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Evaluation of the Difficulty of Self-Efficacy Items in Mathematics Learning Using Rasch Model Analysis

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ABSTRAK

Self-efficacy dalam belajar matematika sangat penting karena dapat membantu dalam menyelesaikan tugas dengan baik. Tujuan penelitian ini adalah (1) mengevaluasi tingkat kesulitan item dalam instrumen *self-efficacy* yang digunakan dalam pembelajaran matematika; (2) mengidentifikasi item yang terlalu mudah atau terlalu sulit; (3) mengidentifikasi item yang tidak sesuai dengan model Rasch; dan (4) memberikan rekomendasi untuk meningkatkan atau mengembangkan instrumen yang lebih akurat. Penelitian ini menggunakan metode kuantitatif dengan pendekatan survei. Data dikumpulkan dari 863 responden menggunakan kuesioner *self-efficacy* yang telah disesuaikan dan diuji validitas serta reliabilitasnya menggunakan model Rasch. Analisis demografis menunjukkan bahwa siswa kelas menengah lebih sering mengalami *self-efficacy* yang rendah (19,5%). Usia juga berperan, dengan kelompok usia 19–28 memiliki *self-efficacy* yang lebih kuat. Perbedaan gender juga diamati, dengan laki-laki umumnya memiliki self-efficacy yang lebih baik daripada perempuan. Kesimpulannya, karakteristik demografis mempengaruhi tingkat *self-efficacy* siswa. Implikasi dari penelitian ini adalah pentingnya pendekatan yang disesuaikan berdasarkan tingkat pendidikan, usia, dan gender dalam upaya meningkatkan *self-efficacy* matematika.

ABSTRACT

Self-efficacy in learning mathematics is very important because it can help in completing tasks well. The objectives of this study were (1) evaluate the level of difficulty of items in the self-efficacy instrument used in mathematics learning; (2) identify items that were too easy or too difficult; (3) identify items that did not fit the Rasch model; and (4) provide recommendations for improving or developing a more accurate instrument. This study employed a quantitative method with a survey approach. Data were collected from 863 respondents using a self-efficacy questionnaire that was adapted and tested for validity and reliability using the Rasch model. Demographic analysis shows that senior students more often experience low self-efficacy (19,5%). Age also plays a role, with the 19–28 age group having stronger self-efficacy. Gender differences were also observed, with men generally having better self-efficacy than women. In conclusion, demographic characteristics influence students' self-efficacy levels. The implications of this study are the importance of tailored approaches based on educational level, age, and gender in efforts to improve students' self-efficacy in mathematics.

INTRODUCTION

Self-efficacy plays an important role in determining students' success in mathematics learning (Muhtadi et al., 2022). Self-efficacy is a strong belief that students have that they are capable of overcoming, directing, solving problems, and acting effectively in certain situations with confidence, intelligence, and ability (Faradillah & Purwitasari, 2022). In addition, self-efficacy refers to the belief that students must complete certain tasks (Hendriana & Kadarisma, 2019; Hidayat & Noer, 2021; Wittkowski et al., 2017). Self-efficacy is not only a passive belief but also an active driver for shaping students behaviour and responses to difficulties. Generally, students with high self-efficacy tend to strive to their fullest and feel challenged when faced with complex problems, and will work hard to solve them, unlike students with low self-efficacy who tend to give up easily and are unable to solve difficult math problems. This difference occurs because self-efficacy directly influences success in learning and problem-solving efforts (Asfanudin et al., 2024; Gee et al., 2025; Hidayat & Noer, 2021; Nurani et al., 2021). Therefore, measuring and understanding students' levels of self-efficacy is crucial. This can be determined through the administration of a questionnaire based on predefined indicators.

The development of a self-efficacy questionnaire instrument needs to be tested for validity and reliability. One way that can be used is the Rasch model. Rasch model is one of the measurement methods that can overcome several obstacles to classical test theory, including limitations in regulating the difficulty level of items (Rahayu et al., 2021). The Rasch model excels in its ability to estimate unavailable data, identify possible guessed responses, and analyze the individual ability level of students based on the difficulty adjustment of each item (Saputra & Sudrajat, 2024).

Several relevant studies in line with the research variables are as follows. First, research was conducted by Faradillah & Septiana, (2022) this study compared the validity and reliability of a mathematical resilience instrument for high school students using the Rasch Model with the Winsteps and SPSS applications, finding that although both indicated that the instrument was valid and reliable with high reliability, Winsteps provided more specific and detailed validity results in identifying invalid items and individuals. Second, Faradillah & Febriani, (2021) this study analyzed mathematical trauma among junior high school students based on class and gender using the Rasch model, and the results showed that most of the instrument items were suitable and valid for measuring mathematical trauma, although there were some items that were less suitable. Another study was conducted by Gee et al., (2025) this study investigates the significant influence of self-awareness and self-efficacy on students' mathematics learning achievement, the study aims to understand how these two important variables affect students' academic performance in mathematics. This study analyzes the direct and indirect effects of self-awareness and self-efficacy on mathematics learning achievement.

Based on the relevant research provided, the gap in this study is that although the study by Gee et al., (2025) examined the influence of self-awareness and self-efficacy on mathematics learning achievement, it did not focus on evaluating the quality of the self-efficacy instrument itself, particularly in terms of item difficulty. Furthermore, the studies by Faradillah & Septiana (2022) and Faradillah & Febriani (2021) did use the Rasch Model to evaluate instruments, but they applied it to instruments of mathematical resilience and mathematical trauma, not to self-efficacy instruments in mathematics learning. The novelty of this study lies in the fact that there are still few studies discussing the validity and reliability of self-efficacy for senior high school students. In addition, many of the instruments used are still in foreign languages, so this study facilitates the analysis of self-

efficacy instruments that are suitable for use in Indonesia. The objectives of this study are (1) evaluate the level of difficulty of items in the self-efficacy instrument used in mathematics learning; (2) identify items that are too easy or too difficult; (3) identify items that are not in accordance with the Rasch model; and (4) provide recommendations for improving or developing a more accurate instrument.

METHOD

This research was conducted using a quantitative method with a survey approach. Survey research is a type of research that contains questions to respondents regarding opinions, beliefs, characteristics or actions that are or have occurred (Purwaningrum & Faradillah, 2020). Meanwhile, according to Salim & Darmawaty, (2016) survey approach involves taking samples from a specific population, with questionnaires as the main instrument for collecting information. Furthermore, for the selection of subjects using purposive sampling. The purposive sampling method is a method of taking using criteria that are aligned with the aim that the data that has been collected can be relevant and can represent the interests of the research (Dani et al., 2019). In this study, the criteria used to select 863 respondents were junior high school, high school, and university students who were pursuing formal education, aged between 13 and 28 years old. These criteria were selected based on the assumption that this age group and level of education had sufficient academic experience to reflect their level of self-efficacy in the context of education, according to Table 1.The recruitment process was carried out by distributing online questionnaire links to prospective respondents who met the criteria. The respondents in this study were predominantly students and university students from urban areas, such as DKI Jakarta, Depok, and Bekasi. Although efforts were made to involve multiple schools, it was unavoidable that the sample had a geographical focus. This focus may limit the generalizability of findings to populations outside the region, particularly in rural areas. Therefore, the interpretation of research results should involve a more geographically and culturally diverse sample.

Table 1. Subject Demographic Codes

Num.	Demographics	Description	Code	Total
1.	Level	Junior	Z	654
		Senior	Y	147
		University	X	62
2.	Age	13-15	A	639
		16-18	B	165
		19-28	C	59
3.	Gender	Female	P	503
		Male	L	360

Table 1 outlines three demographic differences of the total 863 subjects. Overall, the composition of the research subjects shows a predominance of respondents from junior high school, the age range of early adolescence, and the majority being female, reflecting the characteristics of the population that is the focus of this study.

Table 2. Self-Efficacy Instrument

Num.	Indicators	Total Statement
1.	Mastery Experiences	6
2.	Vicarious Experiences	6
3.	Social Persuasions	6
4.	Physiological States	6

Table 2 contains information about the research instrument. The researchers used an instrument adapted from several existing instruments, which was then adjusted to the characteristics of the subjects and language use (Usher & Pajares, 2009). The adaptation of Usher's self-efficacy measurement tool began with translating it from English into Indonesian and validating it by two expert validators with backgrounds in language and psychology. The translated results were then analyzed and discussed to reach a consensus. This stage involved expert validators to obtain suggestions regarding language consistency and contextual appropriateness. The data collection process was conducted in several stages. First, content validity refers to the extent to which the instrument's content is appropriate and comprehensive for measuring what it is intended to measure (Terwee et al., 2018). This validation was conducted by two expert validators, namely a mathematics education lecturer and an English teacher. Additionally, construct validity was evaluated as an indicator of how accurately the instrument measures the intended construct, as evidenced by the relationship between results (positive or negative) that are theoretically consistent with other related variables (Aithal & Aithal, 2020).

After 24 statement items are given to 863 respondents, validity testing will be carried out in the form of item fit. item fit analysis was conducted to determine the items that were appropriate for use in the study (Natanael, 2021). The criteria used as a reference for measuring item fit can be seen through Outfit MNSQ, Outfit ZSTD, and PT.Measure-Core. The following presents the results of the item fit.\

Table 3. Item Fit

Num.	Item	MNSQ Outfit (0,5 < x < 1,5)	ZSTD Outfit (-2,0 < x < 2.0)	PT.MEASURE-CORR (0,4 < x < 0,85)
1.	I3	1.44	8.54	0.49
2.	I20	1.39	7.79	0.51
3.	I24	1.36	7.01	0.56
4.	I11	1.22	3.91	0.44
5.	I23	1.25	5.15	0.58
6.	I21	1.22	4.48	0.60
7.	I19	1.20	4.24	0.60
8.	I9	1.09	1.64	0.48
9.	I8	1.09	1.71	0.45
10.	I10	1.10	1.94	0.45
11.	I7	1.05	0.97	0.49
12.	I22	1.08	1.64	0.63
13.	I4	0.94	-1.12	0.55
14.	I12	0.94	-1.31	0.59

Num.	Item	MNSQ Outfit (0,5 < x < 1,5)	ZSTD Outfit (-2,0 < x < 2.0)	PT.MEASURE-CORR (0,4 < x < 0,85)
15.	I18	0.93	-1.50	0.62
16.	I6	0.90	**-2.08**	0.55
17.	I15	0.87	**-3.07**	0.66
18.	I5	0.81	**-3.91**	0.56
19.	I14	0.83	**-4.03**	0.67
20.	I17	0.78	**-5.13**	0.68
21.	I16	0.77	**-5.57**	0.67
22.	I13	0.74	**-6.20**	0.64
23.	I1	0.66	**-8.14**	0.62
24.	I2	0.63	**-9.20**	0.63

Table 3. Describes the results of the analysis generated from item fit, by looking at MNSQ Outfit, ZSTD Outfit, and PT.Measure-Core. It can be seen that all items listed can be said to be fit, by meeting at least two criteria out of three. Furthermore, the reliability test will be carried out. Testing using the reliability test is a process to measure the extent to which a research instrument can produce consistent and reliable data (Amanda et al., 2019). The bold numbers indicate that the value does not meet one of the required criteria.

Reliability tests can be carried out using the Winsteps application with summary statistics, the reliability criteria adopted in this study include Cronbach's alpha (KR-20) with a limit of > 0.50, meanwhile item and person reliability which are categorized as good (0.81-0.90), very good (0.91-0.94), and excellent (>0.94), where the test results using Winsteps are presented in the following figure (Faradillah & Septiana, 2022).

Table 4. Summary Statistics

Statistics	Value
Person Reliability	0.92
Item Reliability	0.99
Cronbach Alpha (KR-20)	0.93

The reliability test results presented in Table 4 indicate that this research instrument has a very strong level of reliability. The Person Reliability value of 0.92 indicates very good measurement consistency among respondents, meeting the "very good" criteria (0.91-0.94). Similarly, Item Reliability of 0.99 confirms perfect consistency between items, falling into the "excellent" category (>0.94). In addition, Cronbach's Alpha (KR-20) of 0.93 also reinforces this finding, indicating high internal consistency and far exceeding the required limit (>0.50). Overall, these data indicate that the instruments used are reliable and produce consistent measurements.

RESULTS AND DISCUSSION

This study adopted the Rasch Model analysis approach to evaluate students' responses to the distributed questionnaires. The data for this research was collected from 863 respondents spread across various levels of education, ranging from junior, senior, and university. The analysis included an exploration of the data based on three key demographic aspects: education level, gender, and age category. Furthermore, Figure 1 provides a visualization of the Wright Maps depicting the subjects self-efficacy in terms of school level.

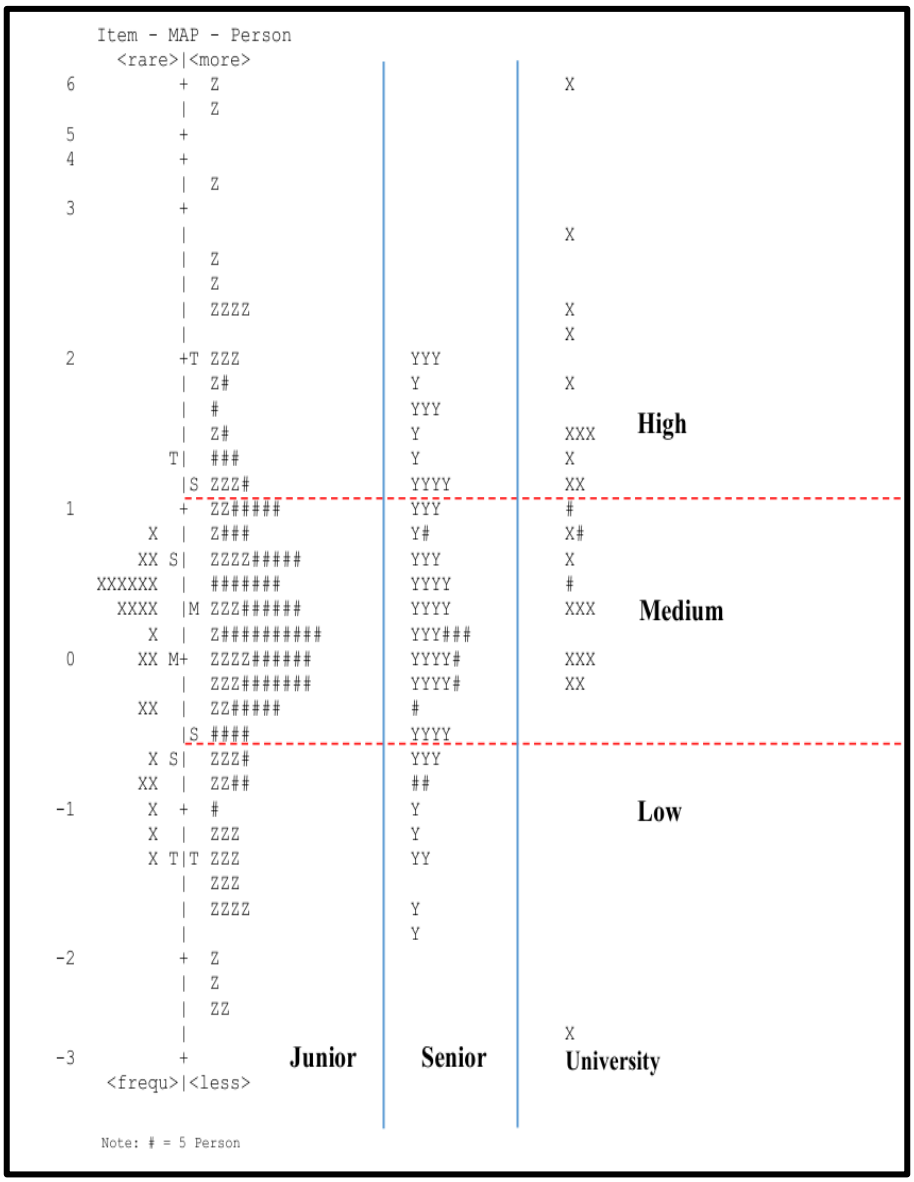

Figure 1. Wright Maps of Self-Efficacy by Level

Figure 1 shows that many senior students have low levels of self-efficacy, with a percentage of 19,5% compared to other levels (Putri & Prabawanto, 2019). Code Z and Y appears significantly in the low and medium areas, indicating that most students are at a suboptimal level. This phenomenon should be noted, as low self-efficacy levels can negatively impact students' academic performance (Jannah et al., 2019). In addition, for code X, there was only one student at the low level. This suggests that university students do not face issues with self-efficacy. Therefore, it can be concluded that at the college level, students demonstrate greater self-efficacy in specific situations compared to others, and this can develop over time (Bartimote-Aufflick et al., 2016). Consequently, educational level also influences the level of self-efficacy an individual possesses (Amila et al., 2018).

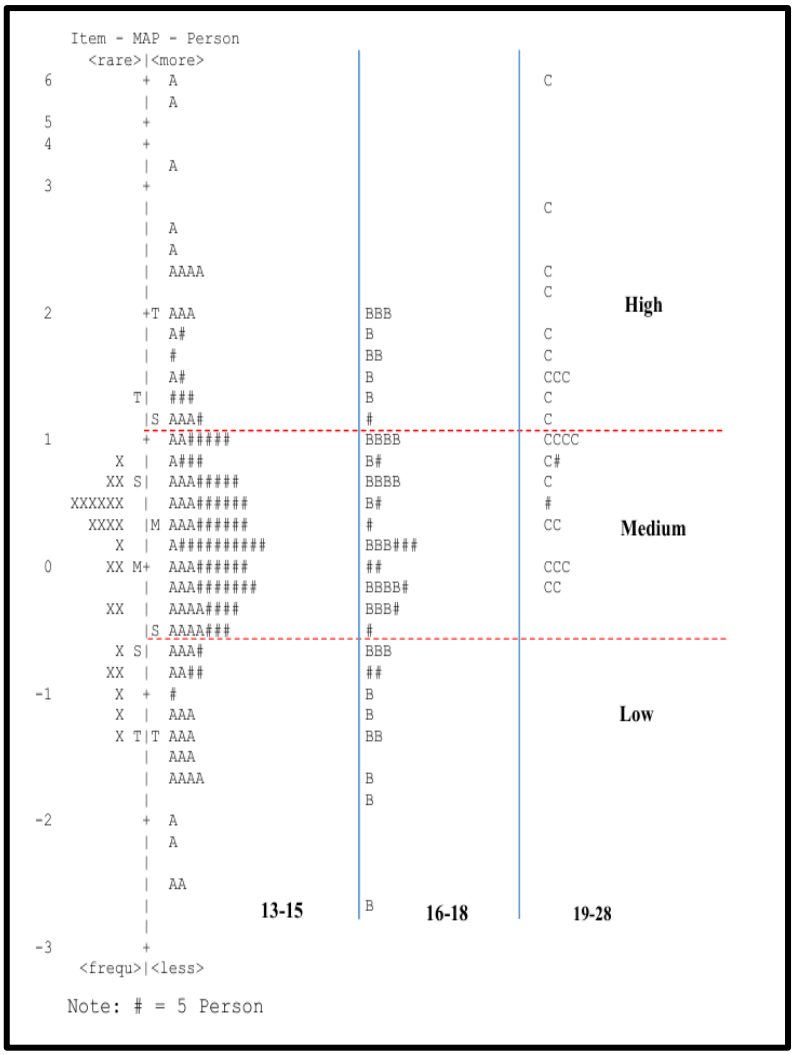

Figure 2. Wright Maps of Self-Efficacy by Age

Figure 2, in terms of age the 13-15 and 16-18 age groups have a moderate level with a higher percentage than other levels, with an average percentage above 69%. The results indicate that students with moderate self-efficacy tend to doubt their ability to solve the problems given and often assume that their work is incorrect (Nurani et al., 2021). Mathematical literacy skills in junior high school are related to self-efficacy (Kurniawati & Mahmudi, 2019). Meanwhile, in the 19-28 age group, none had low self-efficacy levels. This suggests that individuals in this age group tend to have stronger self-efficacy. It is likely that experience plays a role in shaping higher levels of self-efficacy (Wardani & Syah, 2022). Thus, age can be one of the variables influencing the improvement of self-efficacy in an individual (Amila et al., 2018). Older people usually have stable emotions, and this emotional stability contributes to their level of self-efficacy, therefore they do not encounter any difficulties (Sukatin et al., 2023). Therefore, it can be concluded that age is positively correlated with increased self-efficacy, with older age groups showing a stronger tendency toward self-efficacy, most likely influenced by accumulated experience and emotional stability.

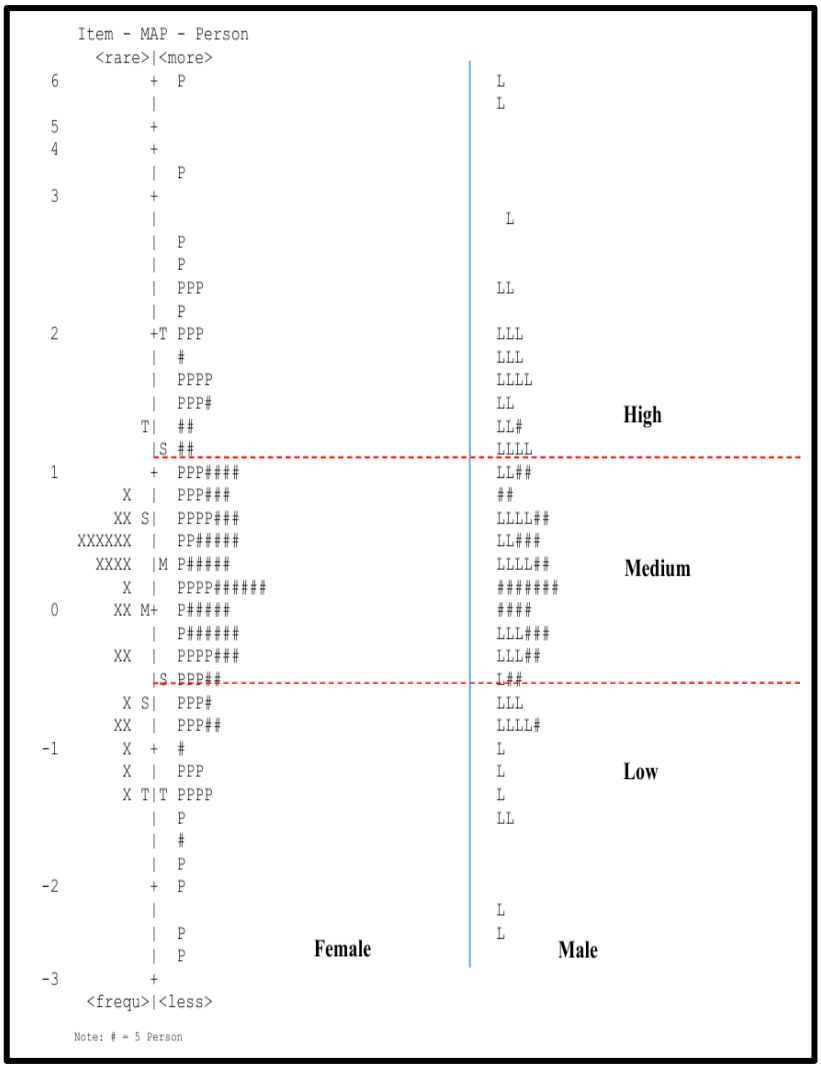

Figure 3. Wright Maps of Self-Efficacy by Gender

Based on figure 3. there is a striking difference in self-efficacy levels between men and women. When viewed based on moderate and high levels, women have lower self-efficacy levels than men (Recber et al., 2018; Zander et al., 2020). This finding is supported by the data in the figure above, which shows that males have a higher percentage of high and moderate self-efficacy levels at 90.9% compared to females at 86.8%. These figures further indicate that the proportion of males with low self-efficacy (9.1%) is much lower than that of females (13.2%), suggesting a more stable and evenly distributed foundation of self-efficacy among male participants in this study. This is consistent with Hiller et al., (2022), who discussed the higher self-efficacy of males compared to females. This relates to research Yuliana & Winarso, (2019) that men think more rationally than women, who tend to use their feelings. This is followed by the idea that men tend to focus on intellectual, objective, and abstract matters, while women tend to be practical, emotional, and personal (Lestari et al., 2021). Therefore, male students have a higher understanding of mathematics compared to female students.

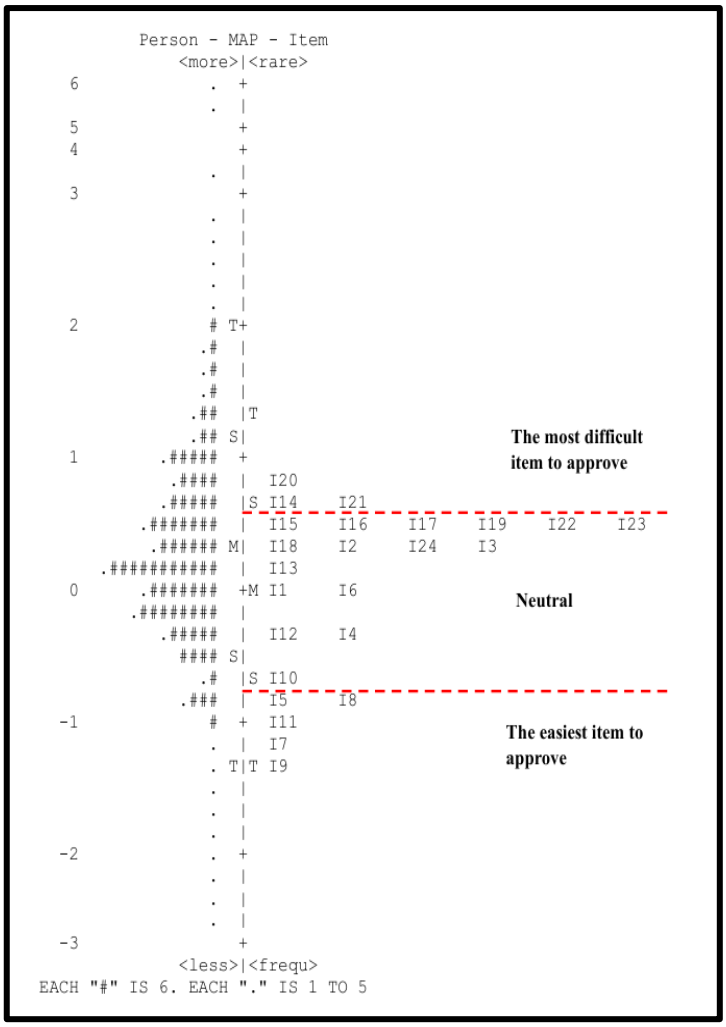

Figure 3. Wright Maps from Self-Efficacy Statements

The figure above shows the results of Wright maps using Winstep regarding statements with a total of 24 items. One of the statements that reveals students experiencing low self-efficacy is "I start to feel stressed when I am about to do math homework". In statement I9, many subjects agree that seeing student achieve better results than ourselves in mathematics can serve as a significant motivator to improve there abilities. This shows that peer experiences play an important role in motivating individuals to try harder and achieve better results in the same field (Sukatin et al., 2023). Based on the findings of Asih & Ujianti, (2021), mathematics is perceived as a difficult subject that often intimidates students. Various characteristics of mathematics, such as its abstract nature, dominance of numbers and formulas, and the need for continuous practice, are often cited as reasons why students dislike this subject (Juliyanti & Pujiastuti, 2020).

Table 5. Self-Efficacy Based on Demographics

Demographics	Findings	Brief explanation/Implications
Level	The results of the study showed that low self-efficacy was	Personal experiences, both successes and failures, can influence an individual's thoughts about their ability to perform tasks. Mastery experiences have been shown to be a strong predictor of self-efficacy in various

Demographics	Findings	Brief explanation/Implications
	found in most high school students, but this condition was very rare among university students, occurring in only one individual.	aspects of education (Lau et al., 2018), which may explain why students demonstrate higher levels of self-efficacy. However, research by Anjaswarni et al., (2021) states that junior and senior high school students have high levels of self-efficacy. The gap between the findings of this study and previous literature highlights the importance of considering demographic, cultural, or even methodological factors in measuring self-efficacy that may contribute to differences in results.
Age	From the results of the study, low self-efficacy was not found in adults, unlike the adolescent group, most of whom had moderate self-efficacy.	Younger age groups tend to experience doubt. Younger age groups tend to experience more doubt. Consistent with the findings of Aguilar et al., (2021) dimensions of self-efficacy had a positive relationship with age, suggesting that age plays an important role in shaping stronger self-efficacy in more mature individuals.
Gender	Found that men had a greater percentage of self-efficacy in the high and medium categories than women	Gender also influences a person's self-efficacy (Panadero et al., 2017). However, on the other hand, there is research showing that self-efficacy is higher among women than among men. Women are more likely to be categorized as high, indicating that most women have fairly good self-efficacy regarding their abilities (Muega-Geronimo & Carlos, 2023). These differences may indicate that specific research contexts, such as culture, field of study, or social environment, play an important role in shaping individuals' gender-based self-efficacy beliefs.
Items that trigger low self-efficacy	One of the items indicating that students have low self-efficacy is found in the physiological states.	Self-efficacy is one of the important variables in controlling stress (Freire et al., 2020). Other studies also suggest that self-efficacy can influence physiological stress responses, either by reducing or increasing them (Schönfeld et al., 2017).

CONCLUSION

The conclusion of this study is that students' self-efficacy in mathematics is greatly influenced by demographic factors such as educational level, age, and gender. Specifically, this study found that senior students tend to show lower levels of self-efficacy, while college students show higher levels of self-efficacy. A similar pattern was observed based on age, where self-efficacy levels generally increased with age. In addition, males showed more

positive self-efficacy levels than females. Another important finding was the strong correlation between stress caused by mathematical tasks and low self-efficacy levels, often caused by the perception that mathematics is a difficult subject. For further research, it is recommended that efforts to improve students' self-efficacy consider their demographic characteristics, the important role of teachers in shaping self-efficacy, and explore specific steps that can improve self-efficacy in demographic groups with lower levels of self-efficacy.

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