College of Teacher Education Students' Mastery of Statistical Concepts: Basis for Proposed Enhancement Program

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ABSTRACT

In the 21st century, data-driven decision-making in education requires statistical literacy. Underprepared teachers, high pupil-teacher ratios, and restricted resource access make statistical concepts challenging for students globally, including in the Philippines. This study aimed to assess the mastery level of statistical concepts among CTE students at Ramon Magsaysay Memorial Colleges (RMMC), identify the factors influencing their statistical mastery, and the challenges they faced in learning statistics. Using a descriptive-correlational survey design, data were collected from 441 fourth-year CTE students through standardized tests and self-developed questionnaires. Results revealed that students generally demonstrated moderate mastery of statistical concepts, with most having low mastery. Cognitive factors like prior knowledge, problem-solving skills, and cognitive load significantly influenced statistical mastery, and affective factors like attitude, anxiety, and self-efficacy. Instructional factors also influenced statistical mastery, such as teaching methods, use of technology, clarity of instruction, and assessment practices. Aside from that, contextual factors like learning environment, resource availability, and cultural context were found to influence their statistical mastery. Personal factors such as learning style, time management, and persistence also influenced their statistical mastery. Moreover, the relationship was not statistically significant despite a weak positive correlation between influencing factors and mastery levels. Aside from that, students encountered several challenges in learning statistics, including retaining statistical concepts, real-life applications, cognitive overload, and access to adequate learning resources. The study concludes with a proposed enhancement program focusing on remedial classes, innovative teaching methods, stress management, and improved resource access to equip future educators with essential statistical skills.

Keywords: Mastery level, Statistical challenges, Statistical concepts, Teacher education

INTRODUCTION

In the 21st century, statistical literacy has become essential, particularly in education, where data-driven decision-making is increasingly emphasized. The ability to interpret, analyze, and communicate statistical information is crucial for educators, enabling them to evaluate research, design effective interventions, and adapt teaching strategies to meet diverse student needs. However, despite its importance, students worldwide, including those in the Philippines, struggle with statistical concepts. Many learners face difficulties applying statistical reasoning to real-world contexts, particularly in probability, sampling, and data interpretation. These challenges are further compounded by the rapid increase in data availability, necessitating higher levels of statistical literacy to navigate complex modern information landscapes. As a result, enhancing statistical education is imperative to equip future educators with the necessary skills to thrive in a data-driven world.

The Programme for International Student Assessment (PISA, 2022) highlights that students often struggle to apply statistical reasoning in real-world contexts. Apino et al. (2024) argue that the increasing demand for statistical literacy is driven by the rapid expansion of data availability, requiring individuals to develop higher-

order thinking skills. The research underscores the need for a strengthened approach to statistical education that fosters deeper conceptual understanding rather than rote memorization (Teng et al., 2024; Callingham & Watson, 2017).

In the Philippines, these challenges are exacerbated by systemic issues such as underprepared teachers, high pupil-teacher ratios, and limited resource access (North et al., 2014). Studies indicate that Filipino students often exhibit low levels of statistical literacy, struggling to apply statistical reasoning in practical contexts (Reston, 2023; Repedro & Diego, 2021). Additionally, traditional teaching methods in many Philippine schools emphasize memorization over conceptual understanding, hindering students' ability to develop critical statistical thinking skills (Sharma, 2017). This local context underscores the urgent need for targeted interventions to improve statistical education, particularly in teacher preparation programs, where the next generation of educators is being trained.

Existing studies have explored various aspects of mathematics education. However, there is a notable gap in research focusing on the mastery of statistical concepts among college teacher education students, particularly in developing countries like the Philippines. While prior research has examined factors influencing general mathematics performance, few studies have specifically investigated how teacher education students acquire and apply statistical knowledge and how this impacts their future teaching practices (Tintle et al., 2018; Dong et al., 2020). Addressing this gap is essential for designing curriculum enhancements that strengthen statistical literacy among future educators.

Recent studies emphasize the need for innovative pedagogical approaches in teaching statistics to improve students' conceptual understanding and application of statistical reasoning. Simulation-based learning has emerged as an effective method for enhancing statistical literacy, allowing students to engage with real-world data through interactive tools (Tintle et al., 2015). Research by Garfield et al. (2008) highlights that students who use statistical simulations develop a deeper understanding of probability distributions and inferential reasoning. Additionally, project-based learning, which integrates statistical concepts with practical applications, has enhanced student engagement and problem-solving skills (Chuah et al., 2021). These approaches contrast traditional lecture-based instruction, often leading to rote memorization rather than meaningful comprehension.

Cognitive and affective factors significantly influence students' mastery of statistical concepts. Prior knowledge plays a crucial role in students' ability to understand new statistical concepts, as highlighted in studies by Pamungkas and Khaerunnisa (2020), which found that students with a strong mathematical foundation perform better in statistics courses. Conversely, students with weak prior knowledge experience a higher cognitive load, which can hinder learning (Zheng & Gupta, 2020).

Affective factors such as anxiety, self-efficacy, and attitudes toward statistics also impact learning outcomes. Statistics anxiety negatively correlates with student performance, as demonstrated in research by Paechter et al. (2017), who found that high-anxiety students struggle with statistical problem-solving and conceptual understanding. However, fostering positive attitudes through interactive and collaborative learning environments can mitigate anxiety and enhance engagement (Melad, 2022). Furthermore, self-efficacy has been identified as a strong predictor of success in statistics courses, with studies showing that students who believe in their ability to succeed are more likely to persist and achieve higher mastery levels (Zhao et al., 2024).

International studies offer valuable insights into statistical literacy development across different educational contexts. In Western countries, statistical education is often integrated with data science and computational thinking, emphasizing statistical reasoning over procedural calculations (Frank et al., 2016). In contrast, many developing countries, including the Philippines, still rely heavily on traditional, lecture-based approaches (Sharma, 2017). Research by Watson and Callingham (2017) highlights that students in data-driven education systems demonstrate higher statistical literacy levels, benefiting from access to statistical software and real-world data analysis tasks.

Furthermore, studies in the United States and Europe indicate that incorporating culturally relevant data in statistics education improves student engagement and comprehension (Weiland & Williams, 2023). These

findings suggest that adapting instructional strategies to local contexts, such as integrating Philippine-based datasets, can enhance students' ability to relate to statistical concepts and improve mastery outcomes.

The reviewed literature underscores the importance of adopting contemporary teaching strategies, addressing cognitive and affective barriers, and considering international best practices to enhance statistical literacy. Future research should explore how these approaches can be effectively adapted within the Philippine education system to improve teacher-education students' statistical mastery. Implementing interactive, technology-enhanced learning environments and culturally responsive pedagogy could bridge existing gaps and foster a more statistically literate teaching workforce.

This study aims to assess the levels of statistical mastery among college teacher education students, identify the factors influencing their learning, and analyze the challenges they face. The findings will serve as the basis for developing a proposed enhancement program to improve statistical literacy in teacher education programs. The study's significance extends to teacher education students, educational institutions, educators, and policymakers by providing insights into improving statistical instruction. This research contributes to the ongoing discourse on effective mathematics education by addressing the research gap and ensuring that future educators are well-equipped with essential statistical competencies necessary for 21st-century teaching.

METHODOLOGY

Research Design

This study employed a descriptive-correlational survey design to assess the mastery level of statistical concepts among College of Teacher Education students, explore the factors influencing their learning, and identify their challenges. This design was chosen because it systematically describes students' statistical proficiency while simultaneously analyzing associations between various influencing factors and mastery levels without manipulating any variables (Devi et al., 2022).

Descriptive research is appropriate for identifying students' current mastery levels, while correlational research examines the relationships between mastery and cognitive, affective, instructional, contextual, and personal factors. This approach is widely used in educational research to understand student performance patterns and how various elements contribute to learning outcomes (Creswell, 2012).

Furthermore, a survey-based approach was adopted because it efficiently collects data from a large sample size. Surveys provide a broad yet detailed perspective on students' learning experiences, attitudes, and challenges in statistics (Mustieles, 2020). Using standardized tests and self-developed questionnaires ensures that objective and subjective aspects of statistical mastery are captured, allowing for a more comprehensive analysis of the factors influencing students' performance. Similar methodologies have been applied in previous studies investigating academic mastery and learning influences (Dong et al., 2020; Whitaker et al., 2015), reinforcing the validity of this approach.

This study employs a descriptive-correlational survey design to provide empirical insights into statistical mastery among future educators, informing the development of targeted interventions and enhancement programs.

Research Locale

The study was conducted at Ramon Magsaysay Memorial Colleges (RMMC), Pioneer Avenue in General Santos City, Philippines. RMMC is a private, nonsectarian educational institution recognized for its commitment to providing high-quality and affordable education.

By selecting RMMC as the research locale, the study ensures that its findings are grounded in a real-world educational setting that reflects the systemic, cultural, and instructional challenges faced by teacher education programs in the Philippines. This choice enhances the relevance and applicability of the study's outcomes to similar contexts in developing countries.

Research Participants

The study's respondents were the 441 4th-year students of the College of Teacher Education from Ramon Magsaysay Memorial Colleges, General Santos City, as they are in the final stage of their pre-service teacher training. These students have prior exposure to statistics, both in Senior High School and during their college education, and have completed extensive coursework providing a solid foundation for evaluating their competencies. Research suggests that learning retention and mastery are better evaluated after students have had multiple exposures to a subject and opportunities to apply it in different contexts (Zapata-Cardona & Martínez-Castro, 2021). Unlike students in lower year levels, they have undergone practice teaching or simulations where they might have applied statistical concepts in real-world classroom settings, making them valuable respondents for analyzing the practical integration of statistics in teaching.

By selecting these students, the study ensures that respondents have the necessary background and experience to provide reliable insights into their mastery of statistical concepts, the challenges they face, and the factors influencing their learning.

Research Instrument

The validity and reliability of the research instruments used in this study were established through a rigorous process to ensure the accuracy and consistency of the collected data. The study employed a standardized test and a self-developed questionnaire, requiring a thorough discussion of their construction, validation, and reliability testing procedures.

The standardized test questionnaire was adapted from the Level of Conceptual Understanding in Statistics (LOCUS) Project (Whitaker et al., 2015) to measure students' mastery of statistical concepts. A Table of Specifications (TOS) was developed to ensure alignment with the study's objectives, detailing the distribution of test items across various statistical topics. The questions were designed based on Bloom’s Taxonomy to assess different cognitive levels, including knowledge, comprehension, application, and analysis.

The self-developed questionnaire, which aimed to identify influencing factors and challenges in learning statistics, was constructed based on a review of existing literature and frameworks on statistical learning. The questionnaire was divided into sections addressing cognitive, affective, instructional, contextual, and personal factors, as well as common challenges faced by students. The wording of each item was carefully formulated to ensure clarity and relevance to the target respondents.

A pilot test was conducted among a group of 30 students with similar academic backgrounds to the actual respondents to assess the preliminary effectiveness of the instruments. The responses were analyzed to identify any ambiguities, inconsistencies, or difficulties in comprehension. Item difficulty and discrimination indices were computed for the standardized test using the upper-lower (U-L) index method (Hartati & Yogi, 2019). Items with poor discrimination values were either revised or removed. Additionally, feedback from the pilot respondents was collected to refine ambiguous questionnaire items, ensuring that they effectively captured the intended constructs

The self-developed questionnaire underwent content validation by a panel of four experts in mathematics education and educational measurement. The panel consisted of two doctorate holders and two master’s degree holders, all specializing in quantitative research and assessment. The experts evaluated each item based on its clarity, relevance, and alignment with the study’s objectives. A Content Validity Index (CVI) was computed, with a score of 0.92, indicating a high level of agreement among the experts regarding the appropriateness of the items. Adjustments were made to items with lower validity scores before finalizing the instrument.

To establish the reliability of the research instruments, statistical analyses were conducted. The reliability of the standardized test was evaluated using KR-20, yielding a coefficient of 0.92, which indicates excellent internal consistency. The reliability of the self-developed questionnaire was assessed using Cronbach’s Alpha, resulting in coefficients of 0.97 for the factors influencing statistical mastery and 0.91 for the challenges in learning statistics. Both values exceed the accepted threshold of 0.70, confirming strong reliability. The high-reliability

scores suggest that the instruments produced consistent measurements across different respondents. These procedures collectively ensured the robustness of the data collection tools, enhancing the credibility of the study's findings.

Data Gathering Procedure

The research procedure for this study involved a systematic and structured approach to gather, analyze, and interpret data regarding the mastery level of statistical concepts of the students of the College of Teacher Education, the factors that influence their mastery of statistical concepts, and the challenges they face in learning statistical concepts. The researcher first constructed the research instruments, then had them validated by the pool of experts. Next, it underwent a reliability test to ensure that it is reliable and trustworthy. Then, the researcher obtained necessary approvals from SKSU Graduate School and RMMC. Ensured that participants' rights, confidentiality, and informed consent were upheld throughout the research process.

The researcher then administered the survey and test questionnaires to the identified participants through Google Forms. Using Google Forms is effective, cost-efficient, and minimizes paper usage, particularly on large samples (Iqbal et al., 2018). The researcher then collated the collected data and utilized appropriate statistical techniques to analyze the results with the help of a knowledgeable statistician who helped employ correlation analyses and other relevant methods.

After collating the results, the researcher discussed the implications of the findings in relation to existing literature. The researcher analyzed how the results contribute to the student's mastery level of statistical concepts, the factors influencing their learning, and their challenges in learning statistical concepts.

Ethical Considerations

This research study followed ethical guidelines. Ethical approval was obtained from Ramon Magsaysay Memorial Colleges' Research Ethics Board. All participants provided informed consent, and confidentiality was maintained in compliance with international research ethics standards.

RESULTS AND DISCUSSION

Level of Influence of Various Factors on Students' Mastery of Statistical Concepts

Cognitive Factors

As shown in Table 1, the cognitive factor, with an overall mean of 3.02 (SD = .51), highlights the role of students' prior knowledge, problem-solving skills, and cognitive load. Moreover, all indicators were interpreted as "Influential." This suggests that these cognitive aspects significantly influence students' ability to understand and master statistical concepts.

Table 1. Level of Influence of Cognitive Factors on Students' Mastery of Statistical Concepts

Indicators	Mean	SD	Interpretation
Prior Knowledge	3.10	.58	Influential
Problem-solving Skill	2.86	.55	Influential
Cognitive Load	3.11	.58	Influential
Overall Mean	3.02	.51	Influential

Among the three indicators, cognitive load has the highest mean score (M = 3.11), indicating that the mental effort required to process statistical information significantly affects students' mastery. Respondents highlighted that visual aids and examples helped reduce cognitive load, making statistical concepts easier to understand.

These findings align with research by Yin et al. (2023), which suggests that well-designed visual materials enhance comprehension while minimizing cognitive overload. Similarly, Bancilhon et al. (2023) demonstrated that combining text with visuals reduces errors and improves cognitive processing, particularly for students with lower working memory capacity.

Meanwhile, problem-solving skills have the lowest mean score (M = 2.86) but remain influential. This suggests that students rely on problem-solving abilities to understand statistical concepts. Setyani and Kristanto (2020) reported that problem-solving activities enhance students' understanding of statistical principles. Likewise, Putri et al. (2018) found that problem-based learning strategies improve conceptual comprehension and motivation in mathematics and statistics education.

Prior knowledge (M = 3.10) is also critical, indicating that students' previous exposure to mathematical concepts significantly impacts their success in learning statistics. These results are consistent with the findings of Tintle et al. (2018), who emphasized the role of prior mathematical understanding in statistical learning. Similarly, Apino et al. (2024) asserted that a strong foundation in mathematics enables students to grasp complex statistical ideas more efficiently.

Affective Factors

The table presents the level of influence of affective factors on students' mastery of statistical concepts, focusing on three key indicators: attitude toward statistics, anxiety, and self-efficacy. The results indicate that affective factors were interpreted as "Influential", with an overall mean of M = 2.86 (SD = 0.55). Moreover, all individual indicators were also classified as "Influential", suggesting that students' emotions and attitudes significantly impact their ability to grasp statistical concepts.

Table 2. Level of Influence of Affective Factors on Students' Mastery of Statistical Concepts

Indicators	Mean	SD	Interpretation
Attitude towards Statistics	2.99	.58	Influential
Anxiety	2.69	.64	Influential
Self-efficacy	2.90	.60	Influential
Overall Mean	2.86	.55	Influential

Among the three indicators, attitude towards statistics has the highest mean score (M = 2.99, SD = 0.58), indicating that students believe maintaining a positive attitude improves mastery. This finding aligns with Peiró-Signes et al. (2020), who found that students with a positive attitude toward statistics were more likely to engage with the subject and achieve higher performance. Similarly, Reston (2023) reported that fostering a positive outlook on statistics through real-world applications enhances students' statistical literacy.

Self-efficacy, with a mean of M = 2.90 (SD = 0.60), also plays a significant role, suggesting that students' confidence in their ability to learn statistics affects their performance. These findings support the research of Whitcomb et al. (2020), who identified self-efficacy as a key predictor of success in statistical learning. Likewise, Hogan (2016) emphasized that students with higher self-confidence tend to perform better in mathematics and statistics-related courses.

Anxiety, while having the lowest mean (M = 2.69, SD = 0.58), remains an influential factor, highlighting the role of stress and nervousness in learning statistics. These findings are consistent with Khasawneh et al. (2021), who found that students with high statistics anxiety performed worse due to cognitive interference. Additionally, Maat et al. (2022) emphasized that reducing anxiety through structured learning strategies enhances statistical comprehension and test performance.

Instructional Factors

Table 3 shows that the instructional factor, with an overall mean of M = 3.15 (SD = 0.55), was interpreted as "Influential." This suggests that effective instruction enhances learning outcomes and fosters a better understanding of statistical concepts. Additionally, all individual indicators were classified as "Influential," reinforcing the importance of instructional strategies in statistical education.

Table 3. Level of Influence of Instructional Factors on Students' Mastery of Statistical Concepts

Indicators	Mean	SD	Interpretation
Teaching Method	3.20	.59	Influential
Use of Technology	3.11	.63	Influential
Clarity of Instruction	3.17	.60	Influential
Assessment Practices	3.13	.56	Influential
Overall Mean	3.15	.55	Influential

Among the indicators, teaching method had the highest mean (M = 3.20, SD = 0.59) and was interpreted as "Influential". These findings align with Xu et al. (2021), who emphasized that well-organized instructional strategies reduce cognitive overload and enhance long-term retention. Similarly, Eitel et al. (2020) found that practical teaching approaches improve student engagement and statistical literacy.

The use of technology, with a mean of M = 3.11, SD = 0.63, was also classified as "Influential". This suggests that teachers should maximize the integration of technology by incorporating statistical software such as SPSS, R, and Excel, along with interactive learning platforms. Hasim et al. (2024) emphasized that technology-driven approaches foster deeper learning and student engagement in statistical education.

Clarity of instruction was interpreted as "Influential", with a mean of M = 3.17, SD = 0.60. The results highlight that clear and well-structured instruction is essential for students to comprehend statistical concepts and reduce anxiety. According to Xu et al. (2021), reducing cognitive load through well-organized teaching approaches and breaking down complex concepts into smaller, manageable parts enhances students' retention and comprehension of statistical material. Likewise, Eitel et al. (2020) noted that instructional clarity and stress reduction boost student engagement and motivation, improving mastery of statistical concepts.

Finally, assessment practices, with a mean of M = 3.13, SD = 0.56, were also considered "Influential". This aligns with findings by Morris et al. (2021), who highlighted the positive impact of formative assessment practices—particularly feedback and problem-solving assessments—on students' statistical skills.

Contextual Factors

In Table 4, with an overall mean of 3.14 (SD = .54), contextual factor was interpreted as "Influential". This suggests that students' mastery of statistical concepts is significantly shaped by their surrounding environment, their available resources, and cultural influences.

Table 4. Level of Influence of Contextual Factors on Students' Mastery of Statistical Concepts

Indicators	Mean	SD	Interpretation
Learning Environment	3.16	.59	Influential
Availability of Resources	3.19	.59	Influential

Culture Context	3.08	.59	Influential
Overall Mean	3.14	.54	Influential

All indicators were interpreted as "Influential". Specifically, among the indicators, availability of resources garnered the highest mean of 3.19 (SD = .59). This emphasizes the importance of having adequate learning materials, technology, and instructional tools in mastering statistics. Burckhardt et al. (2020) highlighted that increased statistical learning outcomes could be achieved by integrating computing tools and various instructional resources. In addition, the research conducted by Cai (2018) emphasized that both the student's home environment and the school environment played a significant role in determining the level of mathematical achievement that the student attained, thus highlighting the importance of resource availability concerning academic success.

The learning environment is closely followed, with a mean of 3.16 (SD = .59), indicating that a well-structured, supportive, and engaging academic setting plays a crucial role in student learning. Rusticus et al. (2022) discovered that a positive learning environment increased students' intrinsic motivation and engagement, ultimately leading to greater academic achievement.

Meanwhile, cultural context has the lowest mean score of 3.08 (SD = .59). However, it is still considered influential, highlighting that cultural relevance in statistical examples and incorporating cultural context in the statistics lesson affects their statistical learning process. Hu et al. (2018) discovered that culturally relevant examples in statistical education improved comprehension and engagement because students considered the topic more relatable.

Personal Factors

Data in Table 5 show that the personal factor was interpreted as "Influential," with an overall mean of 3.17 (SD = .56). This suggests that students' individual characteristics and behaviors significantly impact their ability to master statistical concepts.

Table 5. Level of Influence of Personal Factors on Students' Mastery of Statistical Concepts

Indicators	Mean	SD	Interpretation
Learning Style	3.17	.61	Influential
Time Management	3.19	.59	Influential
Persistence	3.14	.59	Influential
Overall Mean	3.17	.56	Influential

Among the indicators, time management has the highest mean score of 3.19 (SD = .59), indicating that effectively organizing study schedules and balancing academic tasks play a critical role in learning statistics. Ahmad et al. (2019) stated that students who planned their studies performed better academically. Massing et al. (2021) stated that students who studied consistently learned statistical concepts better.

Learning style follows closely with a mean of 3.17 (SD = .61), highlighting the importance of using study techniques suited to individual preferences, such as visual, auditory, or hands-on learning. Yousef (2016) demonstrated that students with various learning styles showed improved comprehension and recall of statistical ideas when they were taught using diverse modalities from different perspectives.

Persistence, with a mean of 3.14 (SD = .59), also proves to be influential, suggesting that students who demonstrate determination and perseverance tend to master statistical concepts better. Peiró-Signes et al. (2020) stated that students with higher self-confidence and statistical skills exhibited more remarkable persistence,

participated in statistical activities more extensively, and showed enhanced comprehension. According to Ismail and Chan (2015), students overcame various challenges associated with statistical learning by utilizing self-perception and motivation.

Mastery Level of Statistical Concepts

Table 6 presents the mastery level of statistical concepts among College of Teacher Education students. Results show that the majority of students, 236 out of 441 (53.51%), fell within the "Low Mastery" level, with scores ranging from 11 to 20. A significant portion, 131 students (29.71%), achieved scores between 21 and 30, indicating "Moderate Mastery." Additionally, 74 students (16.78%) scored between 31 and 40, reflecting "High Mastery" of statistical concepts.

Table 6. Mastery Level of Statistical Concepts of the College of Teacher Education Students

Score Range	Frequency	Percentage (%)	Level
21 – 30	74	16.78	High Mastery
11 – 20	131	29.71	Moderate Mastery
10 and below	236	53.51	Low Mastery
Total	441	100	
Average Score	12.32	Moderate Mastery	

The average score across all students was 12.32, corresponding to the "Moderate Mastery" level. While this suggests that students have a fair understanding of statistical concepts, a considerable number still struggle with mastering them. This finding was supported by Yotongyos et al. (2015) who found that undergraduate students have a moderate level of overall statistical literacy. Reston (2023) also found that students struggled to apply statistical reasoning to real-world situations, particularly when learning complex concepts such as probability and data interpretation.

Pearson-r Momemt Correlation Coefficient Analysis

Table 7 presents the results of the Pearson-r analysis examining the relationship between the level of influence of various factors on students' mastery of statistical concepts and their actual mastery level of statistical concepts.

Table 7. Results of Pearson-r Analysis between the Level of Influence of Various Factors and Mastery Level of Statistical Concepts

Variables	Correlation Coefficient (r)	P-value
Level of Influence of Various Factors	.882	.0641**
Mastery Level of Statistical Concepts		

**Correlation not significant at 0.05 level of significance. (2-tailed)

The correlation coefficient (r = .0882) indicates a very weak positive relationship between various factors' influence level and students' mastery of statistical concepts (Ullah, 2024). However, the p-value of 0.0641 exceeds the 0.05 significance level, meaning the relationship is not statistically significant.

This suggests that while these factors play a role, they do not strongly predict mastery, indicating that other variables may be more critical.

The weak correlation may stem from the complex nature of statistical learning, where multiple factors interact. Prior mathematical achievement, motivation, and access to learning resources could serve as mediators or moderators. Additionally, self-reported responses may introduce bias, affecting the perceived influence of these factors.

Further analysis could enhance understanding. Regression models could determine which factors significantly predict statistical mastery, while Structural Equation Modeling (SEM) could explore direct and indirect relationships. Mediation and moderation analyses may clarify hidden influences, offering a deeper perspective on learning outcomes.

Several studies align with this finding, suggesting that while various factors may influence learning, they do not always lead to mastery. For instance, Weiler and Murad (2022) emphasized the role of motivation and self-regulation in academic success. However, they acknowledged that external instructional and contextual factors do not necessarily translate into direct mastery. Li et al. (2023) state that technological integration and explicit instruction improve independent learning but do not directly affect mastery. Dani and Quraan (2023) found that views towards statistics and anxiety affected students' motivation to study the subject but not mastery.

However, some studies contradict this. Islam et al. (2024) discovered that self-efficacy, including statistical proficiency, predicted academic success.

Challenges Encountered in Learning Statistics

Table 8 outlined the challenges encountered by respondents in learning statistics, with an overall mean of 3.05 (SD = 0.56), indicating that students find learning statistics “Somewhat Challenging.” All statements were interpreted as “Somewhat Challenging”, suggesting that no single factor overwhelmingly hinders learning, but multiple aspects contribute to students' struggles.

Table 8. Challenges Encountered by the Respondents in Learning Statistics

Statements	Mean	SD	Interpretation
1. I find it hard to understand some topics in statistics, like probability or randomness.	3.03	.73	Somewhat Challenging
2. I get confused by the many formulas we need to learn in statistics.	3.11	.69	Somewhat Challenging
3. I struggle to relate statistical principles to real-life circumstances.	3.05	.68	Somewhat Challenging
4. I feel nervous about making mistakes when solving statistics problems.	3.17	.71	Somewhat Challenging
5. I have trouble remembering everything we learn in class because it’s too much at once.	3.06	.73	Somewhat Challenging
6. I don’t have the tools or software I need to practice statistics.	3.03	.71	Somewhat Challenging
7. I feel my math skills aren’t good enough to handle statistics.	3.07	.77	Somewhat Challenging
8. I don’t have enough time to finish my statistics tests or assignments.	2.87	.78	Somewhat Challenging
9. I sometimes find the instructions for statistics activities hard to understand.	3.04	.70	Somewhat Challenging

10. I feel frustrated when group work in statistics is unfair, and some people don't do their part.	3.16	.74	Somewhat Challenging
11. I struggle to keep up when the teacher moves too quickly through the topics.	3.12	.75	Somewhat Challenging
12. I feel shy or unsure about asking questions in statistics class.	3.11	.75	Somewhat Challenging
13. I struggle with the teaching methods used in statistics because they don't work well with the way I learn best.	3.02	.72	Somewhat Challenging
14. I don't get enough feedback from my teacher to help me improve in statistics.	2.87	.76	Somewhat Challenging
15. I struggle to allocate enough time and focus to statistics due to other courseworks.	3.00	.74	Somewhat Challenging
Overall Mean	3.05	0.56	Somewhat Challenging

Among the specific challenges, students report feeling particularly nervous about making mistakes when solving statistics problems, with a mean score of 3.17 (SD = .71). This finding aligned with Hedges (2017), who emphasized that statistics anxiety significantly impacted student performance, leading to hesitation in problem-solving and reduced engagement. Similarly, Maat (2022) found a strong correlation between anxiety and lower exam scores, reinforcing the idea that fear of mistakes hindered students' ability to apply statistical concepts effectively. This is closely followed by frustration with unfair group work, with a mean score of 3.16 (SD = .74). These high scores suggest that emotional and social factors significantly impact students' experiences in statistics.

Additionally, confusion with the many formulas required in statistics (M = 3.11, SD = .69) and difficulty keeping up with the pace of teaching (M = 3.12, SD = .75) are notable cognitive challenges. These concerns highlighted issues related to instructional methods, which Gopal et al. (2018) addressed in their study, emphasizing the role of self-efficacy in student engagement. When students lacked confidence in their ability to ask questions or keep up with the pace of instruction, they were less likely to develop a strong understanding of statistical concepts.

Students also find it somewhat challenging to understand certain topics, such as probability and randomness (M = 3.03, SD = .73), and to relate statistical principles to real-life situations (M = 3.05, SD = .68). Additionally, respondents mentioned challenges related to insufficient tools or software for practicing statistics (M = 3.03, SD = 0.71), unclear instructions for statistics activities (M = 3.04, SD = 0.70), and misalignment of teaching methods with their preferred learning styles (M = 3.02, SD = 0.72). These findings aligned with study of Cujba and Pifarré (2024) highlighting the importance of adaptive teaching methods, such as technology-driven approaches, to accommodate diverse learning preferences.

The lower mean scores, though respondents still agreed on these indicators, were for not having enough time to finish statistics tests or assignments (M = 2.87, SD = 0.78) and not receiving enough feedback from teachers to help improve in statistics (M = 2.87, SD = 0.76). These results suggested that while students recognized time constraints and limited feedback as challenges, they were less pressing than anxiety, instructional clarity, and the complexity of statistical concepts.

Proposed Enhancement Program

Table 9 presents the proposed enhancement program, which addresses key areas of difficulty and issues in statistical knowledge highlighted in the study to increase the mastery of College of Teacher Education students. The program extends beyond traditional instructional strategies by incorporating personalized, student-centered interventions emphasizing self-regulation, time management, and adaptive learning approaches.

While the enhancement program proposes meaningful improvements, its practical application may face several challenges. One major concern is faculty readiness and training, as instructors may require professional development in differentiated instruction, student-centered learning approaches, and adaptive teaching strategies to address diverse learning styles effectively. Resistance to pedagogical change may also arise, making it necessary to engage faculty through incentives and support mechanisms to encourage the adoption of new methodologies.

Institutional constraints may also limit the program's success. Budgetary limitations could affect the feasibility of additional student support services, such as tutoring programs and personalized learning tools. Administrative priorities and rigid curriculum structures may further restrict the flexibility needed to integrate personalized interventions, potentially hindering efforts to enhance statistical mastery.

Another challenge is the student's willingness to engage in remedial activities. Not all students may be receptive to supplementary learning opportunities, especially those experiencing low motivation or academic burnout. To address this, strategies such as incentivizing participation through academic credit, gamification, or embedding support structures within regular coursework may help increase student engagement and participation. To maximize the program's impact, a balanced approach is necessary—one that strengthens both instructional quality and student-driven learning enhancements. Future research could explore pilot testing these interventions to assess their effectiveness before large-scale implementation. Additionally, engaging faculty and institutional leaders in the planning process can help align program goals with available resources and institutional priorities, ensuring sustainability and long-term success.

Table 9. Proposed Enhancement Program

Key Result Area	Objectives	Activities	Responsible Person/Agency
Strengthening Foundations	Improve understanding of core statistical concepts.	Remedial classes, tutorial programs, instructional videos, self-paced learning modules.	Mathematics or Statistics Faculty, Peer Tutors
Innovative Teaching Methods	Enhance engagement and comprehension.	Real-world applications, simulations, adaptive teaching, gamified learning.	Faculty, Instructional Development Office
Reducing Anxiety	Address anxiety and boost confidence in statistics.	Stress management workshops, low-stakes assessments, peer mentoring programs.	Guidance Office, Faculty
Effective Assessments	Provide timely feedback and performance tracking.	Formative quizzes, digital analytics, coaching sessions, personalized feedback mechanisms.	Faculty, Academic Affairs Office
Resource Access	Ensure the availability of learning tools.	Learning hub, statistical software (SPSS, R), online materials, institutional partnerships for resources.	Library, Computer or IT Laboratory, Faculty
Study Habits and Time Management	Develop effective learning strategies.	Workshops, structured study schedules, accountability groups, time management programs.	Student Affairs Office, Faculty
Collaborative Learning	Foster teamwork and interactive learning.	Group projects, Statistics Olympiad, online forums, peer-assisted learning programs.	Student Organizations, Faculty

CONCLUSION

This study investigated the mastery level of statistical concepts among College of Teacher Education students and examined the factors influencing their statistical proficiency. The findings revealed that cognitive, affective, instructional, contextual, and personal factors significantly impact students' ability to understand and apply statistical concepts. Among these, personal factors such as time management, learning styles, and persistence exhibited the highest level of influence, emphasizing the need for self-directed learning and motivation.

The study found that most students demonstrated a moderate level of statistical mastery. While they exhibited competence in fundamental concepts such as exploring data, probability distributions, and hypothesis testing, challenges remained in grasping complex topics. This suggests the necessity for targeted interventions to enhance students' comprehension and practical application of statistical knowledge.

Although a weak positive correlation was identified between the influencing factors and statistical mastery, the relationship was not statistically significant. This indicates that additional variables beyond those studied may play a more critical role in shaping statistical proficiency. Furthermore, students encountered significant challenges, including cognitive overload, difficulties in real-life application, and limited access to statistical software, which hindered their ability to master statistical concepts effectively.

The study proposed an enhancement program incorporating real-world applications, simulations, remedial lectures, and tutorials to address these challenges. Strategies such as stress management workshops and interactive learning methods were recommended to reduce anxiety and foster deeper engagement. The program aims to improve statistical literacy among future educators by adopting evidence-based instructional approaches.

Conflict of Interests

The authors declared no conflict of interest.

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