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[Research Article]

ANALYZING COMPUTATIONAL THINKING SKILLS USING THE RASCH MODEL ABOUT LEARNING ENVIRONMENT AND GENDER

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ABSTRACT

This research analyzes Computational Thinking abilities using the Rasch model in Futuhiyyah High School students regarding sound waves regarding the learning environment and gender. This type of mixed methods research uses a concurrent embedded design. Data were analyzed using Wright maps and different measures assisted by Minister software. The Computational Thinking ability profile of the class: Only 7 out of 27 students had very high abilities. They exceeded the measured value of the decomposition indicator question which was the most difficult question, namely 4.46. Students' Computational Thinking abilities in terms of the learning environment, 18.52% of students in boarding schools and 7.41% of non-cottage students were able to solve very difficult questions, namely decomposition indicators and algorithmic thinking by exceeding the respective indicator's measure values of 4.10 and 4. 46. Students' Computational Thinking ability in terms of gender, 7.41% of male students and 18.52% of female students were able to solve very difficult questions, namely indicators of decomposition and algorithmic thinking. The results of the different measures, boarding school students were higher in answering questions on indicators of abstraction, generalization, and decomposition, while non-residential students focused on evaluation indicators and algorithmic thinking. Male students were higher in answering questions on the indicators of abstraction, generalization, and algorithmic thinking, while female students were higher on the indicators of evaluation and algorithmic thinking.

Keywords: Computational Thinking, Gender, Learning Environment Waves, and Rasch Model

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1. INTRODUCTION

Industrial Revolution 4.0 has an impact on all aspects of life, including education. The educational aspect plays a crucial role in developing students' thinking skills, enabling them to compete globally and make significant contributions (Adler, R. F., & Kim, 2017). One of the student mindset skills that can improve the above is Computational Thinking abilities. Computational Thinking skills in education are needed by the millennial generation to solve problems (Adler, R. F., & Kim, 2017). Computational thinking involves the process of defining problems so that solutions can be articulated as computational steps and algorithms that are executed efficiently. Application of Computational Thinking in the learning process can be assessed using indicators such as decomposition, abstraction, algorithmic thinking, generalization, and evaluation. The steps of Computational Thinking can be divided into three stages: defining the problem, solving the problem, and evaluating the solution (Nur Rahmawati & Fauzi, 2024).

Decomposition is the skill that allows students to analyze problems by breaking them down into smaller components, making them easier to solve and understand. Abstraction is the ability of a student to solve problems by concentrating on gathering important information and disregarding what is unnecessary or irrelevant. Algorithmic thinking empowers students to tackle problems systematically and logically, breaking them down into manageable steps. Generalization refers to students' ability to identify patterns and similarities, adapting solutions by applying them to similar problems. Evaluation is the student's ability to determine the solution used to solve the problem in terms of algorithms, systems, or processes (Maharani et al., 2020).

Students must have skills in applying physics concepts and principles in solving problems, so they do not just memorize formulas and their meanings. Students still have difficulty understanding the concept of sound wave material. Some students still have difficulty working on sound wave questions and the percentage of correct questions is still below 50% (Suganda et al., 2022). Difficulties are also experienced by class XI high school students in Surakarta. Student errors occur due to poor understanding of concepts, so formula determination and problem-solving are less precise (Yoggi et al., 2022).

External factors: The environment has an impact on students' motivation to learn. (Hidayati, M, 2013). A learning environment that can have a positive impact is a learning environment that has discipline. Discipline has an influence on student achievement (Holid, 2020). Discipline is related to rules or regulations. Another external factor that can affect the way students think is gender. Gender is an important aspect in increasing interest in learning. Gender is a character used to determine the differences between men and women based on social and cultural conditions, values and behaviors, spirituality, emotions, and other non-biological factors. Male and female students have different ways of thinking because there are biological differences in the brain and different functions. So that it makes the way of thinking, learning, and conceptualization process different. Previous research that has been conducted on private high school students in Bandung with the results that female students' abilities in mathematics are superior to male students. The ability of men to make observations, review variables, and make conclusions is higher than that of women. However, women have an advantage in conceptual knowledge, and interpreting data (Yamtinah et al., 2017).

The results of observations that have been made at SMA Futuhiyyah Mranggen show that students have heterogeneous characters both in terms of learning styles, *intelligence,* learning environment, and gender. The character of students in terms of learning power such as there are students who can simply take notes on the material explained, must be accompanied by pictures and videos to better understand, group discussions, and cannot be silent which tends to move a lot in learning. *Student intelligence* is like there are students who have low, medium, and high abilities. The learning environment in each classroom consists of a cottage and non-cottage environment. The gender of students in one class consists of male and female students.

Grade XII MIPA students have not completed the KKM of physics subjects, especially in materials that contain several combinations of concepts. Wave material is one of the materials that is difficult for students to complete because several concepts must be understood. Based on difficulties in solving problems, students need to have good thinking skills, *Computational Thinking* is one of the abilities that can help students in difficulty solving problems. Based on the learning environment at SMA Futuhiyyah Mranggen, students who live in Islamic boarding schools dominate achieving achievements more than students who live at home. Meanwhile, based on gender, female students' achievements in solving problems are more thorough than male students. Students have difficulty understanding a concept in sound wave material and there are differences in achievement reviewed from the learning environment and gender.

Previous research has been conducted by Alfina (2017) on students' *Computational Thinking* abilities when they solve social arithmetic problems based on gender. However, this study has not looked at students' computational thinking abilities in their learning environment. This study aims to determine *students' Computational Thinking* ability in solving physics problems on sound wave materials reviewed by learning environment and gender. The data of this study was analyzed using *the Rasch Model* with the help of *winsteps software*. Measurement of *Computational Thinking* ability was carried out using test instruments and analyzed using the *Rasch Model* assisted by *mini-step software.* Rasch Model *analysis* can be used to determine the relationship between questions and students (Sumintono & Widhiarso, 2015).

The learning environment in this study is limited to the learning environment in boarding schools and non-boarding schools. The discipline applied in pesantren is more than just learning activities. which covers all aspects of student life, from waking up to going back to sleep. For example, discipline in waking up, discipline in worship, discipline in learning in the classroom and all Islamic boarding schools, discipline in language, discipline in morals and clothing, and so on. So that a boarding school environment with good discipline students are more cooperative and effective in carrying out learning activities than non-boarding school students who receive less attention from parents in studying at house. This study is to find out the Computational Thinking ability profile *of* students in grade XII of Mipa Futuhiyyah Mranggen High School reviewed from the learning environment and gender using *the Rasch Model* based on *the Wright map and* to find out the *Computational Thinking ability* of students in grade XII MIPA Futuhiyyah Mranggen reviewed the learning environment and gender using *the Rasch Model* based on DIF.

2. METHOD

This type of research is a mixed method that uses *a concurrent embedded design.* This research is a mixture using *a concurrent embedded* design, namely quantitative and qualitative research methods with quantitative methods as the primary method and qualitative methods as reinforcement (Sugiyono, 2013). The research was carried out at SMA Futuhiyyah Mranggen grade XII MIPA in the even semester of the 2022/2023 school year. The sample of this study was taken using *the purposive sampling technique.* Quantitative data collection techniques are tests in the form of description questions integrating *Computational Thinking indicators,* question validation questionnaires, and qualitative data collection techniques using data filled in by students. The validation analysis of the questions used V *Aiken* with a *likert scale* of 1-4 and the content coefficient was calculated using equation 1.

$$V = \frac{\sum s}{n\,(c-1)} \qquad (1)$$

Information:
s = r- lo
lo = lowest valuation assesment figure (1)
c = highest valuation assesment figure (4)
r = numbes given of expert judgment.

The calculated content validity coefficients are categorized as in table 1.

Table 1. Interpretion of *Likert Scale* Validation Results

Validity Coefficient	Interpretation
$V \leq 0{,}4$	Not Valid
$0{,}4 < V < 0{,}8$	Valid
$V \geq 0{,}8$	Very Valid

(Hendryadi, 2017)

Validity analysis of *Computational Thinking* ability using *the Rasch Model*. According to Sumintono & Widhiarso (2014), The validity criteria of the test instrument on the *Rasch Model* are as follows:

1) Outfit mean Squer (MNSQ) value accepted: 0.5 < MNSQ <1.5 (ideally 1.00)
2) Outfit Z-standard (ZSTD) value accepted: -2.0 < ZSTD < +2,0 (ideally 0.00)
3) Point Measure Correlation (Pt Measure Corr) value accepted : 0.4 < Pt Measure Corr < 0.85 (not negative).

If there are criteria that are not met, but the MNSQ value is met, then the questions can still be used because MNSQ is the most important value, namely the accuracy of the middle square measurement.

Reliability analysis of *Computational Thinking* ability using *the Rasch Model*. This test consists of reliability items, subject reliability and *alpha Cronbach*. Reliability is used to measure the quality of question items based on the results of students' answers and the reliability of the subject is to measure the consistency of answers from students. Alpha *Cronbach score* to find out the overall reliability results. The categories of reliability tests with interpretations are shown in Table 2.

Table 2. Test Insrument Reliability Test

Item Reliability	Category
$< 0{,}67$	Very Low
$0{,}67 \leq x < 0{,}80$	Low
$0{,}80 \leq x < 0{,}90$	Enough
$0{,}90 \leq x < 0{,}94$	High
$> 0{,}94$	Very High

(Sumintono & Widhiarso, 2014)

Analysis of the results *of the Computational Thinking* ability test using *the Rasch model*, namely *the Wright* map and *measure* dif. An example of the Wright *map* results can be seen in Figure 1.

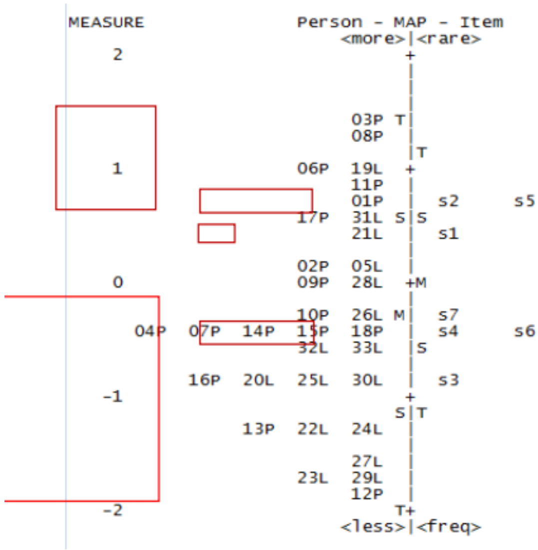

Figure 1. Example of *Wright* Map Results

1. On the left side of the *Wright map* there is a distribution of *student abilities* and student logit (*measure*). While on the right there is a distribution of the difficulty level of the questions. The grouping of categories in terms of *both items* and *people* can be seen from the standard values *of deviation* and logit (*measure*).
2. The most difficult problem to work on can be seen from the right side *of the row of items* found in the row between *the standard deviation* (S) to (T) with a positive logical value (*measure*). Questions that are included in the medium category on the line below the *standard deviation* (S) with a positive measure value to above *the standard deviation* (S) with a negative measure value. Meanwhile, easy problems are found in the line between *the standard deviation* (S) to (T) with a negative logical value (*measure*).
3. The high ability of students can be seen from the left side of the person series. Students' abilities can be seen by adjusting the difficulty level of the questions.

Identification of bias between demographic groups such as gender, ethnicity, age, education, domicile, and so on can be analyzed using *Differential Item Functioning* (DIF). This study has respondents with learning environments and gender groups. The two groups are indicated to have differences in thinking, so it is necessary to conduct an analysis using DIF. The data analyzed using DIF will produce a graph of differences in *Computational Thinking abilities* reviewed from the learning environment, namely boarding and non-boarding school students, and a graph *of Computational Thinking* abilities reviewed from gender, namely male and female students.

The data from the questionnaire filled out by students about computational thinking skills, environmental conditions, and gender will be qualitative and analyzed using the Miles and Huberman model. The analysis of the miles and Huberman model has the stages of data reduction, data presentation, and conclusion.

3. RESULTS AND DISCUSSION

The Computational Thinking *test instrument* was assessed by four experts, namely four physics education lecturers, and analyzed using *Technique* as presented in table 3.

Table 3. Expert Validation

No. Question	Average Validity	Desc.
1	0.883	Very High
2	0.883	Very High
3	0.889	Very High
4	0.861	Very High
5	0.878	Very High
6	0.889	Very High
7	0.889	Very High
8	0.867	Very High

Based on the results of the calculation of the validity coefficient of the content in Table 3, it shows that questions 1 to 8 get a very valid category or very suitable for use in classroom research. The test instruments that have been validated using the test *are* tested on students. The instruments used are only 2 questions and each question contains 5 indicators of *Computational Thinking.* The validity of the Computational Thinking test instrument was obtained from the test scores of students in the trial class, namely class XII MIPA 2 with a total of 22 students.

The validation results indicated by Table 4 include several questions where the Outfit Z-standard (ZSTD) value and one of the Ponint Measure The relationship (Pt Measure Corr) values are not met, but the MNSQ value is. As a result, the questions can still be classified as valid and used. For example, question numbers 2a, 2e, and 2d have not met the Pt Measure Corr value.

Table 4. Intrument Validation

No. Question	*Outfit* MNSQ	*Outfit* ZSTD	*Pt Measure Corr*	Desc.
1.a	1,42	1,01	0,74	Valid
1.b	0,51	-1,43	0,78	Valid
1.c	1,05	0,26	0,51	Valid
1.d	1,36	0,66	0,74	Valid
1.e	1,41	1,18	0,43	Valid
2.a	0,52	-0,44	0,87	Valid
2.b	1,11	0,41	0,72	Valid
2.c	0,62	-1,00	0,77	Valid
2.d	0,49	-1,09	0,87	Valid
2.e	1,32	1,01	0,91	Valid

Because the test instrument satisfied the requirements listed in Table 5, it was deemed dependable.

Table 5. Reliability Result

Reliability Test	Result	Category
Person Reliability	0,89	Good
Item Reliability	0,93	Very good
Cropbach Alpha	0,91	Very good

The Ministep software shown in Figure 2 uses Wright maps to map students' computational thinking skills.

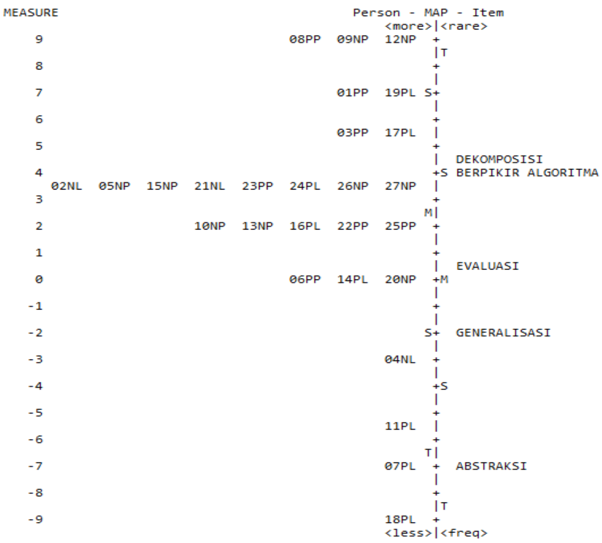

Figure 2. *Wright* Map

Based on the results of the Wright map, the abstraction indicator has the easiest question category because it is at the bottom with minimal measurement values, the generalization indicator questions have the easy category, the evaluation indicator questions, and algorithmic thinking have the difficult category, and the decomposition indicator questions have very difficult questions because they have high measurement values. Very high as presented in Table 6.

Table 6. *Item Measure* Total

Indicator	*Measure*	Category
Abstract	-7,03	Very Eassy
Generalization	-1,88	Eassy
Evaluation	0,35	Difficult
Algorithmic Thinking	4,10	Difficult
Decomposition	4,46	Very Difficult

The average Computational Thinking ability of Class XII MIPA 1 students stands at an impressive 70.30%. This demonstrates a strong foundation in critical thinking skills essential for today's challenges. Notably, cottage students identified by codes 08P, 01P, 19P, 03P, and 17P consistently showcase high abilities, indicating effective learning environments. However, it is concerning that cottage student 18P falls significantly behind with very low abilities. Encouragingly, non-cottage students 09N and 12N also exhibit strong Computational Thinking skills, proving the effectiveness of diverse learning settings. On the other hand, non-cottage student 04N's low abilities highlight the need for targeted support. Overall, we must continue fostering these skills across all student groups to ensure their success in a rapidly evolving world.

Table 7 displays the outcomes of students' computational thinking skills in the learning environment. There are 15 kids enrolled in boarding school and 12 students not enrolled in boarding school.

Table 7. Students' Computational Thinking Abilities are reviewed by the Learning Environment

Indicator	Learning environment	Total	Percentage
Abstraction	Pondok	14	51,85%
	Non pondok	12	44,44%
Generalitaion	Pondok	12	44,44%
	Non pondok	11	40,74%
Evaluation	Pondok	10	37,04%
	Non pondok	10	37,04%
Dekomposition and Algoritmic	Pondok	5	18,52 %
Thinking	Non pondok	2	7,41%

Boarding school students, specifically those with codes 08P, 01P, 19P, 03P, and 17P, make up the majority of students who have answered inquiries on the five Computational Thinking markers. Five students' measurement scores were higher than the measure scores for really challenging items, such as the decomposition indicator, which had a value of 4.46. The percentages of boarding school and non-boarding school students who successfully answered decomposition indicator questions and used algorithmic thinking were 18.52% and 7.41%, respectively. This finding is supported by Widiastuty's (2021) research, which indicates that the learning environment is an external factor influencing student achievement. A positive learning environment helps students enjoy the learning process.

The results of the Wright map analysis were strengthened by the results of a questionnaire filled out by students. Students who are in the complete category in completing the five Computational Thinking indicators, both boarding school and non-boarding school students from the Wright analysis, also have a good category based on the results of the questionnaire. The results of the questionnaire completed by students indicate that they have a comfortable learning environment supported by adequate facilities. Additionally, they can manage their study time effectively and demonstrate a strong interest in participating in physics lessons. Several environmental factors contribute to students—both those in boarding schools and those in non-boarding schools—feeling uncomfortable in their learning environments. This discomfort is particularly evident among students who have not completed the most challenging assignments. Additionally, they struggle to balance their study time effectively and show less interest in participating in learning activities.

Students who spend more time playing than studying, according to Ningrum's (2019) research, can reduce learning motivation and make students lazy to think, especially when solving complex problems. If you look at the results of the questionnaire filled out by the students, they still feel that the learning environment is less comfortable, so they have difficulty allocating time to study and lack interest in participating in physics lessons. Based on external factors that influence students' Computational Thinking abilities, it can be concluded that there needs to be discipline in the learning environment so that students are more disciplined, especially in studying. The Computational Thinking abilities of boarding school students dominate more than non-boarding school students. So the hypothesis of this research is proven due to the disciplinary factor of the learning environment.

The results of the *Computational Thinking* ability of students from gender based on *the Wright* map, namely male students with codes 19L and 17L have high abilities. Male students who have low abilities are with the code 18L. Meanwhile, female students who have high abilities are with codes 08P, 09P, 12P, 01P, and 03P. Female students who have low abilities are with codes 06P and 20P. The results of students' *Computational Thinking* skills reviewed from gender can be presented in Table 8. The number of male students is 11 students while female students are 16 students.

Table 8. Students' *Computational Thinking* Ability in terms of Gender

Indicator	Gender	Total	Percent age
Abstraction	Male	10	37,04%
	Female	16	59,26%
Generalitaion	Male	7	25,93%
	Female	16	59,26%
Evaluation	Male	6	22,22%
	Female	14	51,85%
Dekomposition and Algoritmic Thinking	Male	2	7,41%
	Female	5	18,52%

Students who are included in completing the questions in the five indicators *of Computational Thinking* are dominated by female students, namely with codes 08P, 09P, 12P, 01P, and 03P. The value of the five students' measure can exceed the score of the measure of very difficult questions, namely the decomposition indicator with a score of 4.46. Male and female students who were able to solve decomposition indicator problems and think algorithmically could be presented with a percentage of 7.41% and 18.52%, respectively.

This research is in accordance with the research that has been conducted by Alfina (2017), that male and female students have *different* Computational Thinking *abilities.* Female students have higher thinking skills than men according to the results of research that has been conducted by Athifah & Khusna (2022). Female students tend to have more precision in solving problems than male students. Male students are more likely to answer questions quickly. Female students are more consistent than male students in the use of concepts in the problem-solving process and are strengthened by research results Ani & Rahayu (2018).

The results of the analysis of *the Wright map* were strengthened by the results of the questionnaire filled out by students. Students who are in the category of complete in completing the five *indicators of Computational Thinking*, both male and female students from *the Wright analysis* also have a good category based on the results of the questionnaire. The condition of gender equality from the results of the questionnaire between male and female students does not experience gender inequality in schools.

The results of the questionnaire showed that gender equality was not the cause of the difference in students' thinking ability, especially in *Computational Thinking ability.* So the difference in thinking between male and female students is caused by other factors. Research Dilla (2018) and Yonanda (2020) which shows that male and female students have different ways of thinking, learning, and conceptualization caused by different brain functions. So that the hypothesis of this study is proven because the *Computational Thinking* ability of female students is higher than that of male students.

Based on the DIF *measure score*, there is a difference between boarding school and non-boarding school students, which means that there is a tendency between the two. It can be seen in Figure 3 that there is a difference in the generalization problem indicators, which means that boarding school students have a greater tendency to answer correctly doing *the Generalization Computational Thinking problems of* non-boarding school students. Questions on generalization indicators are more beneficial to boarding school students. Boarding school students have higher measure scores than non-boarding school students on abstraction, generalization, and decomposition indicators. So that when viewed from the value of *the dif measure, the* ability of non-boarding school students to *Computational Thinking is higher than that of* non-boarding school students on the indicators of abstraction, generalization, and decomposition. Non-boarding school students on the evaluation and algorithmic thinking indicators have *higher measure* scores than non-boarding school students. So that when viewed from the value of *the dif measure,* the ability of non-boarding school students is higher than that of boarding school students in the evaluation indicators and algorithmic thinking.

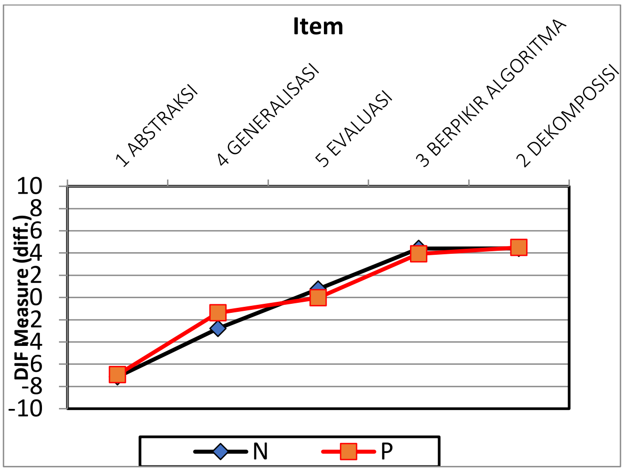

Figure 3. DIF Measure Learning Environment

Information:
Kode P = Pondok
Kode N = Non Pondok

Based on the DIF measure score, there is a difference between male and female students, which means that there is a tendency between the two. It can be seen in figure 4 that there is a difference in the generalization question indicators, which means that male students have a greater tendency to answer correctly and do generalization questions than women. Questions on generalization indicators are more beneficial to male students. Meanwhile, in the evaluation indicators, female students tend to answer correctly.

Male students have higher *measure* scores than women on indicators of abstraction, generalization, and algorithmic thinking. So that when viewed from the value of *the dif measure,* the ability of male students is higher than that of non-boarding school students in the indicators of abstraction, generalization, and algorithmic thinking. Female students in the evaluation and decomposition indicators have *higher measure* scores than male students. So when viewed from the value of *the dif measure,* the ability of female students is higher than that of male students in evaluation and decomposition indicators.

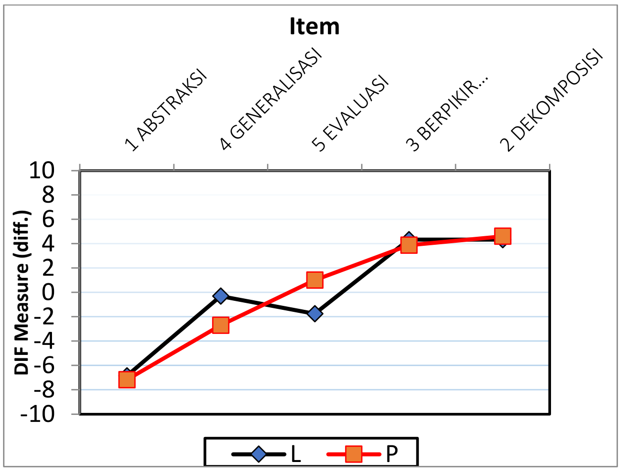

Figure 4. *DIF Measure Gender*

Information:
Kode L = Male
Kode P = Female

4. CONCLUSIONS

The profile of *Computational Thinking ability of* students in grade XII MIPA SMA Futuhiyyah Mranggen sound wave material was reviewed from the learning environment using *the Rasch model* based on *the analysis of the Wright map*, which is included in the good category because the average student has been able to solve difficult problems, namely the evaluation indicator with a measure value of 0.35 and can be represented by 71.37% of students. Students who have very high abilities by exceeding the decomposition *indicator measure* score which is the most difficult problem is 4.46 only 7 students out of 27 students. Students' *Computational Thinking ability* is reviewed from the learning environment, students who are in boarding schools 18.52% and non-boarding schools 7.41% can solve very difficult problems, namely decomposition indicators and algorithmic thinking by exceeding the *measure values* of indicators 4.10 and 4.46, respectively. Students' Computational Thinking *ability* was reviewed from gender, male students 7.41% and female students 18.52% were able to solve very difficult problems, namely decomposition indicators and algorithmic thinking.

The Computational Thinking *ability of* students in grade XII of Mipa Futuhiyyah Mranggen High School was reviewed in a learning environment using *a rasch model* based on the results of the dif *measure* of boarding school students were higher in answering questions about abstraction, generalization, and decomposition indicators, while non-boarding school students were on the evaluation indicators and algorithmic thinking. The results of the student dif *measure* were reviewed from the perspective of gender, male students were higher in answering questions about abstraction, generalization, and algorithmic thinking indicators, while female students were in the evaluation and algorithmic thinking indicators.

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