.. In 20 test questions can be analyzed questions that compare different work opportunities between male learners and female learners.

The difference in the chances of answering a test question or so-called functioning of the question item can be detected through the r-program software version 4.0.0. The functioning of test points or DIF can be detected using Rasch models and can determine which genders benefited using the maple 16 app. In the 20 test questions used identified 5 questions containing

DIF uniform, namely at number 1, 11, 12, 15 and 17 on the daily test subjects IPA grade VIII SMP even semester.

The number 1 test item was detected to contain DIF, which is categorized as a type of easy question in male learners and a difficult category in female learners. The level of item difficulty in male learners was -0.825 and for female learners was 0.511. This test item benefits male learners at intervals of 0.4 to -1.3 and benefits female learners at intervals of 0.0 to 1.0.

The point of test question number 1 has a type of question C3 with the correct answer is D. Item number 1 is a pressure material on solids, as many as 136 out of 200 respondents answered correctly in this item.

The item of test number 11 was identified as containing DIF, which is categorized as a type of difficult question in male learners and an easy category in female learners. The level of item difficulty in male learners was 0.762 and for female learners was -0.610. The test item benefited male learners at intervals of 0.3 to 1.3 and benefited female learners at intervals of -0.1 to -1.2.

Item number 11 test question has a type of question C2 with the correct answer is C. Item question number 11 is a material factor that affects the pressure on the substance, as many as 126 out of 200 respondents answered correctly in this item.

The item of test number 12 was identified as containing DIF, which is categorized as a type of difficult question in male learners and an easy category in female learners. The level of difficulty in male learners was 1,402 and for female learners

was -0.268. The test item benefited male learners at intervals of 1.0 to 1.9 and benefited female learners at intervals of 0.3 to -0.7.

The point of test question number 12 has a type of question C3 with the correct answer is A. Item number 12 is the material application of pressure on living beings, as many as 109 out of 200 respondents answered correctly in this item.

The item of test number 15 was identified as containing DIF, which is categorized as a type of easy question in male learners and a category too easy on female learners. The level of item difficulty in male learners was -0.187 and for female learners was -1,207. The test item benefited male learners at intervals of -0.7 to -1.8 and benefited female learners at intervals of 0.3 to -0.7.

The point of test question number 15 has a type of question C3 with the correct answer is C. Item number 15 is a matter of legal liquid pressure archimedes, as many as 151 out of 200 respondents answered correctly in this item.

The item of test number 17 was identified as containing DIF, which is categorized as a type of difficult question in male learners and a difficult category in female learners. The level of difficulty in male learners was 0.135 and for female learners was 1,687. The test item benefited male learners at intervals of 0.6 to -0.3 and benefited female learners at intervals of 1.3 to 2.1.

Item test question number 17 has a type of question C3 with the correct answer is C. Item question number 17 is a liquid pressure material hydrostatic law, as many as 94 out of 200 respondents answered correctly in this item.

The results of this study can be a reference, if the test questions other than items number 1,11,12,15 and 17 are tested again for different populations then it is better to choose a population that has high ability so as to produce high accuracy of measurement.

Gender differences between men and women in learning where men are superior in thinking according to reason and women excel in the fields of thoroughness, conscientiousness, accuracy, and umpteenth thinking.

In physics subjects women have superior scores than men (Hidayat, 2011, p.472). The existing idea reinforces where the characteristic curve displays a question that benefits male learners or female learners with a line that crosses theta (θ). The characteristic curve in the test questions exposed to DIF showed that questions number 1 and 17 benefited male learners more while the numbers 11, 12 and 15 benefited female

learners. In addition to the dif-containing questions, there are internal factors that affect each gender's way of thinking in solving problems (Aini, 2017, p.17).

The cause of bias in the item still requires further and in-depth research. This can be due to DIF in a grain can be caused by many factors such as the ability of the learner itself, the ability of teachers in delivering materials, facilities and infrastructure, as well as methods and models of imprisonment. DIF is also a systematic error when making test questions to test the knowledge skills of learners (Setiawan, 2020, p.28).

CONCLUSIONS

Characteristics of test items in science subject matter in the field of physics studies class VIII SMP in Tegal City using Rasch model has the characteristics of the difficulty of the items with easy categories, there are 11 items, namely numbers 1, 2, 4, 5, 6, 7, 8, 13, 14, 15 and 18 and in the difficult category there are 9 items, namely monor 3, 9, 10, 11, 12, 16, 17, 19 and 20.

The items detected by DIF in the test questions of science subjects in the field of physics studies for class VIII SMP in Tegal, the subject of stress on substances, contained 5 items detected by DIF with a fit model, namely items number 1 and 17 and benefiting male students while the items 11, 12 and 15 benefit female learners.

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