The Impact of Differences in Attitudes of Male and Female Prospective Teachers in Understanding Statistics

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ABSTRACT

Universities have understood the gender gap of prospective teachers towards attitudes in facing statistics lessons is increasingly growing. However, the understanding of universities about gender in influencing prospective teachers' attitudes toward statistics lessons is still minimal. This is urgent to be studied because there is a gap between expectations in universities and facts in the field, so this study aims to analyze differences in attitudes towards statistics based on gender and identify factors that influence attitudes towards statistics. The research method used is a quantitative survey type. The research sample was 395 prospective mathematics teachers from 18 universities that prepare prospective mathematics teachers in Jakarta and the sample was selected randomly. The data collection technique was a survey using an instrument. The instrument was developed and validated. The instrument was distributed with a rating scale from point 1 to point 5. Data were collected with the help of Google. The data analysis technique used was descriptive statistics with the help of SPSS Version 25.0, assessing the mean, variance, standard deviation, and the t-test. The results found that prospective teachers have a positive attitude towards statistics and the female gender has a significant and more positive influence on attitudes towards statistics lessons. The conclusion is that gender is important in shaping prospective teachers' attitudes towards statistics lessons. The research implies that higher education needs to pay attention to gender factors in implementing the curriculum and provide training to prospective teachers to increase interest in learning statistics.

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A. INTRODUCTION

The concepts implemented by teachers in the classroom in teaching have a positive or negative impact on students' knowledge in learning mathematics (Suhaini, 2020; Vásquez et al., 2023). The attitude of prospective teachers towards mathematics lessons, especially statistics lessons, is one of the factors that support the acquisition of knowledge and learning outcomes (Sakaria et al., 2023; Hidayat & Wardat, 2024). Sahin & Yilmaz (2020) in previous research on the influence of prospective mathematics teacher attitudes towards statistics subjects, it was found that there was a correlation between student attitudes and their learning achievement. Knowledge of student attitudes towards subjects is very important because this information can help students and teachers and can be used to develop a curriculum to improve the teaching and learning process in obtaining results (Ahmed & Melad, 2022; Okagbue et al., 2023; Rizvi et al., 2023). Positive attitudes give students a better understanding of the nature of learning and also make students more open to lessons which can increase their expectations in learning, and

reduce students' anxiety levels in the teaching and learning process (Silvola et al., 2021; Cao & Yu, 2023).

Any profession in the world requires knowledge and skills in statistics, especially in the field of education. By knowing statistics, prospective mathematics teachers can utilize statistics in various fields, including information technology, engineering, science, and mathematics, by using statistical knowledge as a structural method (Madaki, 2021). In developing countries, including Indonesia, statistics have been included in the elementary school curriculum up to higher education levels. However, in reality, many students, especially in countries such as Sub-Saharan Africa (SSA), consider statistics as a difficult subject to understand (Nyoni et al., 2023; Delprato., 2022). Previous researchers have said that non-cognitive factors such as attitudes, perceptions, interests, expectations, and motivation can increase knowledge of statistical material (Dhlamini et al., 2019). Knowledge factors such as mathematical background can also greatly influence the ability of prospective teachers to understand basic statistical concepts because many statistical concepts are abstract, which often leads to misunderstandings in understanding and developing statistical concepts (Azmay et al., 2023). The lack of a positive attitude toward statistics has resulted in reduced and even lost student interest in statistics subjects in most African countries including Jakarta-Indonesia (Oluoch et al., 2020). A study conducted on student performance in statistics in Jakarta-Indonesia showed poor performance in the subject (Dushimimana & Uworwabayeho., 2020). These studies recommend that statistics should be taught in an active atmosphere where students investigate, collect, and analyze data to provide answers to statistical questions. Sáez-López et al. (2020) emphasized that increasing students' enthusiasm for learning can be achieved through various elements, including the care of teachers who teach students.

Alalwan et al. (2020) on effective statistics learning that students' negative attitudes towards the subject, teaching methods, and numerical complexity are some of the factors that cause statistics to be a difficult subject for students. Some students have difficulty understanding statistical concepts due to a lack of adequate statistical reasoning (Legesse et al., 2020; Ahn et al., 2020). One aspect of students' proficiency in statistical reasoning is that they must also apply their knowledge to practical issues in real-world experiences (Berndt et al., 2021). In knowledge and reasoning abilities as a statistics educator, you must be able to demonstrate problem-solving (Hämäläinen et al., 2019).

Male & Lumbantoruan (2021) emphasize statistical knowledge as a valuable skill for prospects. Several studies Male & Lumbantoruan (2021), Patricia Aguilera-Hermida (2020) Students' attitudes toward statistics are related to the development of statistical thinking skills. Lack of motivation and interest in statistics subjects has an impact on academic achievement and decreased understanding of the context of the material in statistics (Estrada & Batanero, 2019; Huang et al., 2020). Improving students' attitudes toward statistics through educational interventions can help them gain confidence in their ability to use statistics to solve problems outside the classroom (Groth & Meletiou-Mavrotheris., 2018). Students' attitudes toward statistics may have a major impact on the development of statistical thinking skills that are useful for applying statistical knowledge. The SATS-36 method can be used in student-centered teaching and is one of the most effective ways to overcome the problem of low achievement in

statistics classes (Filiz et al., 2020a; Wakhata et al., 2023). The integration of the SATS-36 method plays a major role in improving students' knowledge and attitudes (Cladera, 2021).

Gender differences in students' attitudes towards statistics, with females generally showing lower interest and more negative attitudes towards statistics compared to males, whose attitudes are more positive (Gao et al., 2020; Kucuk & Sisman., 2020). Yu & Deng (2022) found that female students in a statistics course reported significantly lower levels of motivation and self-efficacy in statistics learning than male students. Similarly, a study by Keng (2020), found that female students in a psychology statistics course reported more negative attitudes towards statistics than male students. Several factors can contribute to female students' negative attitudes towards statistics. One of the most commonly cited factors is stereotype threat (Barber, 2020). Stereotype threat occurs when individuals are aware of negative stereotypes associated with their group and feel pressure to conform to those stereotypes. In the case of female statistics teacher candidates, they may be aware of the stereotype that women are not as good at math as men. This can create anxiety and decrease their motivation to study statistics classes.

Huh (2020), female preservice teachers tend to view statistics as relevant to business and social sciences, while male preservice teachers tend to view statistics as relevant to science and engineering. Perceptions of statistics as less relevant to their interests and future careers may also contribute to decreased motivation to learn and negative attitudes toward statistics. Although there has been extensive research on attitudes toward statistics, the domain of attitudes is poorly understood, and some areas may have evolved as a result of improvements in course delivery.

In addition, students' attitudes towards statistics were conducted at the university level, and only a few focused on prospective elementary school teachers. Guillen-Gamez et al. (2020), that prospective elementary school teachers have a moderate attitude towards statistics, when comparing the attitudes of prospective elementary school teachers about statistics Chang et al. (2020), found out that both groups have moderate or positive attitudes. In-service teachers better understand the importance of statistics in everyday life, while prospective teachers tend to think about using statistics in their lessons and find them more interesting and easier to learn. Tatto et al. (2020) Conceptual knowledge and attitudes toward statistics for prospective secondary school mathematics teachers recognize that statistics requires discipline and is not something that can be learned quickly by everyone. In exploring the attitudes of prospective primary school teachers toward statistics. They attributed these positive attitudes to a variety of reasons including class size, the level of statistical concepts covered, the use of hands-on experiments when teaching and learning, and the discipline applied by students with the SATS-36 method (Cladera, 2021).

To ensure all students' knowledge, attitudes, skills, and values, it is necessary to review the curriculum to ensure it is aligned with the National objectives. The transition from a Knowledge-Based Curriculum to a Competency-Based Curriculum, as well as the reactivation of the mission given to pre-service teacher training institutions to produce quality teachers, is a major change in the education system. Pre-service primary school teachers are trained at Teacher Training Colleges (TTC) with the ultimate goal of transforming Indonesia from an agricultural-based economy to a knowledge-based economy. With the new curriculum, new

content is introduced. Interestingly, the concepts of statistics and probability previously taught at the advanced level are now introduced to primary education within the Competency Curriculum framework. Since teacher training colleges are mandated to train reserve teachers for the primary school level, it is important to examine the extent to which pre-service teachers understand the new subjects introduced at the primary school level. The mathematics syllabus at all levels of primary education consists of units, and from primary school, there are four statistics units at each learning level (Lu, 2023). This means that this is not the first time these students have studied statistics. However, there are still many prospective teachers whose final exam scores held at the end of their professional education are still in the low category (Huang et al., 2020).

The gender gap in attitudes toward statistics among pre-service mathematics teachers is a pressing issue in mathematics education. This study provides in-depth information on the differences in attitudes between male and female pre-service teachers toward statistics. This study can provide valuable insights for the development of more inclusive curricula and learning strategies. The urgency of this study lies in the importance of understanding the factors that influence attitudes toward statistics among pre-service teachers because positive attitudes toward the subject can improve the quality of mathematics teaching and learning. By highlighting the gender gap in attitudes toward statistics, educators can design more effective training programs to increase pre-service mathematics teachers' interest and motivation to learn, especially in the field of statistics. With the development of theories on the factors that influence attitudes toward statistics, educational institutions can develop more targeted strategies to address the fact that female pre-service teachers' anxiety is high. Therefore, the purpose of this study is to analyze the differences in attitudes toward statistics among pre-service teachers based on gender and to identify the factors that influence these attitudes. The main questions in this study are how do the attitude of male and female pre-service teachers differ toward statistics and what factors can influence pre-service teachers' attitudes toward statistics.

B. METHODS

The research method used is quantitative with a survey approach. The Knowledge-Based Curriculum (KBC) education system is replaced with the Competency-Based Curriculum (KBC) to align with the national education goals in Indonesia, especially in ensuring that the knowledge, abilities, attitudes, and values of prospective mathematics teachers are in line with the needs of 21st-century developments (Supriadi et al., 2020). With this reform, the mathematics curriculum for elementary and secondary levels has been added to the education curriculum in Indonesia. The concepts of statistics and probability, which were previously taught at the advanced level, are now taught from elementary school to higher education (Batanero & Álvarez-Arroyo, 2023). In the New CBC, the teaching and learning process of statistics material emphasizes the integration of ICT and the use of real data. However, research conducted on the performance of prospective mathematics teachers in statistics found that prospective teachers performed poorly in statistics courses (Valtonen et al., 2021). In statistics learning there is one material for each level of education starting from elementary school in the new KBK that needs to be understood. It was also found that third-grade mathematics teachers

to the first grade of elementary school showed a lower level of knowledge in statistics (Yi et al., 2020; Backfisch et al., 2020). The attitude of prospective mathematics teachers has been identified as one of the factors that have an impact on influencing their performance when they enter the field. The location and sample of this research were conducted in Jakarta-Indonesia in the 2022-2023 academic year to a sample of 395 prospective teachers from a population of 18 higher education institutions spread across Jakarta-Indonesia that provide education for prospective mathematics teachers. A sample of 395 prospective teachers was selected randomly without considering the order and background of student abilities. Participants ranged from first-year students to four senior students in the current 6-3-3-4 system with positions that will teach in Elementary Schools, Middle Schools, High Schools, and University Undergraduates. TTC is part of an advanced level that specializes in elementary school teacher training and there are currently 18 TTCs located throughout Jakarta-Indonesia.

The data collection technique in this study used the Attitudes Towards Statistics (SATS-36) survey instrument developed by (Filiz et al., 2020). In SATS-36 30 items are grouped into 6 factor sections. This factor assesses the attitude of prospective mathematics teachers of affect, cognitive ability, value, difficulty, interest, and effort components. This item was assessed by 395 people with a Likert scale from point 1 to point 5 points, from strongly disagree to strongly agree. Before preparing the instrument, items were developed and validated by experts. The survey in the study was poured into Google with a link and shared with respondents via email and WhatsApp. Data interpretation was carried out on the attitudes of students as prospective teachers towards statistics courses, with a positive score of 4.50-7.00, a neutral score of 3.50-4.49, and a negative score of 0.00-3.49.

The data analysis technique uses descriptive statistics with the help of SPSS Version 25.0 to calculate the mean, standard deviation, and standard deviation and use the SATS-36 model Filiz et al. (2020) to see the attitudes of prospective mathematics education teachers in statistics. Validity and reliability tests include confirmatory component analysis and Cronbach's alpha. Reliability and validity were assessed using Cronbach's alpha, initial confirmatory factor analysis (CFA), and confirmatory factor analysis. Exploratory factor analysis was conducted to identify a new model because the appropriate model for confirmatory factor analysis could not produce a good fit for SATS-36 Shau. Vermak rotation technique, exploratory factor analysis (EFA). Independent sample T-test was used to test whether there was a statistically significant difference in the attitudes of prospective teachers between genders Wakhata et al. (2023) applied to improve factor interpretation. This study first investigated CFA for SATS-36 before turning to EFA. To assess the reliability and validity of the new, confirmatory factor analysis (CFA), Cronbach's alpha, and confirmatory factor analysis were used again. Due to the model fit for confirmatory factor analysis, SATS-36 Shau had an excellent fit. According to Bozek et al, (2023) the model was assessed using three different model fit metrics. The Bandler-Bonett Non-normed Fit Index (NNFI) is a relative fit index. The Absolute Fit Indices are the Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error Approximation (RMSEA). Due to the high sample size and the rarity of obtaining a non-significant chi-square for large samples, the chi-square was not used (Uğurlu et al., 2020). Literature Dash & Paul (2021) that the proper model fit is at

a value greater than 0.88 for NNFI, less than 0.06 for RMSEA, less than 0.08 for SRMR, more than 0.90 for GFI, and more than 0.88 for CFI.

C. RESULT AND DISCUSSION

Using SATS-36 Schau, this study examined the attitudes of prospective mathematics teachers in statistical statistics lessons. The results of CFA and all other model fit metrics used to assess model fit for SATS-36 indicate that a good model is built from the data in creating a new model that is superior and eliminates doubts, EFA must be completed. The Goodness of Fit Index for the new model of 30 items with four variables and SATS-36 Schau are shown in Table 1.

Table 1. Fit Indicators for the New Model and SATS-36 Schau

Fit Index Measures	SATS-36 (Six factors)	The new model (Four Factors)
Bandler-Bonett NFFI	0.69	0.88
RMSEA	0.067	0.063
SUMMER	0. 234	0.068
GFI	0.68	0.85
CFI	0.97	0.88

The results of Table 1 show that, for the SATS-36, no fit index yielded values close to the cutoff, while for the new model, only one Bandler-Bonett fit index NFFI yielded a value. In addition, the fit indices for the new four-factor model showed significant improvement over the six-factor model. Competence, value, difficulty, and interest were the four attitude components included in the new model. The effect and effort components were moved to other components or removed altogether. Table 2 shows the factor loadings, factor structure, convergent validity, and reliability of the revised model. The overall Cronbach's alpha of the new model was 0.906.

Table 2. Factor structure, factor loadings, and Cronbach's Alpha

Factor	Item	Factor Loading	Cronbach's Alpha
Competence	I like statistics (affect).	0.921	0.857
	I use statistics in my everyday life (values).	0.864	
	Statistics should be a required part of my professional Training (values).	0.825	
	Statistics conclusions are rarely presented in Everyday Life.	0.821	
	I can learn statistics (values).	0.832	
	I will understand statistics equations.	0.801	
	Most people have to learn a new way of thinking to do statistics (difficulty)	0.698	
	I plan to complete all of my statistics assignments (Effort)	0.722	
	I plan to study hard for every statistics test (Effort)	0.635	
Values	Statistics is worthy	0.789	0.918
	Statistics is useful to my typical professional	0.902	
	Statistical thinking is applicable in my life outside my job	0.799	
	I will have applications for statistics in my profession	0.803	
	Statistics is relevant in my life	0.689	
Difficulty	I will make a lot of math errors in statistics (Cognitive).	0.785	0.931
	I will find it difficult to understand statistical concepts (Cognitive).	0.675	
	Statistics involves massive computations.	0.821	
	Statistics is not a complicated subject	0.687	
	Statistics formulas are easy to understand	0.751	

Factor	Item	Factor	Cronbach's
Interest	I am interested in being able to communicate Statistical information to others.	0.819	0.726
	I am interested in using statistics	0.905	
	I am interested in understanding statistical information	0.668	
	I am interested in learning statistics	0.789	
	Statistical skills will make me more employable (Value)	0.839	
	I will enjoy taking statistics courses (affect)	0.799	

The term in the brackets indicates the components where the item belongs in Schau's model. The items that were excluded include:

1. I feel not intimidated when I have to do statistics problems (item 7,8 dan 9)
2. I will get frustrated going over statistics tests in class (items 13, 15, and 16)
3. I will be under stress during statistics class (items 14, 17,18 dan 19)
4. I will enjoy taking statistics courses (items 11, 12, 14)
5. I am scared by statistics (items 22, 23, 24, 25, 26)
6. I will have trouble understanding statistics because of how I think (items 1, 2, 3)
7. I will have no idea of what's going on in this statistics course (item 18)
8. Statistics is a subject quickly learned by most people (items 27, 28, 29,30)
9. Learning statistics requires a great deal of discipline (items 4, 5, 6).
10. Statistics is highly technical (item 21, 10)
11. I plan to attend every statistics class session (item 20)

Four components of prospective teacher attitudes toward statistical analysis and their results are shown in Table 3.

Table 3. Attitudes of Prospective Teachers Based on New Model Components

Components	Gender	N	Mean	Std. Deviation	Std. Error	t	df	Independent T-test	Effect Size
Overall	Female	148	6.19	0.8231	0.0679				
	Male	247	6.34	0.9853	0.0547				
Competence	Overall	395	6.12	0.9883	0.0789	3.541	309.533	0.011	0.021
	Female	148	6.09	0.772	0.0567				
	Male	247	6.21	0.9891	0.0635				
Values	Overall	395	6.31	0.7234	0.0715	3.891	289.241	0.002	0.005
	Female	148	6.19	0.9951	0.0645				
	Male	247	6.31	0.8780	0.0579				
Difficulty	Overall	395	6.50	0.8721	0.0623	3.298	299.479	0.003	0.003
	Female	148	6.08	0.7690	0.0622				
	Male	247	6.08	0.8921	0.0570				
Interest	Overall	395	5.25	0.8921	0.0633	2.225	236.451	0.121	0.041
	Female	148	5.67	0.9901	0.0661				
	Male	247	5.19	0.8921	0.0678				

Table 3 above shows that prospective teachers have good attitudes towards all aspects of the new model, with difficulty having the least positive attitude, while their attitudes are the same in other aspects. The fact that these prospective teachers have previously studied statistics in elementary school to high school that is the reason for being positive. In the independent T-test, it was found that there were statistically significant differences in the

attitudes of male and female prospective teachers for the components of competence, value, and interest. There was no statistically significant variation in the attitudes of both sexes regarding the component of difficulty. However, in all categories, women showed slightly more positive sentiments than men.

It was found in this study that in general, prospective mathematics teachers seemed to have positive attitudes towards statistics. However, it was found that women were less positive than men. In higher education, it is very important to understand how gender can influence one's attitude towards statistics lessons. This study provides information and insight into how factors such as gender can influence views and attitudes towards certain subjects, such as statistics. These findings help educators in developing more inclusive and effective curricula and teacher education programs, regardless of gender. In addition, this study also highlights the importance of developing a curriculum that integrates statistical applications in real implementation with innovative teaching methods. By showing the relevance and appeal of educators to statistics through a more interactive and applicable approach. Teacher education programs can create a culture of appreciation and enthusiasm for statistics among prospective teachers in Jakarta-Indonesia. This study examines the attitudes of prospective teachers toward statistics using an attitude survey instrument towards statistics adapted from Schlau. Since this model is designed for undergraduate students, this study first investigates the validity and reliability of the model using EFA in the Jakarta-Indonesia context for prospective elementary school mathematics teachers. The modified model was obtained with 30 items grouped into four factors. CFA validated the modified four-factor model and the threshold of the model fit index indicated that the model could be considered acceptable. The four-factor model was obtained by many researchers (Morean & Bold, 2022; Zakariya & Barattucci, 2022). Rodríguez-Hernández et al. (2020) adapt the SATS to their field, although some elements may come from other components, such as comprehension, understanding attitude, and diverse knowledge. The modified four-factor model was used to assess the attitudes of prospective teachers. Prospective teachers had favorable opinions about statistics for each of the four components of the new model. The findings of the current study are in line with other studies that have shown favorable perspectives on tolerance (García-Castro et al., 2020; Sokal et al., 2020). The influence of gender was also tested and the results showed differences in attitudes between boys and girls. In contrast to other studies by da Costa et al. (2023) that females tend to have slightly more positive attitudes than males, this study found that female students had slightly positive attitudes toward all four components of the modified model.

The implications of this study are a better understanding of how gender differences may influence attitudes toward statistics lessons. By understanding these differences in attitudes, a more inclusive and supportive learning approach can be developed for all pre-service teachers to feel comfortable and motivated in learning statistics. In addition, this study also provides insight into factors that influence attitudes toward statistics lessons, which can be the basis for designing more effective training programs for pre-service teachers. However, this study also has limitations. One is that it focuses on pre-service teachers in Jakarta only, which may limit the findings to the overall population of pre-service teachers in Indonesia. In addition, the use of questionnaires as a data collection tool may not be able to capture the deeper nuances and contexts of attitudes toward statistics lessons. Furthermore, this study did not explore cultural

and social factors that may also influence attitudes toward statistics among pre-service teachers. Therefore, it is recommended that future studies involve larger samples and use mixed research methods to better understand the factors that influence pre-service mathematics teachers' attitudes toward statistics.

D. CONCLUSION AND SUGGESTIONS

The conclusion of this study is the attitude gap between genders of prospective teachers towards statistics in statistical materials. It was found that there was a significant difference between male and female prospective teachers. Female attitudes were more positive towards statistics than males in various components. This highlights the importance of considering gender as an important factor in shaping attitudes toward statistical materials among prospective teachers. The findings of this study emphasize the need for interventions and strategies to address gender differences in attitudes toward statistics. The findings of this study provide suggestions for improving prospective teachers attitudes toward statistics in mathematics education by improving training programs. This study also recommends additional support and resources tailored to the needs of prospective teachers. In addition, professional development opportunities to improve positive attitudes toward statistics should be offered to prospective teachers. These programs can be in the form of workshops, seminars, and training sessions aimed at building confidence and competence in statistical concepts or with the help of further research.

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