Prior knowledge of students in analytical geometry in terms of gender analyzed using the Rasch model

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Abstract. The purpose of this study is to describe the prior mathematical proficiency of students in terms of gender analyzed by the Rasch model. Participants consisted of a class of second-semester students who contacted analytic geometry courses comprised of 11 men and 29 women at one of the universities in Indonesia. The research instrument was a test item describing five questions about points and lines in the plane. The results showed students answered questions according to their level of ability, and there was no gender bias. Therefore in learning that will carried out in groups should be heterogeneous from the prior level of mathematical and gender prior knowledge.

1. Introduction

Prior knowledge of students is essential because it is the key to developing expertise and providing provisions for learning. Prior knowledge describes the readiness of students in receiving lessons so that they affect the success of students in education [1]–[4].

The fact that prior knowledge has become an educational variable that contributes significantly to learning outcomes has been demonstrated in several studies. Dochy reports that knowledge is measured before the course, explaining, on average, not less than 50% of the variance in post-test scores (ranging from 20 to 80%). Other studies have shown that there is an interaction between mathematical prior knowledge and learning that has a significant influence on improving students' reasoning abilities [5]. Student learning outcomes with high initial mathematical ability in the experimental class are higher than the control class, whereas for students with low mathematical initial ability there is no significant difference [6]–[9]. Other studies report students with small, medium, and high prior mathematical knowledge have little, right, and excellent high-level thinking skills [4]. Differences in student ability further affect the achievement of learning objectives [10]. Students' prior mathematical knowledge is one of the factors that should be a concern of lecturers to create a learning process that can provide optimal results for students [11].

Gender is also one of the factors that influence learning. The results showed that gender differences were found in the ability to solve mathematical problems [12]–[18]. In solving geometry problems, male participants (class XI students) dominantly used their spatial skills while female participants lacked their spatial abilities [13]. The geometry of boys is higher than that of girls, so according to reports that in geometry, boys are more fortunate [16].

One analysis in the rating scale is using the Rasch model. The advantages of Rasch modeling are that it can provide a linear level at the same interval, predict missing data, provide more precise estimates, detect inaccurate models, and produce replicable measurements [19]. Based on the index of the level of
difficulty through the approach of classical test theory does not yet have good quality. At the same time, the results of the analysis through the Rasch model show varying levels of difficulty, namely easy, painful, and very difficult [20].

Research on prior mathematical knowledge is widely studied by previous researchers but mostly discusses correlation studies. Besides, discussions about analytic geometry are still rare. Therefore, in this article, the prior knowledge of students in analytic geometry will be presented in terms of gender analyzed using the Rasch model.

2. Methods
This study is descriptive research. The study population was all students who studied analytic geometry in the 2019/2020 school year at the mathematics education department at one of the universities in Bandung, Indonesia. The sample was selected by purposive sampling consisting of one class of students comprised of 11 men and 29 women at the mathematics education department at one of the universities in Bandung, Indonesia. The instrument used was a test description of the concept of points and lines in a field consisting of five questions that were done on paper for 100 minutes. The test is done at mid-test, where the results become a prior knowledge of students to learn conic and space geometry. Furthermore, the answers were assessed using the rubric of assessment and analyzed using the Rasch model assisted by Winstep software version 4.4.6.

3. Result and Discussion
The following are the results of the prior mathematical knowledge data analysis of students taken from the previous knowledge test results.

3.1 Wright Map Analysis (Person-Item Map)

![Figure 1. Person map item prior mathematical knowledge](image)

Based on the person map item figure, it is known that male and female participants are scattered in their ability to answer prior mathematical knowledge questions. Participants with the lowest prior knowledge were 25P (participants to 25 women), while the highest was 29L (participants to 29 men).
3.2 Detection of bias items

In the DIF prior mathematical knowledge figure, it is known that the probability of all questions is more than 5%, which means there is no gender bias in these questions.

3.3 Individual Ability Analysis

Data on individual student ability can be known from the Person Measure figures. If the categorization is divided into three (13 upper groups, 14 middle groups, and 13 low groups), the same values are ranked 13th and 14th, and 26th and 27th. To get the measure again using SD, which is equal to 0.74. This ½ SD value if combined with an average logit (mean) value of -0.88, then the individual ability of students can be grouped into the category of high ability ≥ (-0.88) + ½.0.74 = -0.51, the medium ability category is between -0.88 - ½.0.74 = -1.25 and (-0.88) + ½.0.74 = -0.51, and the category of low ability is ≤ -0.88 - ½. 0.74 = -1.25. Thus 14 people (four men and ten women) belong to the high category, 12 people (five men and seven women) belong to the medium category, and 14 people (2 men and 12 women) belong to the low category.
### 3.4 Individual Compliance Level

According to the figure of prior mathematical knowledge's misfit person, it is known that all participants, both men, and women, give answers according to their ability level, except student 08P.

Based on these findings, it is known that all participants answered prior knowledge tests according to their level of ability, which is divided into high, medium, and low categories. This prior knowledge illustrates the readiness of students in receiving lessons so that lecturers should pay attention to this in learning [1]–[4]. Besides, there is no gender bias so that in line with the findings of Fryer and Levitt, who reported that there is no gender gap in mathematics [21]. In contrast to other results that gender differences are found in the ability to solve mathematical problems [12]–[18]. In solving geometry problems, male participants dominantly used their spatial skills while female participants lacked their spatial abilities [13]. The geometry of boys is higher than that of girls [16], [22], [23].

### 4. Conclusion

Based on the analysis using the Rasch model, it is known that students answer mathematical prior knowledge questions according to their level of ability so that previous knowledge of students is divided into high, medium, and low categories. There is no gender bias in the mathematical of prior experience. Therefore, lecturers should pay attention to previous knowledge of mathematics and gender in learning carried out, including heterogeneity of last knowledge and gender in group learning. Besides that, further research is needed to describe the initial abilities of students.

### 5. References

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