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Graduate-Level Students' Statistical Skills in Bataan Peninsula State University: Assessment and Programmatic Recommendations

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ABSTRACT

The study determined the statistical skills of graduate students at the Bataan Peninsula State University from the Academic Year 2018 to 2022. In addition, the questionnaire was organized into sections. The first section focused on gathering the profiles of those who responded. This included the respondents' age, sex, and nature of work. The second part consisted of multiple-choice questions that determined the level of statistical skills in terms of statistical literacy and mathematical knowledge. The third part contained data visualization and presentation. The results show that the biggest percentage of respondents is in the age group of 22 to 27. Regarding their sex, more than half of the total respondents are female. Many respondents are in the teaching profession in line with their nature of work. Furthermore, the results have shown that the statistical skill with the highest rating is Mathematical Knowledge, followed by Statistical Literacy, and the indicator with the lowest rating is Data Visualization and Presentation. The evaluation suggests that those taking the survey should have basic statistical knowledge. Additionally, there's no connection between the respondents' statistical skills and their profiles. In connection with this, a program enhancement has been proposed based on the study's outcomes. The following recommendations were presented: Graduate School students should undergo training, seminars, and workshops to improve their statistics skills further.

INTRODUCTION

In today's data-driven society, the need for individuals to acquire and apply statistical skills has never been more critical. The dynamic and evolving landscape of global and national development, particularly in rapidly transforming countries like the Philippines, requires citizens to possess strong statistical competencies (Franklin *et al.,* 2007; Mittag, 2010). Statistical literacy, defined as the ability to interpret, critically evaluate, and communicate data-based information, is increasingly seen as a foundational skill across educational levels (Gal, 2002; Batanero & Díaz, 2010). As individuals are continually exposed to data in daily life, it becomes essential for education systems to equip learners with the necessary skills to analyze and make data-informed decisions.

Statistics education begins as early as elementary school and continues through higher education, including graduate programs (Franklin *et al.,* 2007). However, despite its curricular inclusion, evidence shows that learners often struggle with statistical reasoning, proportional thinking, and data interpretation (Hansen & Myers, 2012). In the Philippines, the integration of statistics within the K–12 curriculum has made strides, yet persistent gaps remain. Students frequently graduate from high school without a solid foundation in statistical concepts (Lemana, 2012), highlighting the need for reinforcement, especially in graduate-level programs where research competence is paramount.

Although the Commission on Higher Education (CHED) in the Philippines has issued policy mandates, such as Memorandum Order No. 15, s. 2019, which outlines the standards and expected learning outcomes for graduate education, there remains a pressing concern regarding the actual statistical competencies of graduate students in education-related fields. Reston (2005) revealed that graduate students in the Philippines performed poorly on statistical literacy assessments, underscoring a widespread deficiency in basic statistical knowledge, interpretive skills, and analytical reasoning. Furthermore, statistical literacy is a multifaceted construct encompassing not only statistical and mathematical knowledge but also literacy skills, contextual understanding, and the capacity for critical questioning (Gal, 2002).

Statistical anxiety further compounds the problem. Research suggests that learners' attitudes and perceived relevance of statistics significantly affect their performance (Siew *et al.,* 2019; Abd Jalal *et al.,* 2023). This is particularly evident among graduate students from non-quantitative backgrounds, where the lack of prior exposure and confidence creates a barrier to learning. While instructional methods such as technology-enhanced learning, student-centered pedagogy, and contextualized teaching have been recognized for their efficacy (Aziz & Rosli, 2021; Bilgin, 2021; Utari *et al.,* 2023), their implementation remains inconsistent.

Moreover, studies have demonstrated the critical role of attitudes and cognitive factors in developing statistical literacy (Callingham & Watson, 2017; Makwakwa *et al.,* 2023). Disparities in prior knowledge and learning experiences further widen the gap in proficiency

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(Pamungkas & Khaerunnisa, 2020; Santelices *et al.,* 2024), emphasizing the need for a deliberate approach to curriculum design and instructional delivery. In response, researchers advocate for intentional, context-based instruction that bridges foundational mathematical skills with real-world applications (Engel, 2017).

The study determined the statistical skills of students in the Master of Arts in Education (MAED) Mathematics program at Bataan Peninsula State University by evaluating the students' proficiency in statistical literacy and the gaps that hinders their academic and professional development. The findings served as the basis for developing targeted program enhancements, such as training modules, workshops, and curricular revisions that are aligned with CHED's standards for quality graduate education.

LITERATURE REVIEW

Advanced Higher Education is one of the most essential keys to addressing the reforms and difficulties of the twenty-first century. Daguplo *et al.* (2019) pointed out that graduate school has been considered one of the nation's most compassionate and active interventions for the upliftment of socio-economic status as well as combating poverty for a long time. Graduate education cultivates and develops the workforce, as well as helps in instilling and improving the values, knowledge, and skills required for society to have an individual who is a valuable and productive member. It all begins with the proper training and workshops to enhance and improve the skills. The Commission on Higher Education is pushing a well-grounded and research-based vision to enable colleges and universities to produce high-quality graduate students with advanced learning who acquire national development and international comparability. Different skills are needed, and one of the most essential skills is statistical skills.

Abd Jalal *et al.* (2023) found no significant correlation between attitude toward statistics and statistical literacy among education officials, though statistics fear negatively impacted literacy. Non-cognitive factors like attitudes likely contribute to statistical challenges, as effective instruction is key to building a statistically literate society. This highlights the need to address both pedagogical and psychological barriers in statistics education. The study of Pamungkas and Khaerunnisa (2020) analyzed the students' statistical literacy. The study results have shown different knowledge levels, such as students attained high prior knowledge while others were average. Furthermore, in terms of self-esteem in mathematics, most of the students have high self-esteem. Conversely, there is a notable distinction between the student's prior knowledge and statistical literacy. It was emphasized that since both are crucial to statistical literacy, students should make the most of them. Similarly, Aziz *et al.* (2021) emphasized that statistical literacy is vital for students to navigate data-driven decisions in modern society, making statistics education crucial at all academic levels. Their study found that learning environments, student attitudes, teaching methods, and prior knowledge significantly influence statistical literacy development. Among teacher-centered, student-centered, and materials-based instructional approaches, materials-based methods were most commonly used to enhance statistical literacy. These findings highlight the need for strategic teaching approaches to improve statistical comprehension and application in education.

Meanwhile, Siew *et al.* (2019) found that college students with low statistics anxiety often dismiss the subject as irrelevant to their daily lives or careers, while those with high anxiety attribute their struggles to perceived mathematical inadequacies. The study highlighted that low-anxiety students focus on external factors (e.g., perceived uselessness of statistics), whereas high-anxiety students blame internal factors (e.g., lack of math skills). The researchers suggested that effective interventions should challenge the misconception that strong math ability is essential for statistical success. Also, Tuktun (2019) asserted that statistics anxiety severely impairs graduate students' performance, particularly in social science programs where students often lack quantitative preparation, fostering negative attitudes toward statistics courses. These psychological barriers significantly compromise their academic success in required statistics coursework. Furthermore, Utomo (2021) revealed that while middle school students of all ability levels could understand statistical problems, low-ability students struggled with interpreting and managing data, showing inadequate literacy skills. Moderate-ability students demonstrated competent analysis, while high-ability students excelled at deeper causal reasoning, linking their strong mathematical skills to superior statistical literacy. These findings reveal significant skill disparities tied to mathematical proficiency, emphasizing the need for differentiated instruction to improve statistical literacy across ability levels.

According to Engel (2017), students are also required to have a strong foundation in mathematics and context, knowledge of basic statistics and the appropriate graphical and numerical techniques for data representation, the ability to think critically, and a willingness to conduct independent research. More than ever, it is imperative that citizens learn to evaluate media reports critically, recognize when data are abused, and understand practical solutions. Relatively, Tiro (2017) indicated that since statistics is a distinct field with ways of thinking and tools for problem-solving, it should be taught differently from mathematics in schools. Also, teachers who instruct students in statistical literacy and statistical thinking should encourage active learning to boost pupils' educational outcomes. According to Nahdi *et al.* (2021), Statistics is significant in many areas of human existence. Statistics are crucial in education for resolving issues during in-class learning activities. Thus, having statistical literacy abilities is vital for pre-service teachers. The capacity to understand data displayed in diagrams and tables, to offer data understandably, and to interpret the data accurately is an essential indicator of statistical literacy.

Furthermore, Syed and Choudhury (2023), comprehensively explained and assessed how assisting and enhancing certain employability skills increases the likelihood of obtaining entry-level occupations, a statistical analysis was conducted. According to the study, to develop employability skills, students combined traditional and student-centered learning pedagogies. The employability factors were "numeracy skills (mathematical)," "IT literacy skills," "decision making skills," "communication skills," "critical-analysis skills," "competence in specialized subject area," and "ability to apply specialized knowledge from various field," according to a statistical analysis of the students' responses. The relevance of interpersonal, problem-solving, and communication skills is frequently found in the literature, but the study's finding that "learning skills" are the second-most crucial employability skill is significant.

In the study of Amaran *et al.* (2022) it was revealed that statistical data analysis, a key quantitative skill, is essential for graduate students, particularly in scientific research, despite its perceived complexity. Their survey of 102 creative arts undergraduates at UNIMAS revealed a pressing need for statistical training to meet workforce demands and thesis requirements. While students recognized the advantages of these skills, the study emphasized that mere exposure to quantitative analysis is insufficient for true competency. The findings underscore the necessity of building a stronger foundational curriculum in statistical data analysis for arts students to bridge this critical skills gap.

Dangprasert's (2021) study examined the impact of combining tutoring applications with self-directed learning to enhance statistical analysis skills, revealing significantly higher posttest scores compared to pretest results. The findings confirmed that this blended approach effectively improved students' statistical abilities while accelerating their learning process. The results aligned with the law of exercise, showing that consistent practice and structured learning activities boosted engagement, preparation, and motivation for self-directed skill development. However, the study identified implementation challenges requiring careful management of digital resources, instructional materials, and pedagogical strategies. The research emphasized that both educators and learners need proper preparation with technological tools and teaching frameworks to fully optimize this learning methodology's potential.

MATERIALS AND METHODS

This descriptive study aimed to assess the statistical skills of students enrolled in the Master of Arts in Education major in Mathematics program at Bataan Peninsula State University. Descriptive research, as described by Tejero (2011), is used to describe and characterize phenomena without manipulating variables. The study employed a structured survey to collect data from 32 graduate students across four academic years (A.Y. 2018-2019 to A.Y. 2021-2022), selected through convenience sampling. The questionnaire, which consisted of three sections—respondent profiles (age, sex, nature of work), statistical literacy and mathematical knowledge, and data visualization and presentation—was developed by the researcher to assess the students' statistical skills. Responses were evaluated using a proficiency scale adapted from DepEd Order No. 73, S. 2012, categorizing the students' skills into five levels: Advanced, Proficient, Approaching Proficiency, Developing, and Beginning. Data were analyzed using IBM-SPSS Statistics 23, with frequency, percentage, and weighted mean used to summarize the respondents' profiles and overall statistical skills. Pearson's Product Moment Correlation Coefficient and Point-Biserial Correlation Coefficient were employed to examine relationships between variables such as age, sex, and nature of work with statistical proficiency. A significance level of 0.05 was applied to test hypotheses. The interpretation of results followed the established scales for both proficiency levels and correlation strength, ranging from negligible to high relationship.

RESULTS AND DISCUSSION

Profile of the Respondents

Thirty-four percent (34%) of the respondents were between the ages of 22 and 27. In addition, fifty-six percent (56%) are females and ninety-one percent (91%) are in the teaching profession.

Table 1: Profile of the Respondents

Profile	Frequency	Percentage
Age		
22 to 27 years old	11	34
28 to 33 years old	9	28
34 to 39 years old	7	22
40 years old and above	5	16
Total	32	100
Sex		
Male	14	44
Female	18	56
Total	32	100

Nature of Work		
Teaching	29	91
Non-teaching	3	9
Total	32	100
Number of cases=32		

Graduate Students' Statistical Skills: Gal's Concepts 2010

Scale of Means: 90% and above Advanced; 85-89% Proficient; 80-84% Approaching Proficiency; 75-79% Developing; 74% and below Beginning

Among the key areas of Statistical Skills, the highest rating is "Mathematical Knowledge" (Mean=65.63; sd=13.55; Beginning Level), followed by "Statistical Literacy" (Mean=62.44; sd=11.84; Beginning Level), and the lowest rating is "Data Visualization and Presentation" (Mean=42.59; sd=21.12; Beginning Level). Collectively, the rating (Mean=56.94; sd=12.34) suggests the respondents have a "Beginning Level of Statistical Skills." It can be inferred that the respondents demonstrate a strong foundation in mathematical knowledge, there is room for improvement in areas such as data visualization and presentation. Addressing these skills gaps through targeted training and professional development initiatives can enhance the statistical proficiency and empower individuals to effectively analyze and communicate data in different contexts.

Table 2: Level of Statistical Skills

Indicator	Mean	SD	Level
Statistical Literacy	62.44	11.84	Beginning Level
Mathematical Knowledge	65.63	13.55	Beginning Level
Data Visualization and Presentation	42.59	21.12	Beginning Level
Composite	56.94	12.34	Beginning Level

Furthermore, Kim *et al.* (2019) analyzed mathematics teachers' statistical literacy in Korea. The study's findings demonstrate that teachers' statistical literacy was lacking and it was likewise seen that there was a significant level of contrast between them. In line with this, the study suggests finding implications to see how important or appropriate it is to educate teachers who oversee statistical education.

As Abidin (2017) and Nurgiyantoro *et al.* (2020) mentioned, the multiliteracy approach should include statistical literate. to create essential educational plans. More innovations and teaching strategies should be used for teaching statistics. Furthermore, modern technology can help students increase their statistical reasoning and literacy. Moreover, Sharma (2019) highlighted the role of statistical literacy in everyday decision-making, from interpreting news reports to making health-related decisions, underscoring the need for education systems to prioritize this skill.

Relationship between the Level of Statistical Skills and the Respondents' Profiles

Table 3: Level of Statistical Skills and Profile

Level of Statistical Skills	Profile of the Respondents											
	Age				Sex				Nature of Work			
	r	R^2	p-value	Relationship	r_{pbi}	R^2	p-value	Relationship	r_{pbi}	R^2	p-value	Relationship
Statistical Literacy	.28^{ns}	.08	.115	Low	.10^{ns}	.01	.573	Negligible	.12^{ns}	.01	.525	Negligible
Mathematical Knowledge	.21^{ns}	.04	.254	Low	.37*	.14	.036	Low	-.06^{ns}	.01	.764	Negligible
Data Visualization and Presentation	.25^{ns}	.06	.160	Low	.10^{ns}	.01	.571	Negligible	.16^{ns}	.03	.379	Negligible
Overall	.32^{ns}	.10	.078	Low	.23^{ns}	.05	.197	Low	.11^{ns}	.01	.558	Negligible

Note: Point-Biserial Correlation Coefficient (r_{pbi}); Pearson's Product Moment Correlation Coefficient (r)

**–significant at 0.05 level; ns – not significant at 0.05 alpha level*

In Table 3, there is no statistically significant relationships between the respondents' profile variables and the variables of their Level of Statistical Skills, as indicated by p-values exceeding the conventional threshold of significance ($p > 0.05$). Specifically, correlation analyses between age and the sub-variables—Statistical Literacy ($r = .28$, $R^2 = 8\%$, $p = .115$), Mathematical Knowledge ($r = .21$, $R^2 = 4\%$, $p = .254$), and Data Visualization and Presentation ($r = .25$, $R^2 = 6\%$, $p = .160$)—indicated weak, non-significant associations.

Regarding sex as a profile variable, both Statistical Literacy ($r_{pbi} = .10$, $R^2 = 1\%$, $p = .573$) and Data Visualization and Presentation ($r_{pbi} = .10$, $R^2 = 1\%$, $p = .571$) demonstrated negligible associations. A notable exception, however, was observed for Mathematical Knowledge, which exhibited a statistically significant but low association with sex ($r_{pbi} = .37$, $R^2 = 14\%$, $p = .036$). This result suggests that male respondents performed better in mathematical knowledge compared to their female counterparts. While the effect size is modest, the finding aligns with existing literature indicating a persistent, albeit small, gender gap in mathematical performance (Johnson, 2017). Johnson's study reported consistent male advantage across a variety of mathematical performance metrics, with small to moderate effect sizes observed across different age groups and educational levels. Similarly, Gunderson *et al.* (2018) found that while male and female students generally demonstrate comparable statistical performance, males often report higher levels of self-confidence and interest in statistical tasks—factors which may contribute indirectly to performance outcomes.

Concerning the respondents' nature of work, all sub-variables of statistical skills showed negligible relationships: Statistical Literacy ($r_{pbi} = .12$, $R^2 = 1\%$, $p = .525$), Mathematical Knowledge ($r_{pbi} = -.06$, $R^2 = 1\%$, $p = .764$), and Data Visualization and Presentation ($r_{pbi} = .16$, $R^2 = 3\%$, $p = .379$). A summary correlation analysis further supports these findings, with the composite Level of Statistical Skills showing weak associations with Age ($r = .32$, $R^2 = 10\%$, $p = .078$), Sex ($r_{pbi} = .23$, $R^2 = 5\%$, $p = .197$), and Nature of Work ($r_{pbi} = .11$, $R^2 = 1\%$, $p = .558$). These results collectively indicate that demographic factors such as age, sex, and nature of work do not significantly influence graduate students' statistical skills.

Given the absence of strong or statistically significant associations, the demographic characteristics are not reliable predictors of statistical skill levels within the graduate school context. Consequently, interventions aimed at enhancing statistical competencies should adopt an inclusive approach, ensuring that support mechanisms, training programs, and learning opportunities are equitably accessible to all students, regardless of their demographic profile. Tailored programs such as statistical literacy workshops, mathematical skill enhancement modules, and data visualization seminars may be implemented to promote universal improvement, with an emphasis on fostering competence across diverse learner backgrounds.

CONCLUSION

Among the key areas of Statistical Skills, "Mathematical Knowledge" has the highest rating followed by "Statistical Literacy," while "Data Visualization and Presentation" has the lowest rating. Thus, the respondents have the beginning skills in statistical literacy, mathematical knowledge, data visualization, and presentation. Moreover, the statistical abilities of graduate students were found to have no significant relationship with their profile, such as sex, age, and nature of work. A comprehensive training program was implemented to improve understanding fundamental statistical concepts and principles. Moreover, it helps develop a strong foundation in mathematical knowledge and problem-solving skills essential for success in academic pursuits and future careers. The training program includes collaborative activities that will help uplift the competency level.

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