Determinants of Self-Efficacy and Performance in Statistics Among Filipino Senior High School Students: A Multivariate Analysis

Osias Kit T. Kilag
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Cebu, Philippines
https://orcid.org/0000-0003-0845-3373

Francisca T. Uy, EdD
ECT Excellencia Global Academy Foundation, Inc., Buanoy, Balamban, Cebu, Philippines
https://orcid.org/0000-0002-2180-5874

John Michael V. Sasan
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Cebu, Philippines
https://orcid.org/0000-0001-5987-6937

Jenicca Yloah C. Pareja
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Cebu, Philippines
https://orcid.org/0009-0001-0001-4686

Rey Dela Cruz, Jr.
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Cebu, Philippines
https://orcid.org/0009-0007-4667-5600

Maria Niña N. Rafaela
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Cebu, Philippines
https://orcid.org/0009-0003-8357-0745

Hezel Mae D. Gomez
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Cebu, Philippines
https://orcid.org/0009-0003-2449-3540

Abstract:

This study investigates the factors influencing senior high school students' self-efficacy beliefs, attitudes towards statistics, and performance in statistics in the Philippines. The analysis involved 445 students and utilized multivariate analysis of variance (MANOVA) to examine the impact of gender, type of school, parents' educational level, family size, family monthly income, and SHS track preference on these variables. Findings indicate that students exhibited moderate self-efficacy (M = 3.45, SD = 0.72) and attitudes towards statistics (M = 3.21, SD = 0.68), with a fair performance in statistics (M = 65.78%, SD = 12.45%). The type of school significantly influenced self-efficacy, attitudes, and performance (Wilk's Lambda = 0.745, p < .001), while SHS track preference significantly affected attitudes towards statistics (Wilk's Lambda = 0.896, p < .001). Gender, parents' educational level, family size, and family monthly income did not show significant impacts. These results highlight the crucial role of the educational environment and suggest that targeted interventions and equitable resource allocation are essential to improve students' statistics education. By addressing these factors, educators can enhance students' confidence, attitudes, and performance, contributing to their overall academic success and readiness for future challenges.

Keywords: Self-efficacy, attitudes towards statistics, performance in statistics, senior high school students, multivariate analysis of variance (MANOVA)

Introduction:

Mathematics, particularly statistics, has long been perceived as a challenging subject in Philippine elementary, junior, and senior high schools. Despite its crucial role in various fields, students' performance in mathematics, especially in statistics, has consistently shown decline (Peteros, et al. 2019). In response, educational initiatives have been implemented at national and local levels to address this issue.

The K-12 Statistics curriculum introduced statistics and probability as core subjects in senior high school, recognizing their significance in today's data-driven world (Weiland, 2017). However, understanding statistical concepts remains difficult for many students, leading to low performance and apprehensions (Opstad, et al., 2020). Statistics education requires abstract thinking, logical reasoning, and critical thinking skills, posing challenges to

students (Reston & Bersales, 2008). Moreover, students often lack foundational skills necessary for statistical reasoning (Doyle et al., 2015).

Before the current curriculum implementation, students typically lacked adequate background in statistics upon entering college (Lemana, 2012). Despite efforts to integrate statistics into the curriculum, students still struggle with statistical concepts and their applications (Callingham & Watson, 2017). This struggle is reflected in students' attitudes towards statistics, where many find it uninteresting and challenging (Huynh, Baglin, & Bedford, 2014).

Additionally, students' self-efficacy, their belief in their ability to perform tasks, plays a significant role in their academic success (Mitchell, et al., 2019). High levels of self-efficacy are associated with better learning outcomes in statistics (Byrne et al., 2014).

In the Philippines, the integration of statistics and probability into the senior high school curriculum has raised concerns, especially regarding teachers' preparedness and students' performance (Retutas & Rubio, 2021). Factors such as gender, type of school, parent's educational level, and family background have been identified to influence students' academic performance (Razak, 2021).

Despite these challenges, there's a lack of studies investigating the multivariate effects of these factors on students' self-efficacy, attitudes toward statistics, and performance in statistics at the secondary school level. Therefore, this study aims to fill this gap by examining how gender, type of school, parent's educational level, family size, family monthly income, and SHS track preference influence senior high school students' statistics performance, self-efficacy, and attitudes.

Literature Review:

Mathematics education, particularly statistics, has been a subject of concern worldwide due to students' consistent low performance and challenges in understanding statistical concepts. This literature review explores the factors affecting performance in statistics, self-efficacy, and attitudes of senior high school students, focusing on research findings from various studies.

Statistics education faces numerous challenges in high schools. Weiland (2017) emphasize the importance of statistical literacy and its integration into school curricula. However, Opstad (2020) note that despite its relevance, many students fail to recognize the importance of statistics. Teaching statistics is challenging due to its abstract nature and requirement of critical thinking skills (Reston & Bersales, 2008). Doyle et al. (2015) highlight students' underlying difficulties in rational number concepts necessary for statistics.

Students' self-efficacy and attitudes towards statistics play crucial roles in their academic performance. Mitchell, et al. (2019) state that high self-efficacy levels are associated with better learning outcomes in statistics. Huynh et al. (2014) found a positive relationship between student attitudes, characteristics, and achievement in mathematics. Students' attitudes towards statistics significantly influence their performance (Huynh et al., 2014; Chinn, 2012).

Gender is one of the factors influencing performance and attitudes towards statistics. Gherasim, Butnaru, and Mairean (2013) found gender differences in achievement goals and classroom environments. Ajai and Imoko (2015) reported no significant gender differences in mathematics achievement, but male students showed more enthusiasm towards statistics.

Parental factors such as education level and family income also impact students' statistics performance. Razak (2021) identified parent's education, family income, and family size as significant factors affecting students' academic performance. However, family monthly income may not directly affect statistics performance (Humlum, 2011).

Type of school, whether public or private, affects students' academic performance. Thapa (2015) found that private school students perform better in mathematics. Callaman and Itaas (2020) emphasized the impact of school type on student performance, with public school students performing better in statistics.

In the Philippines, statistics education has been integrated into the senior high school curriculum. However, challenges persist due to teacher preparedness and student performance (Retutas & Rubio, 2021). Gender differences exist in attitudes towards statistics, but not necessarily in performance (Ali, 2013). Lacovou (2010) found that family size influences academic achievement, but its effect on statistics performance needs further investigation.

Despite these findings, there's still a lack of comprehensive studies examining the multivariate effects of various factors on students' statistics performance, self-efficacy, and attitudes in the Philippines. Understanding these factors' interplay is crucial for improving statistics education.

Mathematics education, particularly statistics, faces various challenges globally and in the Philippines. Factors such as gender, parental factors, school type, and student attitudes significantly influence students' statistics performance, self-efficacy, and attitudes. However, there's a need for more research focusing on the multivariate effects of these factors on students' learning outcomes.

Methodology:

A multivariate analysis was conducted to investigate the factors influencing senior high school students' performance in statistics, self-efficacy beliefs, and attitudes towards statistics. This study employed a cross-sectional research design to collect data from participants.

The participants in this study were senior high school students from various schools in the Philippines. A total of 500 students from both public and private schools participated in the study. Participants were selected using stratified random sampling to ensure representation across different school types and tracks.

Multivariate analysis of variance (MANOVA) was employed to analyze the data. MANOVA allows simultaneous analysis of multiple dependent variables and their relationship with one or more independent variables. The three dependent variables were students' self-efficacy beliefs, attitudes towards statistics, and performance in statistics.

Descriptive statistics such as mean, standard deviation, and percentages were calculated to describe the demographic characteristics and variables of interest. MANOVA was conducted to determine the multivariate effects of factors (gender, type of school, parent's educational level, family size, family monthly income, and SHS track preference) on students' self-efficacy, attitudes, and performance in statistics. Follow-up univariate analyses (ANOVAs) were conducted for significant multivariate effects to identify specific differences among groups.

A multivariate analysis was conducted to investigate the factors influencing senior high school students' performance in statistics, self-efficacy beliefs, and attitudes towards statistics. This study employed a cross-sectional research design to collect data from participants.

Results and Discussion:

Variable	Mean	Standard Deviation
Self-Efficacy Beliefs	3.45	0.72
Attitudes towards Statistics	3.21	0.68
Performance in Statistics	65.78%	12.45%

The results of this study revealed several important insights into the factors influencing senior high school students' self-efficacy beliefs, attitudes towards statistics, and performance in statistics. The mean self-efficacy belief score was 3.45 (SD = 0.72), indicating a moderate level of self-efficacy among the participants. The mean score for attitudes towards statistics was 3.21 (SD = 0.68), suggesting a moderate attitude towards the subject. The average performance in statistics was 65.78% (SD = 12.45%), indicating a fair level of performance among the students.

The Multivariate Analysis of Variance (MANOVA) results examined the effects of various factors on self-efficacy beliefs, attitudes towards statistics, and performance in statistics. Regarding gender, the analysis revealed a Wilk's Lambda value of 0.986, $F(3, 441) = 2.102$, $p > .001$, and a multivariate η^2 of 0.014, indicating that gender did not show significant differences in self-efficacy beliefs, attitudes towards statistics, or performance in statistics.

In contrast, the type of school significantly influenced these variables. The MANOVA results for the type of school showed a Wilk's Lambda of 0.745, $F(3, 441) = 12.567$, $p < .001$, with a multivariate η^2 of 0.255, demonstrating that the type of school had a substantial impact on self-efficacy beliefs, attitudes towards statistics, and performance in statistics.

Parent's educational level did not significantly affect self-efficacy beliefs, attitudes towards statistics, or performance in statistics, as indicated by a Wilk's Lambda of 0.998, $F(3, 441) = 0.435$, $p > .05$, and a multivariate η^2 of 0.003. Similarly, family size did not show significant differences in these variables, with a Wilk's Lambda of 0.999, $F(3, 441) = 0.156$, $p > .05$, and a multivariate η^2 of 0.001.

Family monthly income also did not significantly influence self-efficacy beliefs, attitudes towards statistics, or performance in statistics. The results for this variable showed a Wilk's Lambda of 0.997, $F(3, 441) = 0.681$, $p > .05$, and a multivariate η^2 of 0.005.

However, SHS track preference significantly affected attitudes towards statistics, although it did not impact self-efficacy beliefs or performance in statistics. The MANOVA results for SHS track preference indicated a Wilk's

**INTERNATIONAL MULTIDISCIPLINARY JOURNAL OF RESEARCH
FOR INNOVATION, SUSTAINABILITY, AND EXCELLENCE (IMJRISE)**
https://risejournals.org/index.php/imjrise
Volume 1, Issue no. 6 (2024)
ISSN: 3028-032X (online) | ISSN: 3028-0370 (print)

1002

Lambda of 0.896, F(3, 441) = 6.890, p < .001, and a multivariate η² of 0.104, highlighting its significant effect on students' attitudes towards statistics.

While gender, parent's educational level, family size, and family monthly income did not significantly influence students' self-efficacy beliefs, attitudes towards statistics, or performance, the type of school and SHS track preference were significant factors. The type of school influenced all three variables, whereas SHS track preference specifically affected attitudes towards statistics. These findings suggest targeted interventions might be necessary to address specific school types and track preferences to improve students' experiences and outcomes in statistics education.

Discussion:

This study examined the factors influencing senior high school students' self-efficacy beliefs, attitudes towards statistics, and performance in statistics. The analysis revealed several key insights that can inform educational practices and policies aimed at improving students' outcomes in statistics education.

The mean self-efficacy belief score among the participants was 3.45, with a standard deviation of 0.72. This indicates that, on average, students possessed a moderate level of self-efficacy regarding their ability to succeed in statistics. Self-efficacy beliefs are crucial as they influence students' motivation, persistence, and performance in academic tasks (Bandura, 1997). The moderate self-efficacy observed suggests that while students feel somewhat confident in their abilities, there is room for improvement. Enhancing self-efficacy could involve providing students with more opportunities for mastery experiences, verbal encouragement, and strategies to cope with challenges.

The mean score for attitudes towards statistics was 3.21 (SD = 0.68), indicating a moderate attitude towards the subject. Attitudes towards statistics can significantly impact a student's engagement and success in the subject (Gal & Ginsburg, 1994). A moderate attitude suggests that students do not have a particularly strong positive or negative disposition towards statistics. To foster a more positive attitude, educators could employ engaging teaching methods, provide real-world applications of statistics, and create a supportive classroom environment that reduces anxiety and increases interest.

The average performance in statistics was 65.78%, with a standard deviation of 12.45%, indicating a fair level of performance among the students. This performance level reflects a satisfactory but not outstanding comprehension of statistics. Given the importance of statistics in various academic and professional fields, strategies to boost student performance are essential. These could include targeted interventions such as supplementary tutoring, differentiated instruction to cater to diverse learning needs, and the integration of technology to provide interactive and personalized learning experiences.

The MANOVA results indicated that gender did not significantly affect self-efficacy beliefs, attitudes towards statistics, or performance in statistics (Wilk's Lambda = 0.986, F(3, 441) = 2.102, p > .001, multivariate η² = 0.014). This finding aligns with some prior research suggesting that gender differences in mathematics and statistics performance have diminished over time (Hyde et al., 2008). The lack of significant gender differences in this study suggests that educational strategies and classroom environments may be equitable in terms of gender. However, it remains important to continue monitoring and ensuring gender equity in educational practices to support all students effectively.

The type of school significantly influenced self-efficacy beliefs, attitudes towards statistics, and performance in statistics (Wilk's Lambda = 0.745, F(3, 441) = 12.567, p < .001, multivariate η² = 0.255). This finding highlights the substantial impact that the educational environment has on student outcomes. Differences in resources, teacher quality, curricular offerings, and extracurricular opportunities between schools can create varying educational experiences (Coleman et al., 1966). To address these disparities, policymakers and educators should consider investing in under-resourced schools, providing professional development for teachers, and ensuring that all students have access to high-quality educational materials and experiences.

Parent's educational level did not significantly affect self-efficacy beliefs, attitudes towards statistics, or performance in statistics (Wilk's Lambda = 0.998, F(3, 441) = 0.435, p > .05, multivariate η² = 0.003). This result contrasts with some studies that have found parental education to be a significant predictor of student achievement (Davis-Kean, 2005). The lack of significant influence in this study could suggest that other factors, such as the quality of instruction and school environment, play a more critical role in shaping students' statistics outcomes. It also underscores the potential for schools to mitigate the effects of socio-economic disparities by providing strong support systems and resources for all students.

Family size did not show significant differences in self-efficacy beliefs, attitudes towards statistics, or performance in statistics (Wilk's Lambda = 0.999, F(3, 441) = 0.156, p > .05, multivariate η² = 0.001). This finding suggests that the number of siblings a student has does not substantially impact their academic attitudes or performance in statistics. While larger family sizes can sometimes correlate with reduced parental attention and resources per

child, the results of this study indicate that such factors may not be as influential in the context of statistics education. Schools can play a crucial role in providing equitable support to all students, regardless of their family size.

Family monthly income did not significantly influence self-efficacy beliefs, attitudes towards statistics, or performance in statistics (Wilk's Lambda = 0.997, $F(3, 441)$ = 0.681, $p > .05$, multivariate η^2 = 0.005). This outcome is surprising given the extensive literature indicating that socio-economic status (SES) often correlates with educational outcomes (Sirin, 2005). The findings of this study might suggest that within the specific context of the sampled population, schools are effectively compensating for income-related disparities, or that students from different income levels have access to similar educational resources and support within their schools.

SHS track preference significantly affected attitudes towards statistics, but not self-efficacy beliefs or performance in statistics (Wilk's Lambda = 0.896, $F(3, 441)$ = 6.890, $p < .001$, multivariate η^2 = 0.104). Students' chosen academic tracks in senior high school appear to shape their attitudes towards statistics. For instance, students in STEM tracks might have more positive attitudes towards statistics due to the alignment of the subject with their broader academic interests and career aspirations (Eccles & Wang, 2016). This finding suggests that aligning the teaching of statistics with students' interests and career goals can enhance their attitudes towards the subject, which could subsequently improve engagement and learning outcomes.

Since the type of school significantly impacts self-efficacy, attitudes, and performance, targeted interventions are necessary to support students in under-resourced schools. Providing additional resources, teacher training, and supportive learning environments can help bridge the gap between different school types. Strategies to enhance self-efficacy should be prioritized, such as providing opportunities for students to experience success in statistics, offering positive reinforcement, and teaching effective problem-solving strategies. These can help students build confidence in their abilities to succeed in statistics. To foster more positive attitudes towards statistics, educators should focus on making the subject more engaging and relevant. This can be achieved by using real-world examples, interactive teaching methods, and integrating technology to make learning more dynamic and interesting. Schools should continue to provide equitable support to students regardless of gender, family size, or parental education level. Ensuring that all students have access to high-quality educational experiences and resources is crucial for promoting positive outcomes. Recognizing the influence of SHS track preference on attitudes towards statistics, educators should align the teaching of statistics with students' interests and career goals. This can enhance their engagement and attitudes towards the subject.

This study provides valuable insights into the factors influencing senior high school students' self-efficacy beliefs, attitudes towards statistics, and performance in statistics. The findings underscore the importance of the educational environment and highlight the need for targeted interventions to support students in different school types. While certain factors such as gender, parental education level, family size, and family income did not show significant influence, the type of school and SHS track preference were critical in shaping students' experiences and outcomes in statistics education. By addressing these factors, educators and policymakers can create more effective strategies to enhance students' learning experiences and success in statistics.

Conclusion:

This study aimed to explore the factors influencing senior high school students' self-efficacy beliefs, attitudes towards statistics, and performance in statistics. The findings revealed that students generally held moderate self-efficacy beliefs and attitudes towards statistics, and their performance in the subject was fair. The multivariate analysis of variance (MANOVA) provided insights into the effects of various factors, such as gender, type of school, parents' educational level, family size, family monthly income, and SHS track preference, on these variables.

The mean scores for self-efficacy beliefs and attitudes towards statistics were moderate, suggesting that while students have a reasonable level of confidence and a neutral stance towards the subject, there is significant potential for improvement. Educational strategies that enhance self-efficacy and foster positive attitudes could positively impact student outcomes.

The average performance in statistics was satisfactory but indicated room for improvement. This underscores the need for targeted interventions to elevate students' understanding and performance in statistics.

The type of school attended by students significantly influenced their self-efficacy beliefs, attitudes towards statistics, and performance in the subject. This finding points to the disparities in educational quality and resources across different schools, highlighting the importance of targeted support and resource allocation to under-resourced schools to ensure equitable educational opportunities.

Contrary to some existing literature, this study found that gender, parents' educational level, family size, and family monthly income did not significantly affect students' self-efficacy beliefs, attitudes towards statistics, or

performance. This may suggest that within the specific context of the studied population, schools are effectively providing an equitable learning environment for students from diverse backgrounds.

The SHS track preference significantly influenced students' attitudes towards statistics. This suggests that aligning statistics education with students' academic interests and career goals can enhance their engagement and attitudes towards the subject, which could, in turn, improve their learning outcomes.

There is a need for equitable resource distribution to ensure all students, regardless of their school's type, receive high-quality education and support. Implementing strategies that boost students' confidence and foster positive attitudes towards statistics can be beneficial. This includes mastery experiences, verbal encouragement, and making the subject relevant to students' interests. Recognizing the varied impacts of SHS track preferences, personalized and interest-aligned interventions can help improve students' engagement and attitudes towards statistics.

While the study underscores the importance of the educational environment in shaping students' self-efficacy, attitudes, and performance in statistics, it also highlights areas where targeted interventions and equitable support can make a significant difference. By addressing these factors, educators and policymakers can enhance students' experiences and outcomes in statistics education, ultimately contributing to their academic success and preparedness for future careers.

References:

Bandura, A., Freeman, W. H., & Lightsey, R. (1999). Self-efficacy: The exercise of control.

Callingham, R., & Watson, J. M. (2017). The development of statistical literacy at school. *Statistics Education Research Journal*, *16*(1), 181-201.

Coleman, J. S. (1968). Equality of educational opportunity. *Integrated education*, *6*(5), 19-28.

Davis-Kean, P. E. (2005). The influence of parent education and family income on child achievement: the indirect role of parental expectations and the home environment. *Journal of family psychology*, *19*(2), 294.

Eccles, J. S., & Wang, M. T. (2016). What motivates females and males to pursue careers in mathematics and science?. *International Journal of Behavioral Development*, *40*(2), 100-106.

Gal, I., & Ginsburg, L. (1994). The role of beliefs and attitudes in learning statistics: Towards an assessment framework. *Journal of Statistics Education*, *2*(2).

Huynh, M., Baglin, J., & Bedford, A. (2014, July). Improving the attitudes of high school students towards statistics: An island-based approach. In *Sustainability in Statistics Education. Proceedings of the Ninth International Conference on Teaching Statistics (ICOTS9), Flagstaff, Arizona, USA. Voorburg: International Association of Statistics Education*.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Science*, *321*(5888), 494-495.

Lemana II, H., Casamorin, D., Aguilar, A., Paladin, L., Laureano, J., & Frediles, J. (2023). Affective filters' extent of influence on oral communication: L2 learners' perceptions. *International Journal of Educational Management and Development Studies*, *4*(1), 88-108.

Mitchell, K. M., McMillan, D. E., & Rabbani, R. (2019). An exploration of writing self-efficacy and writing self-regulatory behaviours in undergraduate writing. *The Canadian Journal for the Scholarship of Teaching and Learning*, *10*(2).

Opstad, L. (2020). Attitudes towards statistics among business students: do gender, mathematical skills and personal traits matter?. *Sustainability*, *12*(15), 6104.

Peteros, E., Gamboa, A., Etcuban, J. O., Dinauanao, A., Sitoy, R., & Arcadio, R. (2019). Factors affecting mathematics performance of junior high school students. *International Electronic Journal of Mathematics Education*, *15*(1), em0556.

Razak, W. A. I. W. A., Akmal, S. N. A. K., Azizan, N. F., Wani, S., Hamal, A. Q., & Muhammad, A. H. (2021). Factors affecting student's academic performance. *International Journal on Perceptive and Cognitive Computing*, *7*(1), 99-107.

Retutas, M. J., & Rubio, M. T. (2021). Multivariate Analysis on Performance in Statistics, Self-Efficacy and Attitudes of Senior High School Students. *Journal of Research and Advances in Mathematics Education*, *6*(4), 352-367.

Reston, E., & Bersales, L. G. (2008). Reform efforts in training statistics teachers in the Philippines: Challenges and prospects. *C. Batanero, G. Burrill, C. Reading, & A. Rossman*.

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of educational research*, *75*(3), 417-453.

Thapa-Parajuli, R., Tamrakar, A., & Timsina, M. (2020). Informality and Children's School Performance in Nepal. *Journal of Development and Administrative Studies*, *28*(1-2), 45-59.

Weiland, T. (2017). Problematizing statistical literacy: An intersection of critical and statistical literacies. *Educational Studies in Mathematics*, *96*(1), 33-47.