

Comparison of students' physics motivation by gender using the Physics Motivation Questionnaire (PMQ): Rasch model analysis

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Abstract

During the pandemic, many physics teachers only deliver material without adequate learning assistance. This directly or indirectly has influenced students' motivation to learn physics. The analysis of motivation so far has only used the classical test theory approach, so it cannot describe motivation at the individual level. Therefore, this study analyzes students' motivation to learn physics using the Rasch model. This research uses a survey research type. The survey was conducted on 27 class X and XI students who were selected using convenience sampling. The instrument used is the Physics Motivation Questionnaire (PMQ), adapted from the Science Motivation Questionnaire (SQM) developed by Glynn et al. The PMQ uses a 5-point Likert rating scale. Motivation levels were collected online using the Google Forms platform. Motivation level data were analyzed using the Wright map, LVP (Logit Value of Person), and Differential Item Functioning (DIF). The analysis results show that the average level of student motivation is higher than the item difficulty level. Male and female students have the highest motivation on the factor/dimension of Career Motivation. Regarding Gender, male students are more anxious and worried about failing physics exams than girls. Meanwhile, female students were more motivated to study physics better than other students. So, there are differences in the motivation of male and female students. Teachers must insert particular messages for students so they both have positive motivation when studying physics. Students must stay focused on their learning efforts and keep trying to improve their understanding of physics.

Keywords: Physics Motivation Questionnaire, Science Motivation, Rasch Model, Motivation based on Gender

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I. Introduction

The COVID-19 pandemic has created a large-scale disruption in student life [1]. This has dramatically changed teaching and learning in many countries, including Indonesia. Along with the increasing number of Covid-19 cases, the governments of various countries, including Indonesia, have stopped face-to-face learning and instructed all learning to be done online at various levels of education [2]–[9]. Not all students are ready for this sudden change [10]. Many students experience more significant depression and anxiety than before Covid-19 [11], [12]. The sudden shift in learning modes has changed the physical, psychological, or educational environment of students so that it has an impact on changes in their cognition and motivation [13].

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The existence of gender differences is also one of the factors that affect the level of student learning motivation [12].

During the pandemic, many teachers only provide material without adequate assistance. This makes it a burden for most students and ultimately has an impact on decreasing their learning motivation. Motivating students to learn is very important because students who have high motivation are more likely to seek to master the material through effective self-regulation strategies [14], [15]. On the other hand, students who are not motivated to learn tend not to optimize their role during the learning process. Various studies report the role of motivation on student learning outcomes [16].

The Science Motivation Questionnaire (SMQ) developed by Glynn et al. [17] is one of the ideal scales to identify the level of student motivation because it has been reported that the quality of psychometric properties in science and non-science students has been reported [14]. SMQ has been tested and adapted to various cultural contexts [18]–[23]. In the context of Indonesian culture, SMQ has shown its suitability to the context of Indonesian culture through the adaptation process carried out by Wardhany et al. [21], Rahmayanti et al. [24], and Aini et al. [25] used the classical test theory approach and modern test theory (Rasch Model). Meanwhile, the implementation of SMQ to assess students' learning motivation in Indonesia, especially in physics, in terms of Gender, is still very limited. Compared to the classical test theory, the Rasch model is one of the most powerful analytical techniques to assess the level of student learning motivation. The Rasch model can describe the level of student learning motivation at the individual level. Therefore, this study aims to assess students' motivation to learn physics based on Gender using the Rasch model.

II. Methods

This research belongs to the type of survey research and is included in the category of quantitative research. A survey of students' motivation to learn physics was conducted at one of the public high schools in Yogyakarta. The number of respondents involved was 27 people (13 male and 14 female) students from classes X and XI. L symbolizes the male students, and the female is symbolized by P. Respondents were selected using the convenience sampling technique.

The instrument used to assess the level of student motivation is an adaptation of the Science Motivation Questionnaire (SQM) developed by Glynn et al. [17] became the Physics Motivation Questionnaire (PMQ). PMQ consists of 30 items which are distributed in 5 aspects/factors, namely: a) Intrinsic motivation and personal relevance (IMPR, ten items), b) Self-efficacy and assessment anxiety (SEAA, nine items), c) Self-determination (SD, four items), d) Career motivation (CM, two items), and e) Grade motivation (GM, five items). The PMQ uses a 5-point Likert rating scale from 1 representing "Never" to 5 representing "Always."

Students' motivation to learn physics is collected using PMQ, formatted as Google Forms to simplify the data administration process. Data collection is carried out after regular learning activities are carried out. Student participation is voluntary, and students can withdraw the response if they feel uncomfortable with the conditions. Withdrawal of responses can be made by contacting the contact person written on the Google Form. The average time it takes students to complete a set of instruments is about 30 minutes.

Data on students' motivation to learn physics were analyzed using Winsteps 4.6.1 software [26]. Before being analyzed using Winsteps, the raw data was coded using Ms. Excel and then saved as a Control file. The level of students' motivation to learn physics was evaluated using the Wright map, LVP (Logit Value of Person), and Differential Item Functioning (DIF). Wright map is used to map the level of student motivation based on the hierarchical location of student motivation and the level of item difficulty. LVP is used to determine the level of motivation in each aspect. Meanwhile, DIF is used to see the real differences in the learning motivation of male and female students.

III. Results and discussion

Distribution of student's motivation to learn physics

In detail, students' motivation to learn physics was analyzed using a person-item map (Wright map). Figure 1 visualizes the hierarchy of students' motivation in learning physics to the item difficulty level.

Figure 1 is also known as a person-item map or Wright map. This map describes the condition of students' motivation on the item's difficulty level. The Wright map is divided into two parts: the left side shows the students' motivation levels distribution, and the right shows the distribution of item difficulty levels [27].

Symbol M shows the average level of student motivation and the average difficulty level of the questions. At the same time, the symbols S and T each show the value of the standard deviation and twice the standard deviation. Based on Figure 1, the average level of student motivation is higher than the item difficulty level.

Students on the bottom left indicate students with the lowest motivation level to learn physics (26L students). Then, the higher the level, the higher the level of motivation. Students who have the highest motivation are students 14L and 22P. Although 26L students have the lowest motivation, 26L students have good motivation on 7 items (GM2, SEAA6, GM3, CM2, SEAA4, SD1, and IMPR10). Meanwhile, students 14L and 22P have high motivation in all factors/aspects of motivation to learn physics. The number of students with a motivation level below the average is 16 (59.2%).

The item on the bottom right (GM2, Getting a good grade in physics is essential to me) was most approved by students. Good physics grades can have many positive benefits and consequences for students regarding self-confidence, academic abilities, and future career opportunities [28], [29]. Therefore, students need to understand the importance of studying physics seriously and getting good grades on physics exams. The higher the item's difficulty level, the higher the item's location, and the SEAA2 item "I'm worried about failing the physics test" was the student's least favorite item. That is, students need to be more motivated on these items. Using a hierarchy between people and items, four items (GM1, SEAA5, SEAA1, and SEAA2) do not motivate most students (18 out of 27 students or 66.7%) in learning physics because the items are located higher. So, in general, the level of student motivation is high.

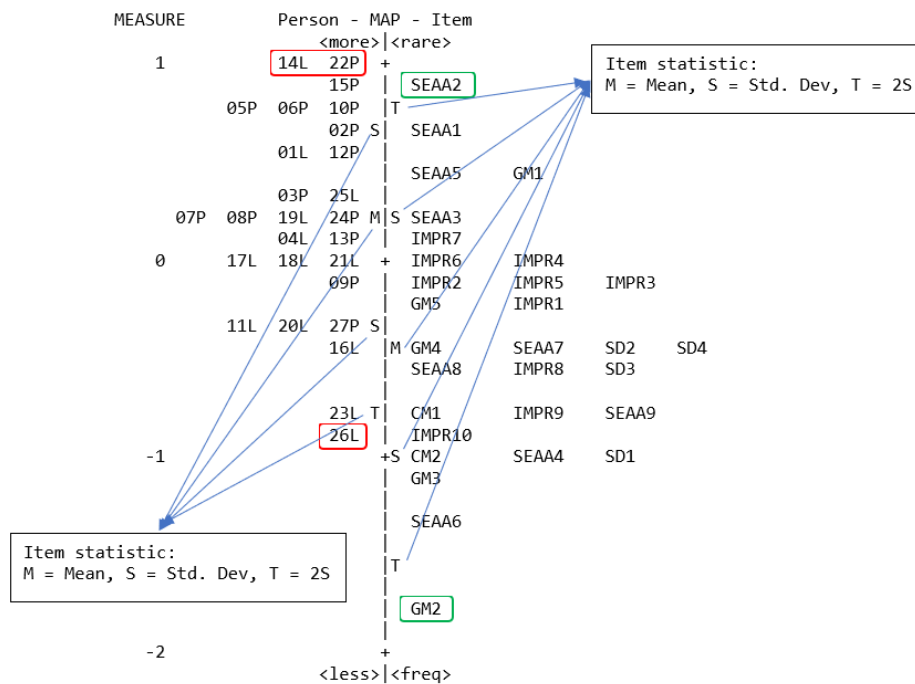


Figure 1. Distribution of Students' motivation levels in Studying Physics

Student Motivation on each factor/aspect

Student motivation on each factor is shown in Table 1.

Table 1. Students' motivation to learn physics on each factor

Factor	Male (Logit)		Female (Logit)	
	Mean	Std. Deviation	Mean	Std. Deviation
All Factor	0.17	0.41	0.44	0.52
Factor 1: IMPR	0.08	0.52	0.49	0.70
Factor 2: SEAA	0.17	0.43	0.24	0.47
Factor 3: SD	0.40	0.75	1.14	1.59
Factor 4: CM	0.46	2.27	1.36	1.95
Factor 5: GM	0.31	0.77	0.80	0.88

Note: IMPR = Intrinsic Motivation and Personal Relevance; SEAA = Self-Efficacy and Assessment anxiety; SD = Self-Determination; CM = Career Motivation; GM = Grade Motivation

Based on Table 1, in general, the motivation of male students to study physics is much lower than that of female students. It can be seen from the average value of male student motivation of 0.17, while the average female motivation of 0.44. In the IMPR factor, the average motivation of male students is 0.08 logit in studying physics, and female students' motivation is 0.45 logit. On the SEAA factor, female students' motivation is 1.4 times higher than male students. The same thing happened to the elementary school factor. The motivation of male students was only 35% of the level of motivation of female students. Meanwhile, on the CM and GM factors, female students' motivation level in studying physics is three times that of male students.

Differences in Motivation by Gender

Differences in student motivation in studying Physics based on Gender can be explored in more detail using Differential Item Functioning (DIF). The DIF graph is shown in Figure 2.

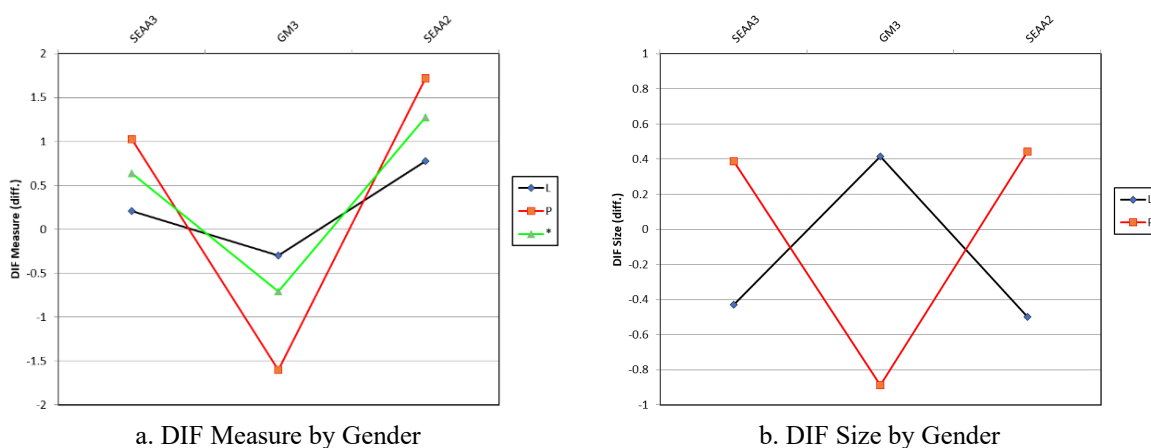


Figure 2. Differences in student motivation by Gender

Based on Figure 2a, it appears that there is a significant difference between the motivation to study physics for male and female students on three indicators (items), namely the SEAA3 item "I am anxious when I will take the physics exam," GM3 "I hope to do better than other students. while studying physics", and SEAA2 "I am worried that I will fail the physics exam." This difference is based on the probability value of all items. This data is also supported by the location width between men and women in Figure 2b. Male students agree more easily on SEAA3 items than girls. This means male students feel more anxious than girls when facing physics exams.

On the other hand, female students agree more easily on GM3 items than boys. This means that female students want to learn physics better than other students. In the SEAA2 item, men agree more easily than women. This means that male students worry more about failing a physics exam than girls. This concern is in line with the anxiety of male students when facing physics exams.

IV. Conclusions

Based on the results of the previous analysis and discussion, the level of student motivation in learning physics is quite high. Female students' motivation in various aspects is higher than that of male students. Female students are more motivated to learn better than other students. Meanwhile, male students feel more anxious when facing physics exams and are worried about failing the exam.

Analysis of students' motivation levels using the Rasch Model has contributed to evaluating students' motivation levels in learning physics. Aspects that motivate students to learn physics can be explored in detail at the individual level. To provide an overview to the teacher or instructor to condition students to be ready to learn physics. However, the level of student motivation can be explored more deeply by combining types of qualitative research. Therefore, we recommend for future research use Mix method research to obtain more in-depth information.

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