

THE RELATIONSHIP BETWEEN STATISTICAL ANXIETY AND SELF-
EFFICACY IN TEACHING STATISTICS AMONG PRESERVICE
TEACHERS

by

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ABSTRACT

THE RELATIONSHIP BETWEEN STATISTICAL ANXIETY AND SELF-EFFICACY IN TEACHING STATISTICS AMONG PRESERVICE TEACHERS

This study investigates the relationship between statistical anxiety and self-efficacy in teaching statistics among preservice mathematics teachers at highly ranked public university in Türkiye. It focuses on preservice teachers in the mathematics education and primary mathematics education programs. Statistical anxiety can reduce teachers' self efficacy in teaching statistics. In other words, understanding this relationship is important for improving teacher preparation. A mixed-methods design was used in the research. The quantitative part of the study used the Statistics Anxiety Scale (SAS) and the Self-Efficacy to Teach Statistics (SETS) instrument. Data were collected from preservice teachers who are taking the SCED 301 course in the university. The results showed a strong negative correlation (Spearman's $\rho = -.890$, $p < .001$). This means higher anxiety is related to lower self efficacy in teaching statistics. The qualitative part of the study included semi-structured interviews. It helps to understand participants' experiences. Thematic analysis discovered anxiety factors. Fear of making mistakes, statistical data interpretation difficulty, and avoidance are these reasons. To minimise anxiety and enhance self-efficacy, participants emphasised supportive learning environments, mastery experiences, reflective practice, and real-world applications. These findings show the need for teacher education programs to address statistical anxiety directly. Programs should use teaching strategies that help build self-efficacy. Recommendations include active learning methods, collaborative activities, and practical, meaningful applications in the curriculum. These approaches can help teacher programs develop preservice teachers' self-efficacy in teaching statistics.

ÖZET

ÖĞRETMEN ADAYLARINDA İSTATİSTİK ÖĞRETİMİNDE İSTATİSTİKSEL KAYGI VE ÖZ-YETERLİLİK ARASINDAKİ İLİŞKİ

Bu çalışma, Türkiye'deki en iyi devlet üniversitelerinden birindeki matematik öğretmen adayları arasında istatistik öğretiminde istatistiksel kaygı ve öz-yeterlilik arasındaki ilişkiyi araştırmaktadır. Çalışma, matematik eğitimi ve ilköğretim matematik öğretmenliği programlarındaki öğretmen adaylarına odaklanmaktadır. İstatistiksel kaygı, öğretmenlerin istatistik öğretiminde öz-yeterliliklerini azaltabilir. Başka bir deyişle, bu ilişkiyi anlamak, öğretmen hazırlığını geliştirmek için önemlidir. Araştırmada karma yöntem tasarımı kullanılmıştır. Çalışmanın nicel kısmında İstatistik Kaygı Ölçeği (SAS) ve İstatistik Öğretiminde Öz-Yeterlilik (SETS) aracı kullanılmıştır. Veriler, bu üniversitede SCED 301 dersini alan öğretmen adaylarından toplanmıştır. Sonuçlar güçlü bir negatif korelasyon göstermiştir (Spearman'ın $\rho = -.890$, $p < .001$). Bu, yüksek kaygının istatistik öğretiminde düşük öz-yeterlilikle ilişkili olduğu anlamına gelir. Çalışmanın nitel kısmı yarı yapılandırılmış görüşmelerden oluşmaktadır. Bu görüşmeler, katılımcıların deneyimlerini anlamaya yardımcı olmaktadır. Tematik analiz, kaygı faktörlerini ortaya koymuştur. Hata yapma korkusu, istatistiksel veri yorumlama zorluğu ve kaçınma bu faktörlerdir. Kaygıyı en aza indirmek ve öz yeterliliği artırmak için katılımcılar, destekleyici öğrenme ortamlarına, ustalık deneyimlerine ve gerçek hayat içerisinden uygulamalara vurgu yapmışlardır. Bu bulgular, öğretmen eğitim programlarının istatistiksel kaygıyı doğrudan ele alması gerektiğini göstermektedir. Programlar, öz yeterliliği geliştirmeye yardımcı öğretim stratejileri kullanmalıdır. Öneriler arasında aktif öğrenme yöntemleri, iş birlikçi etkinlikler ve müfredatta pratik, anlamlı uygulamalar yer almaktadır.

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LIST OF SYMBOLS

p	Probability value
ρ	Spearman's rank-order correlation coefficient



LIST OF ACRONYMS/ABBREVIATIONS

SAS	Statistics Anxiety Scale
SD	Standard Deviation
SETS	Self-Efficacy to Teach Statistics
SPSS	Statistical Package for the Social Sciences



1. INTRODUCTION

In today's world, data is everywhere. Understanding statistics plays an important role in our lives. Making sense of data helps us assess risks and make informed choices in areas such as health, economics, and social sciences (Gal, 2002; Franklin et al., 2007). Teaching statistics is the way to help students acquire these skills. Studying statistics prepares students to handle complex information and think critically. The increasing demand for statistical literacy in today's world makes the role of teachers, especially those in training even more important. They need more than just content knowledge to learn statistics. They must be confident in their ability to communicate statistical ideas well. However, many pre-service teachers struggle with anxiety about statistics and have barriers to teaching, such as low confidence. This can limit both their learning and their future effectiveness. (Onwuegbuzie & Wilson, 2003; Baloglu, 2004).

Statistical anxiety is the fear that some people feel when dealing with statistics, especially tasks such as analyzing data and interpreting results (Onwuegbuzie & Wilson, 2003; Baloglu, 2004). Unlike mathematics anxiety, statistical anxiety is more related to data interpretation and abstract reasoning (Paechter et al., 2017). As anxiety increases, information processing may become more difficult, leading to avoidance of statistical tasks and lower participation and poor performance (Chew & Dillon, 2014). For pre-service teachers, this anxiety can also affect their own learning. They may also have difficulty creating a positive classroom environment, which can be reflected in their teaching. It can negatively affect their students' perspectives on statistical concepts.

A teacher's belief in their ability to teach statistical ideas well is called self-efficacy in teaching statistics. It comes from Bandura's (1997) theory of self-efficacy. This belief includes confidence in planning, organizing, and presenting lessons. Self-efficacy is important in teaching. It shapes how teachers deal with challenges and adjust their methods in the process (Tschannen-Moran & Hoy, 2001). Teachers with high self-efficacy often use student-centered approaches. In their lessons, they encourage questions and critical thinking. Those with low self-efficacy conduct teacher-centered lessons (Finney & Schraw, 2003). Teaching statistics requires confidence to help students with complex ideas. Pre-service

teachers often have lower self-efficacy here. They need specific skills beyond basic mathematics (Harrell-Williams et al., 2015). Without sufficient self-efficacy, they may feel unprepared.

Statistical anxiety and self-efficacy greatly influence how prepared preservice teachers are to teach statistics. Studies show that they are negatively correlated. Higher anxiety generally means lower self-efficacy. This cycle can undermine teaching confidence and preparation (Schneider, 2011; Perepiczka et al., 2011). This issue is important in statistics education. Teaching statistics requires more than just steps and procedures. It also requires skills to explain data, discuss uncertainty, and demonstrate real-world uses (Harrell-Williams et al., 2015). When teachers feel too anxious, they may doubt whether they can explain ideas well. This lowers their self-efficacy and makes them less willing to teach difficult topics.

Statistical anxiety can negatively impact thinking by reducing focus. This makes it harder for preservice teachers to learn and understand statistical ideas (Macher et al., 2012). Anxiety often leads to avoiding tasks, procrastinating, or not exploring more difficult topics. This prevents teachers from learning the information and strategies they need (Paechter et al., 2017). Low self-efficacy can make this worse. Teachers who doubt themselves may choose teacher-centered methods that focus on steps rather than ideas. This type of instruction can limit students' ability to think critically about statistical topics.

Statistical anxiety and self-efficacy can create a cycle that is difficult for preservice teachers to break. These factors make each other worse. For example, a teacher with high anxiety may avoid statistical tasks. This means fewer opportunities to practice and gain skills, which lowers self-efficacy (Bandura, 1997). Lower self-efficacy then increases anxiety. To stop this cycle, both issues need to be addressed simultaneously. Helpful strategies include creating supportive learning spaces, practicing for mastery, and providing helpful feedback. These steps can reduce anxiety and increase confidence.

Understanding how statistical anxiety and self-efficacy are linked is important for teacher education. Knowing this connection helps educators identify preservice teachers who struggle with statistics. They can then design ways to reduce anxiety and build confidence.

With these two approaches, teachers can be prepared for the teaching process. It also helps promote statistical literacy in schools. Future students will gain the skills they need in a world full of data.

The concepts of statistical anxiety and self-efficacy have been studied before. However, studies examining how they work together are scarce. Studies are particularly hard to come by for preservice teachers learning to teach statistics. Anxiety can impair thinking and reduce engagement. Low self-efficacy can reduce confidence in using good teaching methods. This study examines how these factors are related. The results may help teacher preparation programs. They may offer ways to reduce anxiety and help future teachers acquire the skills they need to teach statistics well.

1.1. Significance of the Study

This study is important for several reasons. First, it fills a gap in research on the challenges that preservice teachers face when learning and teaching statistics. Statistical anxiety is known to be a barrier for students. However, there is less research on how statistical anxiety affects preservice teachers (Baloglu, 2004; Onwuegbuzie & Wilson, 2003). For these teachers, anxiety can be detrimental to their own learning. It can also shape how well they interact with students. By looking at this anxiety in teacher education, the study provides insight into the specific challenges they face. This study helps fill an important gap in the research. The contribution matters because preservice teachers are the future workforce. They will be responsible for introducing statistics to their students. Their struggles are not only personal challenges. They also have long-term consequences for education.

Second, this study looks at self-efficacy in teaching statistics, which needs different interpretive skills than teaching math. Many studies have looked at self-efficacy in general instruction (Bandura, 1997; Tschannen-Moran & Hoy, 2001). But there isn't a lot of study on the precise self-efficacy needed to teach statistics. Harrell-Williams et al. (2015) emphasized that general confidence in mathematics does not necessarily translate into confidence in teaching statistics. Harrell-Williams et al. (2015) also suggested that preservice teachers may need targeted support to develop the self-efficacy required for

effective statistics education. Understanding these self-efficacy gaps would be a positive contribution to teacher preparation programs and could also enable them to design curricula that meet the specific needs of future statistics educators. By highlighting where preservice teachers feel confident in mathematics but less confident in teaching statistics, this study clarifies a critical gap in the literature.

The link between statistical anxiety and self-efficacy is well known for student learning. However, few studies have looked at this link in pre-service teachers who will teach statistics (Schneider, 2011; Perepiczka et al., 2011). Examining this relationship during teacher education can show how these factors affect teaching preparation. Seeing this link can help teacher education programs. They can work to reduce anxiety and increase confidence. This can lead to better teaching practices in statistics. In this way, the study extends prior research beyond students as learners, to preservice teachers as both learners and future educators.

The findings of this study have real value for teacher preparation programs. By looking at how statistical anxiety and self-efficacy are linked, this research can help create targeted strategies for preservice teachers. Strategies may include active learning, mastery practice, and working in groups. These methods have been shown to help with self-efficacy and reduce anxiety in other settings (D'Andrea & Waters, 2002; Williams, 2010; Nolan et al., 2012). Such strategies can be tailored for preservice teachers who are learning statistics. This can increase their readiness to teach and may also help them build statistical literacy in their students.

In general, while statistical anxiety and self-efficacy have been widely studied in general student populations, this study fills the gap by focusing on preservice mathematics teachers, addressing both their learning challenges and their readiness to teach statistics. To address these issues, the study will investigate the following research questions.

RQ1: According to pre-service mathematics teachers, what are the perceived factors that contribute to statistical anxiety?

RQ2: What is the relationship between statistical anxiety and self-efficacy in teaching statistics among preservice teachers?

RQ2a: Are there differences in preservice mathematics teachers' statistical anxiety and self-efficacy in teaching statistics by program type (primary vs. secondary)?

RQ2b: Are there differences in preservice mathematics teachers' statistical anxiety and self-efficacy in teaching statistics by gender?

RQ3: What strategies do preservice teachers recommend for reducing statistical anxiety and improving self-efficacy in teaching statistics?

2. LITERATURE REVIEW

2.1. Self-Efficacy

Bandura (1997) came up with the idea of self-efficacy. Bandura (1997) says that self-efficacy is the belief that a person has in their ability to do things and get the results they want. Self-efficacy is a big part of being a good teacher. It changes how teachers deal with problems (Tschannen-Moran & Hoy, 2001). Teachers who believe in themselves are more likely to use student-centered methods in their classroom. These methods make the classroom a place where students can learn by doing. On the other hand, teachers who don't believe in themselves generally adopt old-fashioned teaching methods. Harrell-Williams et al. (2015) similarly found that self-efficacy depends on the situation. Being good at teaching general math doesn't always mean you'll be good at teaching statistics. You need to be able to think more abstractly and interpret things better to do statistical reasoning.

Self-efficacy is important for creating good teaching methods when teaching statistics. Using the Self-Efficacy in Teaching Statistics (SETS) instrument, Harrell-Williams et al. (2015) emphasized that most pre-service educators are confident in basic concepts such as graphing. However, they are less confident in more difficult topics such as statistical inference or measuring relationships. Therefore, teacher education programs need to provide special assistance. Such assistance can help pre-service educators feel more confident in difficult areas. Estrada, Batanero, and Lancaster (2011) emphasized that statistical reasoning requires a different type of thinking. In today's world, teachers need to go beyond teaching procedures. They need to focus on how to convey data to students in a deeper way. Recent research on teacher education (Biehler et al., 2021) has also shown how important these interpretive skills are.

The need for statistical literacy is growing in today's education. Because of this, it is important for teacher candidates to feel sure about teaching statistics (Franklin et al., 2007). In Türkiye, new curriculum changes put more focus on statistical literacy. These changes match what is happening worldwide to support data-based citizenship (MEB, 2018; Tatlı & Bulut, 2021). Supportive learning spaces help students feel more sure in tough subjects like

statistics. Nolan, Beran, and Hecker (2012) found that helpful feedback is good for both students and teacher candidates. This kind of support makes people more confident when doing statistical tasks. The link between self-efficacy and anxiety can help or hurt teacher candidates' teaching skills. This is why teacher training programs should focus on building self-efficacy.

2.1.1. Self-Efficacy in Teaching Statistics

Self-efficacy is a person's belief in their ability to accomplish tasks and achieve specific goals (Bandura, 1997). Self-efficacy is very important in teaching. It shapes how teachers deal with challenges (Tschannen-Moran & Hoy, 2001). Teachers with high self-efficacy often choose student-centered teaching methods. This greatly increases student engagement. On the other hand, teachers with low self-efficacy may stick to traditional methods. These methods may not meet the diverse learning needs of all students. Self-efficacy is especially important in teaching statistics. It affects teachers' confidence in explaining complex ideas that require interpretation and analysis (Estrada et al., 2011). Finney and Schraw (2003) found that high self-efficacy in teaching statistics positively affects teachers and students alike. It makes students feel better about learning statistics. Recent research highlights the need to prepare teachers for statistical thinking skills and data literacy, which are becoming increasingly important in the curriculum (Biehler et al., 2021; Tatlı & Bulut, 2021).

2.1.2. Self-Efficacy as Context-Specific

Self-efficacy can vary from situation to situation. Harrell-Williams et al. (2015) examined this in the context of teaching statistics. They found that while pre-service teachers were confident that they could teach general arithmetic, they often did not feel the same way about teaching statistics. The authors used the Self-Efficacy in Teaching Statistics (SETS) instrument, which showed that pre-service teachers were more confident teaching simple things like graphs, but less confident about more difficult things like statistical inference or measures of relationships. Teacher preparation programs are beginning to see this problem. New frameworks now aim to support statistical reasoning and add data science into teaching (Zieffler & Fry, 2018; Biehler et al., 2021).

This context-specific nature of self-efficacy can create challenges for preservice teachers. They may view statistics as a difficult subject because it is abstract and relies on reasoning rather than simple steps (Estrada, Batanero, & Lancaster, 2011). As preservice teachers face these challenges, their self-efficacy in teaching statistics becomes crucial. This can help or hinder them from using good teaching methods that foster statistical thinking.

2.1.3. Impact of Self-Efficacy on Teaching Practices in Statistics

The importance of self-efficacy in teaching is clear. Tschannen-Moran and Hoy (2001) discovered that teachers who believe in themselves utilize more student-centered strategies. One of these is inquiry-based learning, which is vital for helping students improve their statistical thinking. These kinds of activities get kids involved and help them learn more about statistics. For instance, teachers who are sure of themselves might use real-world data projects. This helps pupils learn statistics in a more useful way.

On the other hand, pre-service instructors who don't believe in themselves may not want to teach complicated statistical concepts. They might use strategies that don't really teach statistical literacy (Harrell-Williams et al., 2017). Finney and Schraw (2003) discovered that people who are good at statistics are more likely to utilize tactics that help them think critically. To really understand statistical ideas, you need to use these tactics. Teachers who aren't sure of themselves might stay away from subjects like hypothesis testing or data interpretation. This can mean that students don't get to practice basic statistical concepts too much. Changes to the curriculum in Türkiye recently also encourage teaching statistics in a way that puts the learner first. This makes it even more vital for teachers to be sure of themselves (MEB, 2018).

2.1.4. Influence of Mastery Experiences on Self-Efficacy

Mastery experiences (real successes in teaching or learning statistical ideas) are some of the strongest influences on self-efficacy. Bandura (1997) explains that positive mastery experiences build confidence, especially in tough subjects like statistics. Tschannen-Moran and Hoy (2001) also show that preservice teachers who succeed in their teaching practicum or in simulations report higher self-efficacy for teaching.

For teaching statistics, D'Andrea and Waters (2002) recommend using active learning strategies. These give preservice teachers hands-on experience. Such experiences let them practice complex statistical ideas in a safe. This helps build confidence in their teaching skills. Harrell-Williams et al. (2015) suggest that giving preservice teachers structured chances to teach statistical content, along with feedback and reflection, can greatly boost their self-efficacy. This can lead to better teaching practices. New research also supports these active learning strategies, highlighting their importance for building 21st-century data literacy skills (Zieffler & Fry, 2018).

2.1.5. Role of Supportive Environments in Building Self-Efficacy

Supportive learning environments play an important role in self-efficacy. Nolan, Beran, and Hecker (2012) said that pre-service teachers are more active when they are supported by their instructors. This support increases their self-confidence in difficult subjects such as statistics. Williams (2010) showed that a warm and responsive instructor increases students' self-efficacy. It also reduces anxiety. For pre-service teachers, learning in an area where they can take risks without fear of judgment can increase their self-confidence.

Teacher training programs can help pre-service teachers by creating collaborative learning spaces. When pre-service teachers feel supported, they are more willing to engage with statistical content in greater depth. This leads to higher self-efficacy and better teaching. Franklin et al. (2007) argue that building statistical literacy should be an important part of pre-service education. Confidence in statistical knowledge is important for good teaching. In Türkiye, new curriculum guidelines support data-driven teaching. This situation highlights the need for supportive environments that will help teachers adapt (MEB, 2018; Tatlı & Bulut, 2021).

2.1.6. Implications for Teacher Preparation Programs

Self-efficacy is important in teaching statistics. This suggests that targeted support is needed in teacher education programs. Harrell-Williams et al. (2015) say that programs should create an environment where pre-service teachers can build self-efficacy in statistics.

General mathematics education may not address the challenges of statistical reasoning. Programs can add activities like data analysis projects, statistical simulations, and real-world examples. These give preservice teachers the experience they need to feel confident.

By helping preservice teachers build self-efficacy, teacher preparation programs can prepare them to use effective, inquiry-based methods. These methods promote statistical literacy. Preservice teachers will be more ready to teach statistics with confidence. They can help students develop analytical skills. This supports the bigger goal of building statistical literacy. As teacher education in Türkiye adds data literacy goals, giving this kind of targeted support is even more important (Tatlı & Bulut, 2021).

2.2. Statistical Anxiety

Statistical anxiety refers to feelings such as fear and tension. These feelings occur when working on statistical tasks (Onwuegbuzie and Wilson, 2003). Unlike general mathematical anxiety, which focuses on procedural and computational concerns, statistical anxiety involves abstract reasoning and data interpretation. This creates cognitive challenges for both students and educators (Baloglu, 2004). Chew and Dillon (2014) explain that statistical anxiety includes cognitive, emotional, and physiological aspects. This multidimensional structure makes statistical anxiety more complex than general mathematics anxiety (Macher et al., 2012). Recent studies emphasize that teacher education should directly address statistical anxiety. This can be done through integrated curriculum reforms and support strategies (Chang and Hanna, 2020; Tatlı and Bulut, 2021).

Statistical anxiety is especially seen among pre-service teachers. Many pre-service teachers may already feel nervous about their knowledge of statistics. These individuals often have negative experiences with mathematics or statistics in the past. Due to such experiences, they feel inadequate when faced with statistical tasks (Onwuegbuzie and Wilson, 2003). Paechter et al. (2017) emphasize that statistical anxiety often causes cognitive impairments. Among the cognitive impairments, avoidance behaviors, procrastination, and even physical symptoms such as faster heartbeat are also seen. Such behaviors can reduce the efficiency of the statistics learning process. This situation, in turn, affects the pre-service teacher's teaching ability.

2.2.1. Statistical Anxiety in Preservice Teachers

Statistical anxiety is a specific type of anxiety that affects individuals when they have to work with statistical tasks. This is especially true for tasks that involve abstract reasoning, data interpretation, and probabilistic concepts (Onwuegbuzie & Wilson, 2003). This anxiety is different from general mathematics anxiety, which is usually focused on computational tasks. Statistical anxiety involves fear related to analyzing, understanding, and interpreting statistical information (Baloglu, 2004). This type of anxiety is particularly important for pre-service teachers. They must not only understand statistics themselves, but also teach these concepts effectively in the classroom.

Chew and Dillon (2014) emphasize that statistical anxiety has cognitive, emotional, and physiological components. When these parts come together, it becomes a complex structure. The cognitive aspect includes negative self-evaluation. The emotional aspect includes feelings such as tension. Physiologically, statistical anxiety can cause symptoms such as increased heart rate and sweating. This makes it difficult to think and leads the individual to avoid statistical studies. Therefore, statistical anxiety becomes a serious problem in learning and teaching statistics (Macher et al., 2012). Recent curriculum changes in Türkiye emphasize that teachers need to develop data literacy. (MEB, 2018; Tatlı and Bulut, 2021). Therefore, we can say that statistical anxiety has become an important topic in teacher training programs.

2.2.2. Causes of Statistical Anxiety in Preservice Teachers

The sources of statistical anxiety in pre-service teachers are often diverse. According to Onwuegbuzie and Wilson (2003), individuals who have had negative experiences with mathematics in the past are also likely to have high statistical anxiety. These experiences can lead to a fear of failure. This is especially true when statistics is viewed as an abstract and difficult subject. Additionally, Macher et al. (2012) found that individuals with high anxiety are more likely to experience statistical anxiety.

Baloglu (2004) states that many pre-service teachers view statistics as more complex than general mathematics. This is because data analysis and inference are cognitive

processes. Recent research confirms that statistical anxiety involves uncertainty about interpretation and inference. Many pre-service teachers are anxious because of this uncertainty (Chang and Hanna, 2020). In addition, Harrell-Williams et al. (2017) found that pre-service teachers often find statistics topics difficult compared to other subjects. This perception increases their anxiety as they do not feel prepared to teach statistical content in their future classrooms.

2.2.3. Impact of Statistical Anxiety on Learning and Teaching

Pre-service teachers' learning and teaching processes are greatly affected by statistical anxiety. According to Paechter et al. (2017), avoidance behaviors are a result of high statistical anxiety. This avoidance creates self-confidence problems in pre-service teachers. Due to this situation, pre-service teachers may not be competent in teaching statistical concepts. In other words, teachers with high statistical anxiety may use rote or procedural methods. They may avoid inquiry-based approaches that develop statistical thinking. According to research, active learning strategies have been shown to reduce anxiety and support statistical reasoning (Zieffler & Fry, 2018; Chang & Hanna, 2020). Table 2.1 summarizes the increasing impact of statistical anxiety on teaching practices. In the table, we can see how anxiety affects confidence, engagement, and student learning outcomes.

Table 2.1. Impact of statistical anxiety on teaching practices.

Stage	Description
High Statistical Anxiety	Preservice teachers usually feel anxiety when they are learning statistics.
Fear of Making Mistakes	This anxiety makes the preservice teachers afraid of making mistakes while they solve problems.
Avoidance Behaviors	They start to avoid statistics tasks. This issue reduces practice and engagement.
Minimal Engagement with Statistics	It becomes difficult for preservice teachers who do not have enough practice in statistical subjects to understand.
Reduced Teaching Effectiveness	Teachers with low self-efficacy in teaching statistics have difficulty explaining the statistical concepts.
Negative Student Outcomes	Students begin to learn statistical topics inadequately, and the teacher's anxiety increases.

As we can see in Table 2.1, statistical anxiety is gradual. Initially, anxiety leads to avoidance behaviors. These behaviors reduce pre-service teachers' interaction with statistical topics. This lack of interaction negatively affects the teaching process. And later on, it affects students' learning outcomes. Targeted interventions are needed to eliminate this anxiety. These are different strategies such as mastery experiences, active learning strategies, and supportive teaching environments. Such approaches can break the anxiety cycle and increase teaching effectiveness. In the next section, we will discuss specific strategies to reduce statistical anxiety and increase pre-service teachers' confidence in teaching statistics.

2.2.4. Instructor Support and Mitigating Factors

Teacher support plays an important role in reducing statistical anxiety in pre-service teachers. Williams (2010) found that being approachable, open, and empathetic can reduce anxiety during the learning process. This supportive environment reduces pre-service teachers' fear. It also helps them engage in statistical tasks without worrying about judgment. Nolan, Beran, and Hecker (2012) support this finding also. They emphasise the positive effects of supportive teacher behaviors and constructive feedback. This types of support increase pre-service teachers' engagement in learning statistics.

Additionally, Keeley and colleagues (2008) explain the concept of “optimal anxiety.” They noted that optimal anxiety can increase motivation and focus. However, they said that too much anxiety is problematic for learning process. Finding this balance is important. They need optimal anxiety to stay engaged with statistical content, but not too much. Structured learning experiences can help pre-service teachers build their confidence. This approach reduces stress. The importance of this issue was also emphasized in the study conducted by Tatlı and Bulut (2021). They stated that instructor support is important when adding data science elements to the new curriculum. Such support allows pre-service teachers to gain confidence in teaching statistics (Tatlı and Bulut, 2021).

2.2.5. Implications for Teacher Preparation Programs

In order to overcome statistical anxiety, targeted interventions are needed in teacher education programs. D'Andrea and Waters (2002) recommend active learning strategies to

solve this situation. Active learning strategies help preservice teachers become more familiar with statistical concepts. They reduce anxiety and provide them with mastery experiences (Tschannen-Moran & Hoy, 2001).

In addition to that, Harrell-Williams et al. (2017) say that statistical teaching strategies can help preservice teachers overcome their anxiety. In this way, preservice teachers can develop self-confidence in statistics. As a result, teacher education programs ensure that preservice teachers are prepared to teach effectively. These recommendations are also in line with ongoing innovations in Türkiye's teacher education curriculum. The curriculum increasingly emphasizes statistical literacy and data analysis skills (MEB, 2018; Tatlı & Bulut, 2021).

2.3. The Relationship Between Statistical Anxiety and Self-Efficacy

There is an inverse relationship between statistical anxiety and self-efficacy. High levels of statistical anxiety usually lead to low statistical self-efficacy. Schneider (2011) stated that people with high statistical anxiety usually have low self-efficacy. This situation decreases the performance of pre-service teachers and reduces their interaction with statistical content. According to Perepiczka et al. (2011), low self-efficacy increases anxiety. Both factors are in a cyclical relationship with each other.

Low self-efficacy resulting from statistical anxiety can lead pre-service teachers to exhibit avoidance behaviors. Therefore, they do not want to be exposed to statistical content. This situation also decreases their chances of building confidence (Schneider, 2011). It is difficult to break such a cycle (Harrell-Williams et al., 2015).

There are many factors that affect this cycle. These ultimately shape how pre-service teachers interact with statistics education. Table 2.2 below shows the main factors that affect statistical anxiety and self-efficacy:

Table 2.2. Factors influencing statistical anxiety and self-efficacy.

Factor Category	Factor	Impact on Preservice Teachers
Negative Impact on Statistical Anxiety	Past Math Experiences	The negative situations experienced in education life in the past years lead to fear of statistics.
Negative Impact on Statistical Anxiety	Fear of Failure	Active participation in the educational process decreases due to the fear of making mistakes.
Negative Impact on Statistical Anxiety	Lack of Teaching Training	Not providing practical statistics training reduces self efficacy in teaching statistics.
Positive Impact on Self-Efficacy	Support Systems	Mentors and peer collaboration increase individuals' self-efficacy in statistics.
Positive Impact on Self-Efficacy	Instructor Support	Structured and timely feedback and encouragement increase preservice teachers' self-efficacy in teaching statistics.
Positive Impact on Self-Efficacy	Active Learning Strategies	Tasks related to real-life issues and inquiry learning skills provide positive effects.

As seen in Table 2.2, negative experiences with mathematics and fear of failure lead to the development of statistical anxiety. In contrast, positive teaching experiences and active learning strategies increase self-efficacy. These factors enable pre-service teachers to teach statistical concepts with confidence. Making sense of this process is critical for effective interventions. The interventions help reduce statistical anxiety and also build self-efficacy. In the next part, we will examine specific strategies and interventions that aim to break this negative cycle. In addition, this process is also very important in Türkiye. The latest curriculum, in particular, emphasizes developing data literacy in students. Therefore, teachers need to cope with their own statistical anxiety and build self-efficacy (MEB, 2018; Tatlı & Bulut, 2021).

2.3.1. Impact on Teaching Effectiveness

The relationship between self-efficacy and statistical anxiety in the statistical teaching process directly affects the classroom teaching process. Recent studies show that teachers with low self-efficacy often avoid complex topics. It is also known that such teachers use traditional teaching techniques. This limits the development of students' statistical reasoning (Zieffler and Fry, 2018; Chang and Hanna, 2020). According to Estrada et al. (2011),

confidence in statistics teaching is very important for effective teaching. Low self-efficacy can lead teachers to focus only on procedures in statistical subjects.

For preservice teachers, the connection between anxiety and self-efficacy affects the process of teaching statistics. Teachers who feel anxious are less likely to use creative activities. This situation, in turn, can reduce students' exposure to statistical concepts (Williams, 2010). Over time, this situation can affect students' attitudes and success towards learning statistics.

2.3.2. Instructor Support and Its Influence on Self-Efficacy and Anxiety

Teacher support plays an important role in reducing statistical anxiety and increasing self-efficacy. Encouraging behaviors from teachers can reduce students' statistical anxiety while also increasing their self-efficacy (Williams, 2010). A supportive learning environment creates a safe space for them without fear of being judged. Furthermore, Nolan et al. (2012) found that pre-service teachers' self-efficacy increases when they receive constructive feedback. This feedback helps pre-service teachers learn from their mistakes, which further reduces anxiety.

Harrell-Williams et al. (2017) emphasize that self-efficacy and anxiety can be improved with supportive interventions. As a result, teacher training programs have an important role in building pre-service teachers' confidence in statistics. Mentoring, collaborative learning environments, and structured feedback help pre-service teachers reduce statistical anxiety. The latest curriculum in Türkiye also emphasizes the importance of instructor support. According to Tatlı and Bulut (2021), instructor support helps us to build teachers' confidence in presenting data-driven lessons.

2.3.3. Mastery Experiences as a Pathway to Reduce Anxiety

Mastery experiences are an important factor in increasing an individual's self-efficacy (Bandura, 1997). Positive mastery experiences build confidence and reduce anxiety. This is also very effective in the statistical learning process of pre-service teachers. In addition, Harrell-Williams et al. (2015) also support practice-based interventions. They suggest that

as pre-service teachers become more successful in statistical tasks, their anxiety will naturally decrease. Active learning strategies play an important role in creating mastery experiences in statistics. They allow pre-service teachers to interact with data and statistical concepts in a comfortable environment. Pre-service teachers increase their self-efficacy by doing practical, inquiry-based activities. In this way, their statistical anxiety decreases. Some studies also emphasize adding mastery experiences to teacher education programs. (Zieffler & Fry, 2018; Chang & Hanna, 2020).

2.3.4. Moderate Anxiety as a Motivational Tool

Some researchers emphasize that a moderate level of anxiety can create motivation. This level of anxiety increases focus and participation in the individual. Keeley et al. (2008) defined this level of anxiety as "optimal anxiety". According to them, too much anxiety is harmful, but it is suggested that a moderate level of anxiety can increase motivation. In statistics teaching, a certain level of anxiety can push pre-service teachers to actively participate. Of course, it is necessary to keep this level of anxiety at an optimum level. Teacher training programs can balance this "optimal anxiety" with supportive interventions. Pre-service teachers can be in a productive learning process at an optimum level of anxiety (Nolan et al., 2012). For example, structured experiences that gradually increase in difficulty can enable pre-service teachers to develop coping strategies. Recent studies also emphasize the need to balance challenge and support. This balance helps build self-efficacy while maintaining productive anxiety levels (Chang & Hanna, 2020).

2.3.5. Implications for Teacher Education Programs

Understanding the relationship between statistical anxiety and self-efficacy is very important for teacher education programs. Harrell-Williams et al. (2017) emphasized that this relationship should be addressed early in the education of pre-service teachers. They suggest that this can prevent the development of negative attitudes towards statistical issues. For example, programs, workshops, and collaborative teaching opportunities can help develop both self-efficacy and reduce to statistical anxiety. A supportive environment can help pre-service teachers build the confidence. In addition to that, They can develop the skills they need for statistical concepts. Implementing such interventions can reduce the negative

effects of statistical anxiety. This process directly affects future students. Thus, pre-service teachers can adopt teaching practices that support students' statistical literacy in the future. We can observe that teacher education programs in Türkiye also focus on statistical literacy and data analysis. This situation emphasizes the need for such interventions (MEB, 2018; Tatlı & Bulut, 2021).

2.4. Interventions to Reduce Anxiety and Improve Self-Efficacy

2.4.1. Active Learning Strategies

According to the literature, we can say that active learning is one of the most effective ways to reduce anxiety and build self-efficacy. D'Andrea and Waters (2002) emphasize that the use of hands-on activities produces positive results. Some of these activities can be collaborative data analysis projects and problem-solving exercises. Such activities encourage pre-service teachers to actively engage with statistical concepts. Working directly with data provides pre-service teachers with practical experience. In this way, both their familiarity increases and their self-efficacy is strengthened. Harrell-Williams et al. (2015) also support active learning. They emphasize that such approaches are an important factor in developing self-efficacy. Hands-on activities offer pre-service teachers the chance to explore statistical ideas. Thus, they begin to build confidence in handling the material on their own. Some studies also support the use of technology-supported learning environments. These environments also encourage active participation and, again, help reduce anxiety in statistics education (Zieffler & Fry, 2018; Chang & Hanna, 2020).

2.4.2. Mastery Experiences and Scaffolding

Mastery experiences like active learning strategies can also reduce anxiety and increase self-efficacy in preservice teachers (Bandura, 1997). According to Tschannen-Moran and Hoy (2001), teachers feel more confident when they are successful in addressing difficult topics. On the other hand, implementing progressive learning can positively affect the self-efficacy of preservice teachers. For example, preservice teachers can start with basic statistical tasks. After that, they can move on to more advanced concepts.

In addition, Keeley et al. (2008) say that gradually increasing task difficulty supports “optimal anxiety”. In this way, students are not overwhelmed and they can actively participate. In this way, preservice teachers’ self-efficacy is gradually built. Other studies also suggest that tasks involving real-world data can increase preservice teachers’ confidence and improve their statistical reasoning (Zieffler & Fry, 2018; Tatlı & Bulut, 2021).

2.4.3. Supportive Learning Environments

A supportive learning environment also has positive effects on anxiety and self-efficacy. Williams (2010) argued that positive approaches from the instructor can reduce statistical anxiety. In this way, a less stressful environment is created. This type of environment is especially important for pre-service teachers. They can focus on statistical tasks without fear of being judged. They are also not afraid to take risks in such an environment. Nolan, Beran, and Hecker (2012) emphasized that feedback and constructive criticism are also important for creating self-efficacy. When pre-service teachers receive timely and constructive feedback, they can more easily complete their deficiencies. In this way, they can develop their skills without getting discouraged. Teacher training programs can create these supportive environments in different ways, such as peer evaluation sessions, mentoring opportunities. Such supportive measures not only reduce anxiety, but also help development. A supportive learning environment is very important for creating self-efficacy in difficult subjects such as statistics.

2.4.4. Collaborative Learning and Peer Support

Cooperative learning offers pre-service teachers the opportunity to work together and support each other. For example, group work can reduce anxiety on the individual by distributing the workload among several people. In this way, complex statistical tasks become more manageable.

According to Estrada et al. (2011), collaborative environments foster a sense of community. A sense of community reduces feelings of isolation and encourages a collective approach to problem solving. For pre-service teachers, this sense of community can increase

self-efficacy. They can see that others have similar difficulties and that solutions can be found by working together.

On the other hand, peer support provide pre-service teachers the environments where they can benefit from each other's experiences. According to Onwuegbuzie and Wilson (2003), students who participate in group learning feel lower statistical anxiety and higher self-efficacy. Therefore, cooperative learning is also important for teacher education programs. Another study emphasized the importance of peer learning for improving teachers' statistical literacy and reducing anxiety (Chang & Hanna, 2020).

2.4.5. Reflective Practices and Self-Assessment

Self-assessment is also important for pre-service teachers to track their progress and assess their understanding of statistical concepts. Harrell-Williams et al. (2015) argue that self-assessment helps pre-service teachers see their strengths and identify areas for development. In this way, they approach their educational processes more strategically. Pre-service teachers should regularly check their progress and self-assess. This process strengthens self-efficacy. Tschannen-Moran and Hoy (2001) also emphasized the importance of self-assessment. Pre-service teachers who can self-assess can recognize their successes and have more confidence in their abilities. Thus, their anxiety decreases.

2.4.6. Incorporating Real-World Applications

Using real-life examples in statistics education helps preservice teachers understand statistical concepts more deeply. Franklin et al. (2007) argue that statistical literacy should be based on real-life examples. This increases engagement and builds preservice teachers' confidence in applying statistics. By working with real data, preservice teachers gain hands-on experience in interpreting and analyzing data. These experiences increase their self-efficacy. Real-life applications also make statistics more concrete which helps reduce anxiety. Preservice teachers may be more motivated when they see how statistical methods are used in areas such as health and economics. D'Andrea and Waters (2002) reported that students who work with real data in applied settings have greater confidence in their statistical abilities. They can use their theoretical knowledges into practical outcomes. This

creates a sense of accomplishment. It also reduces anxiety and increases self-efficacy. Current approaches also emphasize the use of real-life data to increase motivation. This is also one of the main goals of Türkiye's latest mathematics curriculum (MEB, 2018; Zieffler & Fry, 2018).

2.5. Theoretical Framework

This study is based on Social Cognitive Theory (Bandura, 1997). This theory emphasizes the importance of self-efficacy. Self-efficacy affects motivation. It plays a significant role in education, especially in shaping how teachers deal with problems. Self-efficacy also affects how they choose teaching strategies and interact with students. According to the literature, teachers with high self-efficacy are more likely to use student-centered methods. On the other hands. teachers with low self-efficacy often rely on more traditional approaches (Tschannen-Moran & Hoy, 2001).

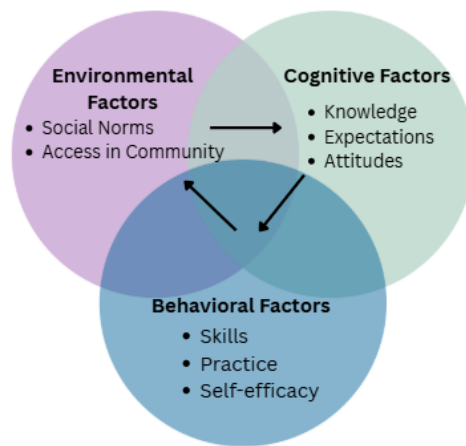


Figure 2.1. Social cognitive theory framework.

In Figure 2.1, we see how personal, behavioral, and environmental factors affect human learning and development.

When we look at this model in the context of teaching statistics, we can talk about the importance of self-efficacy. Statistics requires teachers to be able to transfer technical skills

to students and to encourage analytical reasoning in students. These skills are usually more abstract than standard mathematics subjects. (Finney & Schraw, 2003).

Self-efficacy in teaching statistics is context-specific. In other words, confidence in teaching general mathematics does not automatically mean confidence in teaching statistics. This distinction is important for pre-service teachers. Teaching statistics requires specific teaching techniques, such as data analysis and interpretation. These require abstract reasoning skills that are different from other areas of mathematics (Estrada et al., 2011).

Cognitive-Behavioral Theory provides additional insights for this study by looking at the role of statistical anxiety. Statistical anxiety is different from general math anxiety. Compared to math anxiety, statistical anxiety requires abstract thinking (Baloglu, 2004).

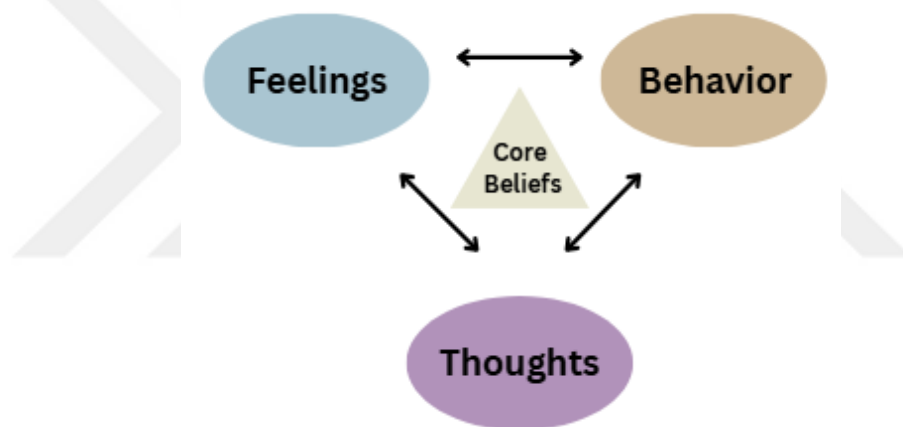


Figure 2.2. Cognitive-behavioral theory model for statistical anxiety.

Looking at Figure 2.2, we can see how thoughts, emotions, and behaviors interact in cognitive-behavioral processes. According to Macher et al. (2012), statistical anxiety can cause preservice teachers to become less attentive, which has an impact on their ability to learn and teach.

Social Cognitive Theory and Cognitive-Behavioral Theory provide a theoretical foundation for examining the relationship between self-efficacy and statistical anxiety in pre-service teachers. Table 2.3 summarizes the key theoretical concepts from both Social Cognitive Theory and Cognitive-Behavioral Theory and how they relate to this study.

Table 2.3. Theoretical foundations of the study.

Theory	Key Concept	Relevance to This Study
Social Cognitive Theory (Bandura, 1997)	Self-efficacy	It shows how preservice teachers' beliefs in their abilities affect their self-confidence and self-efficacy in teaching processes.
Cognitive-Behavioral Theory	Interactions between thoughts, emotions, and behaviors	It demonstrates how anxiety affects the educational process. It explains that increased anxiety leads to lower self-efficacy.
Mastery Experiences (Bandura, 1997)	Success in tasks increases self-confidence.	Positive learning experiences reduce anxiety and increase self-efficacy.
Avoidance Learning (Macher et al., 2012)	Avoidance increases anxiety.	Avoiding statistical tasks increases anxiety and decreases self-confidence over time.
Instructor Support (Williams, 2010)	Positive feedback reduces anxiety and increases self-confidence.	Supportive environments decrease anxiety and increase self-efficacy.

By combining these perspectives, this study aims to investigate the relationship between preservice teachers' self-efficacy and statistical anxiety.

2.6. Statement of the Problem

Statistics education is an important part of the modern life. It provides students with critical thinking skills to interpret data (Franklin et al., 2007). Pre-service teachers play an important role in this process. However, statistical anxiety and low self-efficacy in teaching statistics are quite common among pre-service teachers (Onwuegbuzie & Wilson, 2003; Baloglu, 2004; Schneider, 2011; Perepiczka, Chandler, & Becerra, 2011). This can cause them great problems in the future.

The literature is still insufficient on the problems of statistical anxiety and self-efficacy of pre-service teachers. Studies have examined at the combined effects of statistical anxiety and self-efficacy on pre-service teachers' preparedness to teach statistics, despite the fact that there is a substantial body of research on mathematics anxiety and general teaching self-efficacy.

This study aims to fill this gap by examining the link between statistical anxiety and self-efficacy in teaching statistics among pre-service teachers. By examining how these factors interact, the study hopes to provide insights for teacher preparation programs. These insights may help programs better support pre-service teachers in overcoming psychological barriers. They can also increase confidence and provide the skills needed for effective statistics teaching, which is especially important given the curriculum reforms that make statistics teaching a central responsibility for future educators in Türkiye (MEB, 2018; Tatlı & Bulut, 2021).



3. METHODOLOGY

3.1. Setting and Course Context

This study took place at a highly ranked public university in Türkiye. The school is known all over the world for its high academic standards. Located on the European side of Istanbul, overlooking the Bosphorus, it is considered one of the country's most prestigious universities. It was officially established in 1971 on the foundations of Robert College, the first American college founded outside the United States (in 1863). Since then, it has grown into a research-oriented, internationally recognized university. Instruction at the university is conducted entirely in English, which further strengthens its international profile.

3.1.1. Student Profile and Selectivity

The university accepts Türkiye's most academically successful students. Admission is based on a nationwide university entrance exam. In each academic year, the university enrolled approximately 16,497 students. Of these, 13,116 are undergraduate and 3,381 are graduate students. The Faculty of Education offers highly selective Mathematics Education programs. Each year, approximately 47 students are admitted to the primary mathematics education program and also approximately 21 students to the secondary mathematics education program. This competitive quota reflects both the programs' unique structure and the strength of their student profiles.

3.1.2. Teacher Education Programs

The faculty of education houses both primary mathematics education and secondary mathematics education programs. Both programs prepare pre-service teachers to teach mathematics, but their scope and focus differ. The primary mathematics education curriculum prepares educators for grades 5-8, while the secondary mathematics education program curriculum prepares educators for grades 9-12. Additionally, the primary mathematics curriculum emphasizes conceptual understanding and general pedagogy. In contrast, the secondary mathematics curriculum places greater emphasis on advanced

mathematical content, including abstract topics, than the primary mathematics curriculum. Secondary preservice teachers are expected to master mathematical concepts and translate them into effective teaching strategies for their students. However, secondary students face a heavier theoretical burden.

3.1.3. SCED 301: Statistics for Teaching I

All participants in this study had completed or taken SCED 301, a required third-year course in both programs. SCED 301 plays an important role in preparing preservice teachers for teaching statistics in the curriculum. This course covers

- Descriptive statistics (data representation, measures of central tendency, and variability)
- Normal distribution and standardized scores, probability and correlation (ranking, point-biserial, and multiple regression)
- Inferential statistics (t-tests, ANOVA, hypothesis testing, confidence intervals)
- The use of statistical software for data analysis and reporting.

The course develops both pre-service mathematics teachers' statistical knowledge and teaching skills. It helps prospective teachers learn the content while simultaneously practicing how to teach. In this way, SCED 301 serves as a bridge between statistical concepts and classroom practice. It helps preservice teachers learn not only how to perform statistical analyses but also how to explain concepts, design activities, and integrate examples that make statistics accessible to them.

3.1.4. Program Differences in Relation to SCED 301

Both mathematics education programs require SCED 301 as compulsory. In the primary mathematics education program, SCED 301 is supplemented by courses such as Teaching Probability and Statistics (SCED 354). These courses focus on statistics teaching strategies. In the secondary mathematics education program, students take fewer courses on statistics pedagogy. Their curriculum focuses instead on pure mathematics.

The difference of the curriculums may explain why the secondary preservice teachers in this study reported higher statistical anxiety and lower teaching self-efficacy than the primary preservice teachers.

Considering this study within the context of the university curriculum highlights an important point. Even highly selective and talented preservice teachers with strong academic backgrounds face challenges such as statistical anxiety.

3.2. The Framework

The study used a mixed-methods correlational research approach. The study used both quantitative surveys and qualitative interviews to look at the link between statistical anxiety and self-efficacy in teaching statistics among pre-service teachers who took the SCED 301 course at highly ranked public university. The quantitative element was used to find out how strong and in what direction this link was. The qualitative interviews helped us learn more about how pre-service teachers deal with statistical anxiety and teaching confidence, as well as their experiences and perceptions.

A correlational approach was found appropriate for this study, which measured the relationships between these psychological constructs without manipulating the variables (Creswell and Creswell, 2018). This study used a cross-sectional design that collected data at a single time point through both surveys and interviews. Including interviews strengthens the study by investigating why some pre-service teachers have high or low self-efficacy.

The sample included pre-service mathematics teachers enrolled in highly ranked public university's secondary mathematics education and primary mathematics education undergraduate programs. Participants are pre-service teachers who have successfully completed or are taking SCED 301. Approximately 41 participants completed the survey. Convenience sampling was used for the survey. Moreover, pre-service teachers were selected based on accessibility and willingness to participate. From this group, 8 participants who indicated their willingness to participate at the end of the survey were selected for interviews. Although the survey sample size may appear modest, it is sufficient for exploratory mixed-methods research and comparable to similar studies in the field (e.g.,

Baloglu, 2004; Perepiczka et al., 2011), especially since nonparametric analyses such as Spearman's rho are appropriate for smaller samples and the qualitative phase provides complementary depth.

Two validated instruments were used to measure the core constructs: the Statistics Anxiety Scale (SAS) and the Statistics Teaching Self-Efficacy (SETS). Interviews were also conducted to obtain in-depth perspectives on pre-service teachers' statistical anxiety and teaching confidence. In the survey phase, participants first completed a short demographic section.

Data were collected through online surveys and one-on-one interviews with pre-service teachers. The survey was conducted exclusively through Google Forms. Interviews were conducted via Zoom. Institutional approvals were obtained from the university before data collection began. Participants were provided with informed consent forms explaining the purpose of the study, their rights, and confidentiality measures. They were assured that their responses would remain anonymous and that they could withdraw at any time without any consequences.

The surveys take approximately 10–20 minutes to complete. The interviews lasted 20–30 minutes per participant.

SPSS (Statistical Package for the Social Sciences) was used to analyze the collected data. The primary statistical test, Spearman's rank correlation coefficient (ρ), was used to determine the relationship between statistical anxiety and self-efficacy. Spearman's rho test was chosen because the data did not meet the required normality assumptions. Therefore, Spearman's correlation was the most appropriate nonparametric test (Field, 2013). Descriptive statistics were also used to summarize the sample's responses. Thematic analysis (Braun & Clarke, 2006) for the qualitative interviews identified patterns, themes, and narratives related to anxiety, self-efficacy, and teaching preparation. Combining survey and interview data allowed for a more nuanced understanding of how preservice teachers deal with statistical challenges in education.

3.3. Sample

The sample of this study was pre-service mathematics teachers enrolled in highly the ranked public university's undergraduate programs in secondary mathematics education and primary mathematics education. All participants were pre-service teachers who had successfully completed or taken the SCED 301 – Inferential Statistics I course. In practice, this meant that while some participants had already completed the course, others were in the process of taking it during data collection. Because all participants were given the identical course material and tests, this difference is not expected to affect the results. The purpose of selecting this participant group was to ensure that the study included a consistent population in both statistical content knowledge and pedagogical preparation. By pedagogical preparation, this study refers to the set of methods and instructional courses embedded in the teacher education curriculum (e.g., teaching methods, microteaching, and practicum experiences). Although students may progress through these at slightly different stages depending on program requirements, all participants had received core methodological training as part of their programs, which reduces major differences in pedagogical preparation across individuals.

Approximately 110 eligible students could be reached within these programs. Data were collected from 41 participants for the survey phase. The survey used convenience sampling. For the qualitative phase, eight preservice teachers were selected from the survey respondents who volunteered for interviews. Six participants were from the primary mathematics education program, and two were from the secondary mathematics education program. The selection process was diversified based on SAS and SETS scores. Participants included those with high anxiety and low self-efficacy, as well as those with low anxiety and high self-efficacy.

Demographic factors were also considered when interpreting the responses. These included years in the program, previous statistics courses, and internship experience. Some participants had taken mathematics electives or additional statistics-related courses, such as "teaching statistics and probability." Others had only completed SCED 301. This contextual information provided a more nuanced basis for interpreting the qualitative findings and strengthened the credibility of linking interview results to the quantitative data.

Table 3.1 shows the summary of the sample part of the study.

Table 3.1. Sample distribution and selection criteria.

Participant Type	Selection Criteria	Sample Size	Purpose
Quantitative Phase	Preservice teachers who are in highly ranked public university, secondary mathematics or primary mathematics education program and have taken SCED 301	41 participants	Measuring statistical anxiety and self-efficacy using SAS and SETS
Qualitative Phase	Of the 8 interviewees, 2 were secondary (both high anxiety–low efficacy) and 6 were primary (profiles ranged from low–high efficacy to moderate). 2 had taken an extra statistics elective and completed internships, while the remaining 6 had only SCED 301 with no internship experience.	8 participants	Exploring deep perspectives on statistical anxiety and self-efficacy in teaching statistics

The study followed ethical research protocols. Institutional approval was obtained from highly ranked public university committees before data collection began. Each participant was given an informed consent form explaining their rights, the purpose of the study, and details about data use and storage. In this study, no personal data was collected from any participants. Confidentiality was ensured. All responses were anonymous. Participants were told that they might leave the study at any moment without any consequences. The study made sure that the sample process followed ethical standards.

3.4. Instruments

This study combined validated survey instruments with interviews to examine preservice teachers' statistical concerns and self-efficacy in teaching statistics. This study combined quantitative measures (SAS and SETS) with qualitative interviews. Participants completed a demographic form prior to the survey.

Interview participants were then purposively selected from survey volunteers. Their SAS and SETS scores, along with demographic information such as program type, year of study, and prior coursework, were considered in order to ensure that the qualitative phase represented a diverse range of anxiety and self-efficacy profiles

3.4.1. Demographic Questions

A brief demographic form was used to collect contextual background information from all participants. The form included the following questions:

- Gender (Male/Female/Not Specified)
- Age
- Teacher education program (e.g., Primary/Secondary Mathematics Education)
- Years in program

This demographic information helped interpret patterns seen in both the quantitative and qualitative findings.

3.4.2. Statistics Anxiety Scale (SAS)

The Statistics Anxiety Scale (SAS) was originally developed by Vigil-Colet et al. (2008). And then, the survey was adapted into Turkish by Durak and Karagoz (2021). It was used in this study to assess statistics anxiety among preservice teachers. Statistical anxiety is a critical factor that influences preservice teachers' willingness to engage in statistical content. The SAS offered an appropriate way to evaluate their emotional responses to learning and teaching statistics.

The original SAS includes 24 items, but the validated Turkish version has 23 items. One item was removed during adaptation for psychometric reasons. Participants rated each item on a 5-point Likert scale ranging from 1 = Strongly disagree to 5 = Strongly agree. The instrument is divided into three subtopics that measure different aspects of statistics anxiety:

- Examination Anxiety (EA): Stress and fear that come with taking statistics tests and exams
- Interpretation Anxiety (IA): Worry over being able to understand and explain statistical results.
- Asking for Help Anxiety (AHA): Feeling uncomfortable about asking for help about statistics-related tasks.

The SAS has been quite reliable, with internal consistency coefficients usually between $\alpha = 0.80$ and 0.90 in many research, including its Turkish version (Durak & Karagoz, 2021). Factor analyses have also shown that it is a good way to measure different aspects of statistics anxiety.

We used the verified Turkish version of the SAS for this investigation without making any changes. This option was made to be in line with other studies on statistics anxiety in preservice teachers.

3.4.3. Self-Efficacy to Teach Statistics (SETS)

The Statistics Teaching Self-Efficacy (SETS) tool developed by Harrell-Williams et al. (2015) was used in this study. The Turkish adaptation of the SETS tool was conducted by Batur, Güven, and Akoğlu (2020). The adapted version adapted the structure of the original tool while preserving it. The original SETS consisted of 26 items, while the Turkish version consisted of 24 items, and two items were removed during adaptation. Participants evaluated the items on a 6-point Likert scale ranging from 1 = Not at all confident to 6 = Completely confident. The teaching domains covered by the items are as follows:

- Explaining statistical measures
- Organizing and interpreting data
- Guiding students in statistical inference
- Distinguishing between correlation and causation

It showed high internal consistency for SETS with Cronbach's $\alpha = 0.94$, indicating reliability (Harrell-Williams et al., 2015). The Turkish version validated by Batur, Güven, and Akoğlu (2020) also showed strong reliability and validity. In this study, the validated Turkish version of SETS was used without any modifications to maintain consistency with previous research.

3.4.4. Interviews

The study interviewed eight pre-service teachers in addition to surveying them. These interviews aimed to understand their ideas, experiences, and methods to handle statistical anxieties and fostering self-efficacy. The interviews focused on these teachers' teaching issues, bringing qualitative dimension to the survey data. Participants were selected from those who volunteered to participate. A total of eight preservice teachers were interviewed, including six from the primary mathematics education program and two from the secondary mathematics education program. Selection considered their SAS and SETS profiles to capture variation (for example, high-anxiety low-efficacy as well as low-anxiety high-efficacy participants). Demographic factors such as year of study, prior statistics coursework, and internship experience were also noted. Some participants had only taken SCED 301, while others reported additional exposure through mathematics department electives or the “Teaching Statistics and Probability” course. So, the qualitative part could include a variety of experiences, and the connection between interview data and survey results was more likely to be accurate.

Demographic questions were asked at the beginning of the interview. These questions included gender, age, teacher education program (such as primary or secondary mathematics education), and the period they are in. An interview approach was used. The interviews provided insights into their perspectives, instructional methods, and anxiety control.

The interview design was inspired by Gorospe's (2022) research model. The variables were chosen based on the influence of teaching anxiety and self-efficacy. This framework emphasizes that teaching anxiety and self-efficacy are shaped by multiple interrelated factors, including

- perceived causes of statistics anxiety,
- coping strategies used by pre-service teachers,
- recommendations for reducing anxiety
- perceived self-efficacy in teaching statistics
- confidence development through teaching opportunities.

The variables were chosen based on the influence teaching anxiety and self-efficacy. Thus, Gorospe's model served as an a priori structure to organize the interview protocol, while still leaving room for inductive insights that emerged from participants' responses.

There were three sections to the interview protocol. Each part focused on a different component of the research. The questions are provided below.

Perceived Causes of Statistics Anxiety

The first part of the interview focused on perceived causes of statistics anxiety. Below are the questions for this subtheme.

- How would you describe your general experience with learning statistics during your teacher education program?
- What aspects of learning or teaching statistics made you most anxious?
- Have you ever stayed away from statistical content because it made you anxious? If so, can you tell me about a moment in your life?

Recommendations to Mitigate Statistics Anxiety

The second section includes questions about the strategies used by participants to reduce statistics anxiety. The results obtained in this section aimed to obtain results regarding teaching practices that can increase active participation and reduce anxiety. The questions to be asked in this section are listed below.

- What strategies did you use to reduce anxiety when learning statistics?
- If you could change one thing about how statistics was taught in your program, what would it be?

Self-Efficacy in Teaching Statistics

The third section included questions to assess the participants' statistical self-efficacy. The participants were asked about their confidence in teaching statistical concepts and their experiences in this process. These questions aimed to explore how pre-service teachers develop their self-efficacy in statistical education. The questions to be asked in this section are listed below.

- How confident are you when you are teaching statistical concepts to students?
- Have you ever explained or taught a statistical concept to someone before? How did this experience affect your confidence?
- What would make you feel more sure about teaching statistics?

This interview format comes from the idea that Gorospe put forward in 2022. The interview questions were designed to find the causes of statistics anxiety among pre-service teachers. They also aimed to explore effective strategies to reduce anxiety and increase self-efficacy in teaching statistics. The study used this structured model to make sure that the data collection was accurate and reliable.

The interviews were conducted via Zoom. Audio recordings were transcribed verbatim for thematic analysis. During analysis, Gorospe's framework provided the initial guiding categories, but coding was conducted openly to allow new subthemes to emerge from participants' responses. In this way, the process was structured but still kept its flexibility and was based on real facts. Along with the surveys, interviews were used to improve the study. The study used both quantitative data and qualitative data.

Table 3.2 shows the summary of the tools used in this study. In general, the purposes of the tools, data types, sample size, and application methods are given in the table.

Table 3.2. Overview of data collection instruments.

Instrument	Purpose of the Instrument	The Type of the Data	Sample Size	Method of Administration
Demographic Phase	Collects background and academic profile	Includes short answer and multiple choice items	41 preservice teachers	Online survey
SAS (Statistics Anxiety Scale)	Measures statistical anxiety levels	Quantitative, Likert scale, 23 items	41 preservice teachers	Online survey via Google Forms
SETS (Self-Efficacy to Teach Statistics)	Measures self-efficacy to teach statistics	Quantitative, Likert scale, 24 items	41 teachers	Online survey via Google Forms
Interviews	Explores perceptions of statistical anxiety and self-efficacy in teaching statistics	Qualitative (8 open-ended questions)	8 preservice teachers	Zoom

3.5. Data Collection

In this study, data were collected in two stages. This method provided both quantitative breadth and qualitative depth by combining surveys with interviews. In this way, the relationship between statistical anxiety and self-efficacy in teaching statistics among pre-service teachers was understood in this study.

In the first stage, structured online surveys were used. The surveys included the Self-Efficacy in Teaching Statistics (SETS) and the Statistics Anxiety Scale (SAS). In addition, demographic questions were asked before the surveys in order to obtain information about the sample. The same demographic form was used before both the survey and the interviews to ensure consistency across data sources.

The surveys were distributed via Google Forms to ensure easy access. The survey link was shared through university email announcements and with the help of my thesis supervisor, who is also the instructor of the course. Pre-service teachers were given sufficient time to complete the survey.

Participants were asked to read the informed consent form before beginning the survey. This form explained the purpose of the study, their rights as participants, and the confidentiality measures implemented. Participants were assured of anonymity. No personal information was collected. Participants were informed that participation was voluntary and that they could withdraw at any time without any consequences.

The two surveys typically took 10 to 20 minutes to complete. Once data collection was complete, all responses were securely stored in password-protected files. 41 participants were ultimately included in the survey phase. For the qualitative phase, eight participants were included in the qualitative phase from among those survey participants who indicated their willingness to participate in the survey.

The second phase consisted of interviews conducted via Zoom with willing pre-service teachers. Interviewees were purposively selected based on their SAS and SETS scores, program type (primary or secondary), year of study, prior coursework, and internship experience, so that the qualitative sample reflected a diverse range of anxiety and self-efficacy profiles. Participants completed interviews in approximately 20–30 minutes. The interviews included eight open-ended questions. Participants completed interviews in approximately 20–30 minutes. The interviews included eight open-ended questions. These questions are related to the participants' personal experiences learning statistics, their confidence in teaching statistics, difficulties with statistics anxiety, and strategies which they are used to decrease their anxiety. The qualitative data supports the quantitative data, It provides a deeper look at individual perspectives and challenges that cannot be fully captured with numerical data alone.

ATLAS.ti was used to analyze the interview transcripts. Open coding was performed line by line to capture key phrases and recurring patterns. Codes were then examined for frequency and overlap. They were then grouped into broader categories that formed key themes. Part of the coding was inductive, allowing new ideas to emerge. At the same time, the process was guided by Gorospe's framework on teaching anxiety and self-efficacy. This approach based the analysis factors on the experiences of the participants while also relating them to the literature.

Before any data was collected, permission was obtained. The study hypothesized that pre-service teachers with high levels of statistical anxiety would demonstrate low levels of self-efficacy in teaching statistics.



4. DATA ANALYSIS

4.1. Descriptive Statistics

Descriptive statistics were used to summarize the demographic characteristics of participants. In addition to that they were also used to summarize participants' responses on SAS and SETS. Frequencies and percentages were calculated for categorical demographic variables such as gender, and year in the program.

For the SAS and SETS instruments, means, standard deviations, minimum, and maximum scores were used for both SAS and SETS total scores. These descriptive results provided a foundation for the next inferential analyses. They give a clear overview of participants' responses.

In addition to the survey group, eight preservice teachers joined the qualitative phase through semi-structured interviews. Six were from the primary mathematics education program, and two were from the secondary program. The participants reflected a variety of SAS and SETS profiles. Some had high anxiety and low self-efficacy. Others showed moderate levels, while some had low anxiety and high self-efficacy. Most interviewees were in their third or fourth year of study. Several also had prior internship experience. All had completed SCED 301. Some had also taken extra courses, such as mathematics electives or “teaching statistics and probability”. This variation added strength to the qualitative findings. It ensured that the perspectives represented different program backgrounds, anxiety and efficacy levels, and academic experiences.

4.2. Inferential Statistics

Inferential statistical methods were used to examine the relationship between pre-service mathematics teachers' statistical anxiety levels and their self-efficacy in teaching statistics. The primary test used was Spearman's rank correlation coefficient (ρ). This test assessed the strength and direction of the monotonic relationship between total SAS scores and SETS scores. Before selecting the correlation test, Shapiro-Wilk statistic is used to test

normality. The result indicated that both SAS_TOTAL ($p < .001$) and SETS_TOTAL ($p = .003$) values are not normally distributed in Appendix E (see Table E.1). Therefore, Spearman's rho was chosen as the appropriate measure of correlation for these data. The significance level for inferential tests was set at $\alpha = 0.05$. SPSS was used to analyse.

Alongside the correlation analysis (RQ2), subgroup comparisons were performed to address RQ2a and RQ2b. The analysis use Mann–Whitney U tests. They help tp examine whether SAS and SETS scores showed significant differences by program type (primary vs. secondary) and by gender (female vs. male). These nonparametric tests were chosen because the data did not meet normality assumptions and group sizes were unequal.

4.3. Quantitative Analysis

Qualitative data from interviews were analyzed using thematic analysis. This approach helped to identify themes related to pre-service mathematics teachers' experiences of statistical anxiety and self-efficacy in teaching statistics.

Coding was conducted both inductively and deductively. Inductive coding guided the emergence of themes directly from the participants' perspectives, while deductive coding utilized Gorospe's (2022) framework. Therefore, thematic development incorporated both participant-driven insights and established theoretical categories.

To make the study more reliable and trustworthy, it used peers examine the coding process and writing out the reasons for analytical judgements clearly. ATLAS.ti is used to organise the data. The software allows researchers to upload transcripts and code text parts. Similar codes can be grouped into categories and then organized into broader themes. It also offers frequency counts and visual tools, such as code networks and maps. These features make the coding process more open and strict. The emerging themes offered a more significant perspective for interpreting the data. The qualitative study enhanced comprehension of the relationship between statistical anxiety and self-efficacy. This supported the study's mixed-methods approach.

4.4. Integration of Quantitative and Qualitative Data

This study used mixed methods to combine both quantitative and qualitative data. The aim of the study is to understand the relationship between statistical anxiety and self-efficacy among pre-service mathematics teachers.

On one hand, quantitative data from the SAS and SETS instruments demonstrated relationships between statistical anxiety and self-efficacy. Qualitative interviews, on the other hand, provided a more in-depth explanation of why these patterns exist. For example, themes from the interviews helped explain why some participants had high/low levels of statistical anxiety.

The aim was to generate more meaningful results from the study by comparing and connecting the results from both quantitative and qualitative phases. The integrated approach provided a more nuanced understanding of pre-service teachers' experiences. It also provided guidance for future research to design interventions to reduce statistical anxiety and strengthen statistical self-efficacy.

5. RESULTS

5.1. Participant Demographics

A total of 41 pre-service mathematics teachers who have taken or are taking SCED 301 at highly ranked public university participated in the study. Table 5.1 shows the distribution of participants by gender. Of these, 25 participants (61.0%) were female and 16 participants (39.0%) were male.

Table 5.1. Distribution of participants by gender.

Gender	Frequency	Percent
Male	16	39.0%
Female	25	61.0%
Total	41	100.0%

Table 5.2 shows the distribution of participants by teacher education program. Of the 41 participants, 28 (68.3%) were enrolled in an undergraduate program in primary mathematics education. 13 participants (31.7%) were enrolled in an undergraduate program in secondary mathematics education.

Table 5.2. Distribution of participants by teacher education program.

Program	Frequency	Percent
Primary Mathematics Education	28	68.3%
Secondary Mathematics Education	13	31.7%
Total	41	100.0%

5.2. Quantitative Findings on Statistical Anxiety and Self-Efficacy Among Preservice Teachers

5.2.1. Descriptive Statistics for SAS and SETS Scores

Table 5.3 summarizes the descriptive statistics for SAS and SETS scores. The mean SAS score was 64.24 (SD = 22.60), with scores ranging from 33 to 98. The mean SETS score was 101.25 (SD = 28.09), with scores ranging from 56 to 144. These values indicate moderate levels of general statistical anxiety and relatively high levels of self-efficacy in the sample.

Table 5.3. Descriptive statistics for SAS_TOTAL and SETS_TOTAL scores.

Scale	N	Minimum	Maximum	Mean	Std. Deviation
SAS_TOTAL	41	33.00	98.00	64.24	22.60
SETS_TOTAL	40	56.00	144.00	101.25	28.09

Figure 5.1 shows a histogram of SAS_TOTAL scores, and Figure 5.2 shows a histogram of SETS_TOTAL scores. These plots show the distribution of statistical anxiety and self-efficacy levels in the sample.

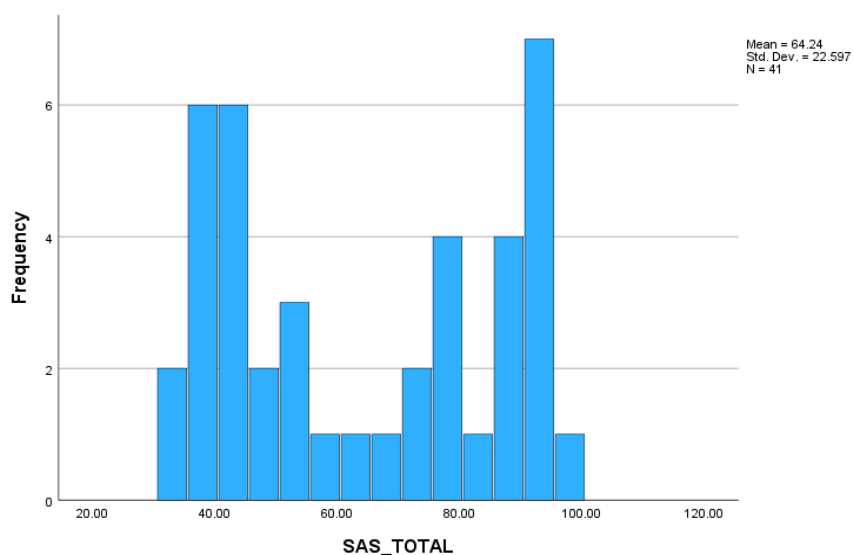


Figure 5.1. Histogram of SAS_TOTAL scores.

The histogram displays the distribution of statistical anxiety scores among preservice teachers.

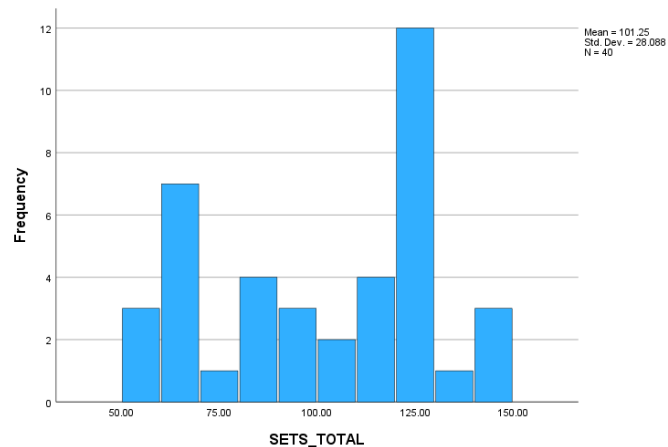


Figure 5.2. Histogram of SETS_TOTAL scores.

The histogram illustrates the distribution of self-efficacy in teaching statistics among preservice teachers.

In addition, mean SAS and SETS scores by gender and by program are observed; inferential comparisons are discussed in Section 5.2.3. In the session, the patterns were explored in more detail.

5.2.2. Correlation Analysis

This section discusses the results of the Spearman's rank correlation analysis. This study's purpose is to examine the relationship statistical anxiety and self-efficacy in teaching statistics among pre-service teachers.

Table 5.4. Spearman's correlation between statistical anxiety and self-efficacy in teaching statistics.

Variables	SAS_TOTAL	SETS_TOTAL
SAS_TOTAL	1	-.890**
SETS_TOTAL	-.890**	1

Note. $p < .001$ (2-tailed).

Table 5.4 shows the Spearman correlation coefficient between the total scores on the Statistics Anxiety Scale (SAS_TOTAL) and the Statistics Teaching Self-Efficacy Scale (SETS_TOTAL).

The analysis revealed a very strong, negative, and statistically significant relationship between these two variables (The result is $\rho = -.890$, $p < .001$). This finding shows that there is a significant relationship between statistical anxiety and self-efficacy in teaching statistics among preservice teachers. The negative direction of the correlation confirms the hypothesized inverse relationship. In addition to that, the magnitude of the result is extremely high ($|\rho| = .890$). The finding is particularly significant, according to Cohen's (1988) guidelines, correlations above .50 are classified as high.

According to the finding, there is a strong relationship between statistical anxiety and preservice teachers' self-efficacy in teaching statistics. This strong inverse relationship may be important for teacher education programs.

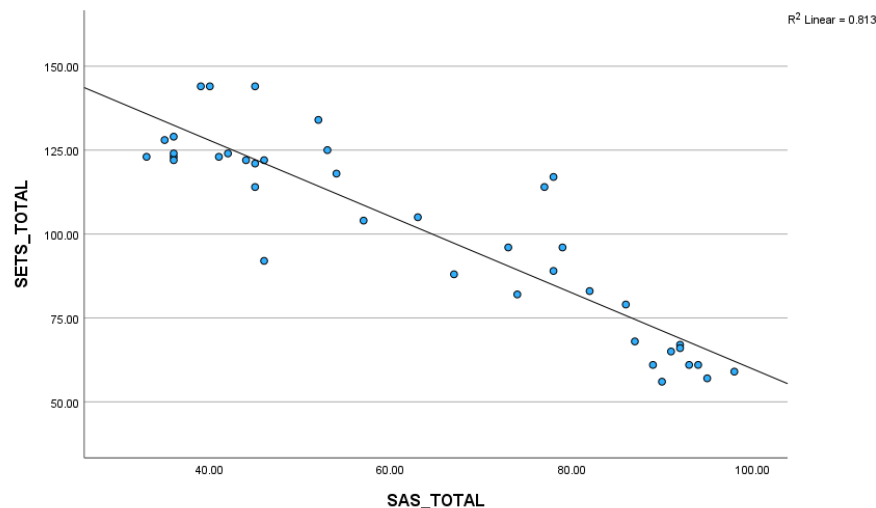


Figure 5.3. Scatterplot of SAS_TOTAL and SETS_TOTAL scores.

Considering the Figure 5.3, a strong negative correlation exists between statistical anxiety among preservice teachers and self-efficacy in teaching statistics. This result may highlight the importance of addressing statistical anxiety in preservice teacher education.

Educational programs can consider various interventions to reduce statistical anxiety and strengthen self-efficacy in teaching statistics among preservice teachers. Some of these interventions could include mastery experiences, supportive learning environments, and active learning activities. By addressing this relationship, teacher education programs can create an educational environment that fosters self-confidence in pre-service teachers. This environment of confidence will positively impact statistics learning. Thus, pre-service teachers, the future teachers, can be better prepared to teach statistical concepts. This, in turn, will positively impact the pre-service teacher's teaching process. This attitude can increase student engagement in the classroom and positively improve learning outcomes.

5.2.3. Comparison by Demographics

In line with RQ2a and RQ2b, subgroup analyses were conducted to compare SAS and SETS scores by gender (female vs. male) and program type (primary vs. secondary). Mann–Whitney U tests were employed because the data violated normality assumptions and group sizes were unequal.

5.2.3.1. Comparison by Gender. Table 5.5 shows the means and standard deviations of SAS and SETS scores by gender. The mean SAS score for male participants was 63.94 (SD = 26.54). On the other hand, the mean SAS score for female participants was 64.44 (SD = 20.27). These values are quite similar, indicating that statistical anxiety were similar among male and female preservice teachers in the sample.

On the other hand, the mean SETS score for female participants was slightly higher (Mean = 103.12, SD = 24.96) than for male participants (Mean = 98.13, SD = 33.36). While these differences are descriptive, inferential tests were used to determine their statistical significance.

Table 5.5. Means and standard deviations of SAS and SETS scores by gender.

Gender	N (SAS)	Mean (SAS)	SD (SAS)	N (SETS)	Mean (SETS)	SD (SETS)
Male	16	63.94	26.54	15	98.13	33.36
Female	25	64.44	20.27	25	103.12	24.96
Total	41	64.24	22.60	40	101.25	28.09

To test for group differences, Mann-Whitney U tests were performed for SAS_TOTAL and SETS_TOTAL scores by gender. This nonparametric test was chosen because normality assumptions were violated for both variables.

Table 5.6 shows the results of the Mann-Whitney U test for SAS_TOTAL by gender. The results do not show a statistically significant difference between male and female preservice teachers compared to the genders ($U = 195.50$, $Z = -0.12$, $p = .904$). The mean ranks were almost same. And it indicates that male and female preservice mathematics teachers have similar statistical anxiety.

Table 5.6. Mann–Whitney U Test results for SAS_TOTAL by gender.

Part 1: Group Ranks

Gender	N	Mean Rank	Sum of Ranks
Male (1)	16	20.72	331.50
Female (2)	25	21.18	529.50
Total	41		

Part 2: Test Statistics

Statistic	Value
Mann–Whitney U	195.500
Z	–0.120
Asymp. Sig. (2-tailed)	.904

Note. Grouping Variable: Gender (1 = Male, 2 = Female).

The Figure 5.4 also compares statistical anxiety scores between male and female preservice mathematics teachers. The distributions appear generally similar also here. The figure is also consistent with the non-significant Mann-Whitney U test result.

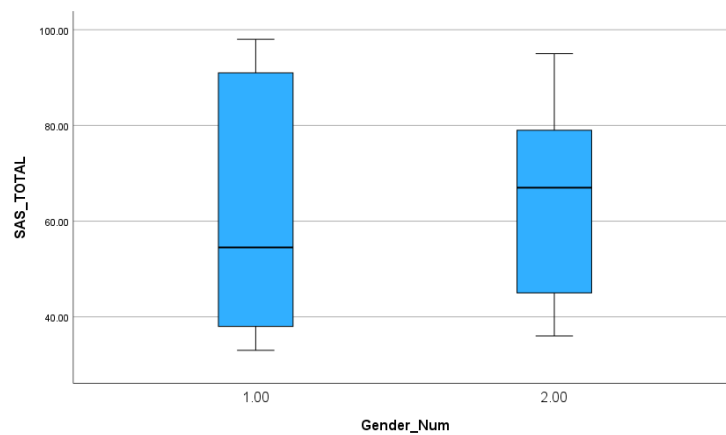


Figure 5.4. Boxplot of SAS_TOTAL by gender.

Table 5.7 also shows the results of the Mann-Whitney U test for SETS_TOTAL scores by gender. The SETS_TOTAL results indicated no statistically significant difference between male and female pre-service teachers ($U = 175.50$, $Z = -0.34$, $p = .737$). The average ranks for males and females were very close to each other, suggesting that both groups had similar levels of self-efficacy in teaching statistics.

Table 5.7. Mann–Whitney U Test results for SETS_TOTAL by gender.

Part 1: Group Ranks

Gender	N	Mean Rank	Sum of Ranks
Male (1)	15	19.70	295.50
Female (2)	25	20.98	524.50
Total	40		

Part 2: Test Statistics

Statistic	Value
Mann–Whitney U	175.500
Z	−0.336
Asymp. Sig. (2-tailed)	.737

Note. Grouping Variable: Gender (1 = Male, 2 = Female).

The Figure 5.5 shows SETS scores by gender. The distributions and medians are similar, supporting the finding of no significant difference.

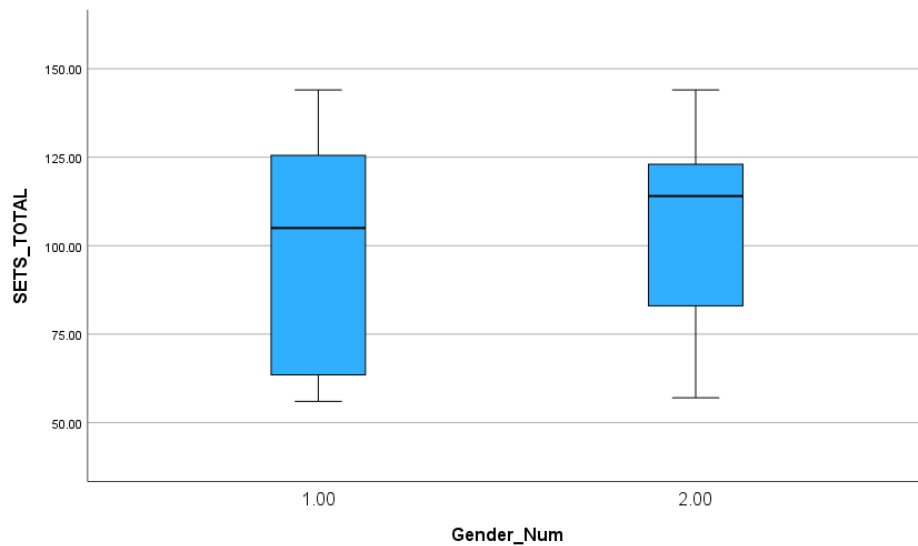


Figure 5.5. Boxplot of SETS_TOTAL by gender.

These findings are consistent with previous research. Onwuegbuzie and Wilson (2003) indicated that gender differences in statistical anxiety are generally minimal among preservice teachers. Similarly, no significant difference was found in SETS scores. Male and female preservice mathematics teachers in this sample appear to have similar self-efficacy in teaching statistics.

5.2.3.2. Comparison by Program. Table 5.8, as in the previous section, summarizes the means and standard deviations of SAS and SETS scores by teacher education program. This table shows that pre-service teachers enrolled in the primary mathematics education program had a lower SAS score (Mean = 59.64, SD = 20.28). In contrast, pre service teachers enrolled in the secondary mathematics education program had a higher SAS score (Mean = 74.15, SD = 24.91). This suggests that pre-service teachers enrolled in the secondary mathematics teaching program experienced higher levels of statistical anxiety.

Furthermore, when we examine self-efficacy, pre-service teachers enrolled in the primary mathematics education program had a significantly higher SETS score (Mean = 108.00, SD = 23.35). In contrast, pre-service teachers enrolled in secondary mathematics teacher education programs had lower SETS scores (Mean = 85.50, SD = 32.74). This suggests higher teacher confidence in the primary group.

Table 5.8. Means and standard deviations of SAS and SETS scores by program.

Program	N (SAS)	Mean (SAS)	SD (SAS)	N (SETS)	Mean (SETS)	SD (SETS)
Primary Mathematics Teacher Education	28	59.64	20.28	28	108.00	23.35
Secondary Mathematics Teacher Education	13	74.15	24.91	12	85.50	32.74
Total	41	64.24	22.60	40	101.25	28.09

To determine whether these observed differences were statistically significant, Mann-Whitney U tests were conducted for both SAS_TOTAL and SETS_TOTAL scores by program type. This nonparametric test was chosen because of violations of normality assumptions.

As seen in Table 5.9, results for SAS_TOTAL showed a statistically significant difference between programs ($U = 110.50$, $Z = -2.005$, $p = .045$). Participants in the secondary mathematics education program had higher mean ranks (26.50) than those in the primary mathematics education program (18.45). This indicates higher levels of statistical anxiety among secondary preservice teachers.

Table 5.9. Mann–Whitney U Test results for SAS_TOTAL by program.

Part 1: Group Rank			
Program	N	Mean Rank	Sum of Ranks
Primary (1)	28	18.45	516.50
Secondary (2)	13	26.50	344.50
Total	41		
Part 2: Test Statistics			
Statistic			Value
Mann–Whitney U			110.500
Z			–2.005
Asymp. Sig. (2-tailed)			.045
Note. Grouping Variable: Program (1 = Primary Mathematics Education Program, 2 = Secondary Mathematics Education Program).			

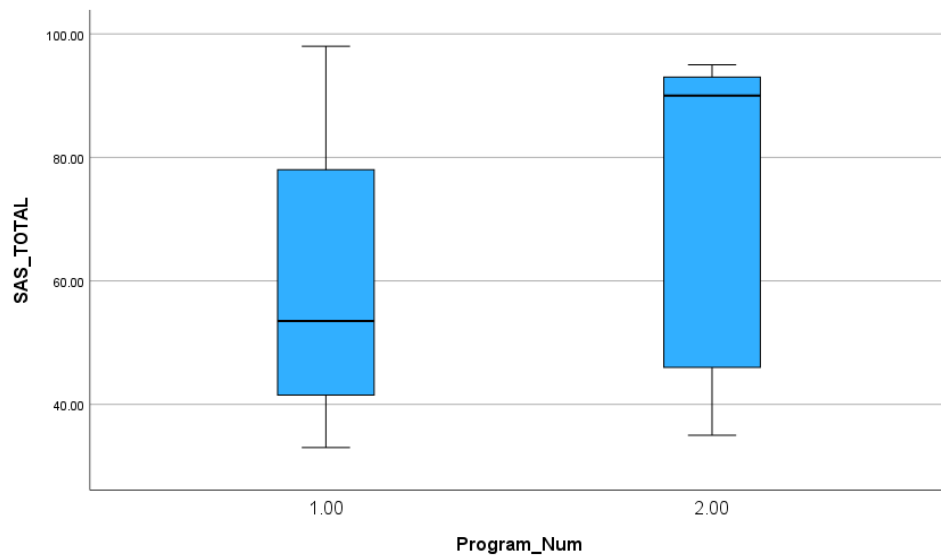


Figure 5.6. Boxplot of SAS_TOTAL by program.

Figure 5.6 shows that pre-service teachers enrolled in the secondary mathematics education program had higher statistical anxiety. This finding is also consistent with the Mann-Whitney U test result.

As seen in Table 5.10, the SETS_TOTAL results revealed a significant difference between the programs ($U = 102.00$, $Z = -1.950$, $p = .051$). Pre-service teachers enrolled in the primary mathematics program had a higher mean rank (22.86) than pre-service teachers enrolled in the secondary mathematics program (15.00). Based on this, it can be argued that pre-service teachers enrolled in the primary mathematics program demonstrated higher self-efficacy in teaching statistics, but the difference was just above conventional significance thresholds.

Table 5.10. Mann–Whitney U Test results for SETS_TOTAL by program.

Part 1: Group Ranks			
Program	N	Mean Rank	Sum of Ranks
Primary (1)	28	22.86	640.00
Secondary (2)	12	15.00	180.00
Total	40		
Part 2: Test Statistics			
Statistic			Value
Mann–Whitney U			102.000
Z			–1.950
Asymp. Sig. (2-tailed)			.051
Note. Grouping Variable: Program (1 = Primary Mathematics Education Program, 2 = Secondary Mathematics Education Program).			

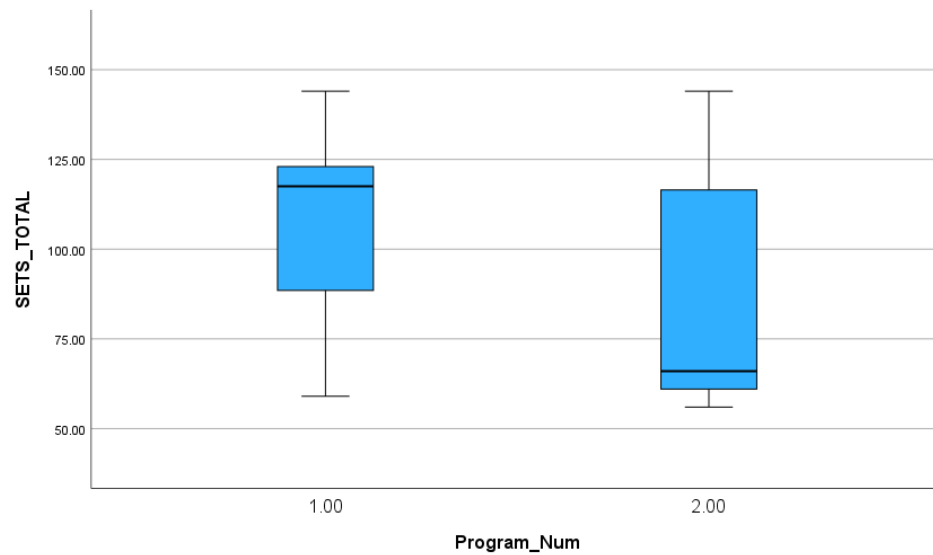


Figure 5.7. Boxplot of SETS_TOTAL by program.

Figure 5.7 shows self-efficacy scores by study program. Pre-service teachers enrolled in the primary mathematics program generally demonstrated higher self-efficacy, which is consistent with the marginally significant test result.

These findings suggest that pre-service teachers enrolled in the secondary mathematics education program face different challenges. Based on the findings, participants in secondary mathematics programs showed higher statistical anxiety and slightly lower self-efficacy in teaching statistics. These differences between the two education programs may have occurred due to differences in curricula or participants' previous experience with statistical content. Rather than a definitive conclusion, this pattern may point to potential gaps in teacher education programs that could be explored further in the discussion section.

5.3. Qualitative Results

This section presents findings from interviews with pre-service mathematics teachers. The qualitative phase aims to identify the causes of pre-service mathematics teachers' statistics anxiety, the strategies they use to reduce it, and their confidence in their statistics teaching skills.

After the interviews were completed, the audio recordings were transcribed for qualitative analysis. Each transcript was carefully read and coded line by line. Similar codes were then grouped into broader categories to identify meaningful patterns and themes.

Table 5.11 presents the final codes and their explanations. This table clarifies how specific ideas were identified and grouped.

Table 5.11. Codes and their explanations

Code	Explanations
Anxiety and Stress About Teaching Statistics	Anxiety about explaining the statistical content
Avoidance Behavior	Delaying statistics topics
Coping Strategies Used	The ways participants used to reduce their anxiety level
Recommendations for Instruction	Participants' ideas to help teacher education programs reduce preservice teachers' anxiety
Self-Efficacy Level	Participants' self-confidence in teaching statistics
Confidence Development	Participants' descriptions of how they improved their confidence levels, often via teaching practice

Figure 5.8 is a screenshot from ATLAS.ti showing how the codes were organized into thematic groups. This screenshot also shows the coding frequency across the dataset. The “grounded” in the screenshot indicates how frequently each code was applied. For example, "Anxiety and Stress About Teaching Statistics" was the most frequently used code, with 29 instances. This issue highlights its importance in participants' responses. "Recommendations for Instruction"(24 instances) and "Coping Strategies Used" (19 instances) were also common. These results suggest that participants strongly focused on the strategies to reduce their anxiety level. In other words, these frequencies highlight how preservice teachers not only emphasized their struggles but also gave substantial attention to possible coping and instructional strategies. Thus, the coding counts provide a quantitative complement to the qualitative analysis.

“Confidence Development” (14 instances) and “Self-Efficacy Level” (18 instances) reflect how participants built their confidence in teaching statistics. “Avoidance Behavior” (12 instances) also emerged as a significant, though less frequent, response pattern.

Reporting the distribution of code frequencies shows that the study was done systematically. It also makes the framework of the themes clearer. Qualitative results becomes more reliable thanks to this issue.

Name	Grounded	Density	Groups
◇ Anxiety and Stress About Teaching Statistics	29	0	[Perceived Causes of Statistics Anxiety]
◇ Avoidance Behavior	12	0	[Perceived Causes of Statistics Anxiety]
◇ Confidence Development	14	0	[Self-Efficacy in Teaching Statistics]
◇ Coping Strategies Used	19	0	[Recommendations to Mitigate Statistics Anxiety]
◇ Recommendations for Instruction	24	0	[Recommendations to Mitigate Statistics Anxiety]
◇ Self-Efficacy Level	18	0	[Self-Efficacy in Teaching Statistics]

Figure 5.8. Screenshot of ATLAS.ti code manager displaying codes and groups.

A second rater coded the transcripts using the same coding framework to make the coding process more reliable. The codes were carefully compared line by line. Cohen's Kappa coefficient was used to see how much the coders agreed with each other. Agreement rates is approximately 90%, which is a good sign of dependability for qualitative research (Creswell & Creswell, 2018).

5.3.1. Perceived Causes of Statistics Anxiety

Under this theme, participants discussed factors that make learning and teaching statistics challenging. Preservice teachers talked about sources of anxiety such as fear of making mistakes or avoidance of complex topics. Analysis of their interview data revealed two primary patterns. These patterns are anxiety and stress about teaching statistics, and avoidance behaviors that reduce engagement with more challenging content.

5.3.1.1. Anxiety and Stress About Teaching Statistics. Participants generally reported anxiety about correctly explaining statistical concepts, appropriately interpreting data, and selecting appropriate tests. Their anxiety often stemmed from making mistakes in front of students, oversimplifying important ideas, or lacking confidence in answering questions. This type of stress was thought to undermine their perceived preparedness to teach statistics.

One example came from a third-year secondary mathematics education student (P2). This participant had a high SAS score, a low SETS score, and had only completed SCED 301 without internship experience. She said: “I get especially nervous about remembering which statistical test to use in different situations, and even more about trying to explain the

formulas to someone else.” This supports the survey result that secondary preservice teachers often reported higher anxiety and lower self-efficacy than their primary peers.

In contrast, a fourth-year primary mathematics education student (P3) had low SAS scores, high SETS scores, and extra experience from an elective course and internship. "My biggest worry is getting questions from students unexpectedly that I can't answer right away," they shared. It shows that this the anxiety makes teaching less effective.

In the third year of primary education program, P4, another participant showed moderate anxiety and moderate efficacy. He had only taken SCED 301. He said, "I get pretty nervous when I have to clearly explain graphs and talk about how data changes over time. When I try to talk about those ideas with my students, I worry that I might oversimplify them or make no sense to them." This shows that third-year students who don't have any extra classes or internships often feel unprepared to clearly explain what they're learning, even though their general anxiety level isn't as high as that of high school students.

Figures 5.9, 5.10, and 5.11 show coding examples for these participant statements.

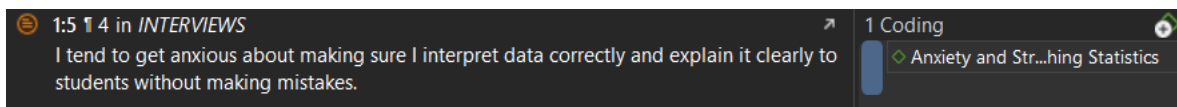


Figure 5.9. Coding examples.

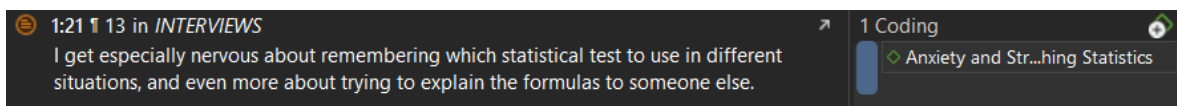


Figure 5.10. Coding examples.

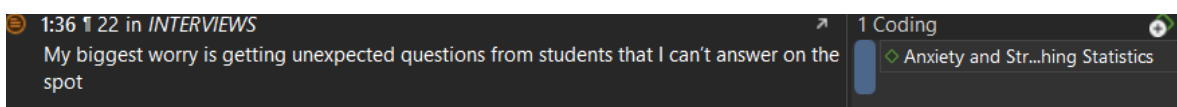


Figure 5.11. Coding examples.

The interviews showed clear differences by program type and year of study. Third-year secondary preservice teachers , who had usually taken only SCED 301, reported high

anxiety and very low self-efficacy (e.g., P2, P5). In contrast, fourth-year primary students, especially those with extra electives and internship experience, described greater confidence and lower anxiety (e.g., P3, P7). These results are consistent with the quantitative findings, where secondary preservice teachers scored higher on SAS and lower on SETS than primary students. Year level and coursework exposure also seemed to affect these patterns. Third-year primary students showed moderate anxiety and only partial confidence (e.g., P1, P4). By the fourth year, with more teaching experience, concerns shifted. Preservice teachers started to worry more about specific problems, such as unexpected classroom questions. Together, these findings show that both curriculum design and instructional practice play a role in shaping preservice teachers' experiences of anxiety and self-efficacy in statistics.

5.3.1.2. Avoidance Behavior. Participants also said that when they felt unprepared, they would skip difficult statistical information on purpose. Their tendencies made it difficult for them to practise. For example, a third-year primary preservice teacher (P1), with a moderate SAS score and moderate SETS profile, noted that while not avoiding the topic entirely, they tended to "delay working on statistical assignments when they felt stuck". This reflects the tendency of moderately nervous pupils to procrastinate rather than address difficult subject directly. Others stated that they avoided group activities or lectures. Another instance involved a third-year secondary mathematics preservice teachers (P2) had anxiety, reduced self-efficacy, and without supplementary coursework or internship experience. He said, "Sometimes I skip readings or let other people do the hard parts of group work." Avoiding statistical stuff made them less interested in it and made their confidence even lower. Another participant shared a similar habit, saying: "Yes, I avoided practice problems that seemed too hard" (Participant 5). These avoidance behaviors acted as coping strategies but limited their familiarity with statistical concepts. Instead, they chose to face difficulties directly. This approach matched their higher self-efficacy scores and prior teaching practice.

Overall, avoidance behaviors were most commonly described by third-year students in the secondary program, whose high SAS and low SETS profiles made them less likely to persist through challenging tasks. Primary preservice teachers, especially those in their fourth year with additional coursework or internship experience, were less likely to engage in avoidance and more likely to persevere. This pattern is consistent with the quantitative

results, which showed secondary preservice teachers had significantly higher statistical anxiety and lower teaching self-efficacy than primary preservice teachers.

5.3.2. Recommendations to Mitigate Statistics Anxiety

This theme will illustrate the ideas and personal solutions that participants have for reducing their statistical anxiety and increasing their self-efficacy in teaching statistics. The responses include ways for pre-service teachers to deal with stress. In addition to that, they talked about the ideas for how to make teacher education programs better. Analysis of their interview data revealed two primary patterns. These are coping strategies used and recommendations for instruction.

5.3.2.1. Coping Strategies Used. Participants talked about different ways they used to deal with statistical anxiety. Many of them talked about that reviewing course materials and seeking alternative explanations are so helpful. One participant, for example, said that “I used different resources to help me learn better”, saying that I would “go back to lecture notes, watch online tutorials, or talk it through with classmates” (Participant 1). This participant was a third-year primary preservice teachers with a moderate SAS and moderate SETS profile, who had only taken SCED 301 and no internship. Their reliance on multiple resources reflects the moderate balance between anxiety and self-efficacy in their profile.

On the other hand, some of the participants said they used memorisation and also group learning tactics to make hard ideas clearer. The another participant also said, “I used flashcards for formulas and asked friends to explain” (Participant 8). This was a third-year primary preservice teacher with moderate anxiety and low–moderate efficacy. Their use of flashcards and peer support suggests they lacked strong confidence but sought simpler strategies to manage their discomfort. The another participant also uses organisational tools and he/she added that they are beneficial for making complicated ideas easier to understand: “I use flowcharts and break steps down clearly for myself” (Participant 6). This participant was also a third-year primary preservice teacher, with a moderate anxiety–moderate efficacy profile. Their focus on step-by-step organization highlights how participants with intermediate profiles developed structured but independent coping mechanisms. In general, both individual and peer learning strategies showed that people were trying to understand

better and feel less uncomfortable using controlled repetition, conversation, and simpler representations.

Overall, the coping strategies varied by anxiety/efficacy profile. Participants with moderate anxiety (e.g., P1, P6) used organizational and review strategies. Those with lower self-efficacy (e.g., P8) relied more on memorization. These results suggest that coping approaches are linked to both program background and self-efficacy level. They also support the quantitative findings, where lower efficacy scores were connected to more surface-level strategies.

5.3.2.2. Recommendations for Instruction. In addition to personal coping strategies, participants offered suggestions for how teacher education programs could better support them in reducing statistical anxiety and improving self efficacy in teaching statistics. Some emphasized the importance of structured opportunities for lesson design and implementation. Participant 1 said that “I think what would help me the most is having more structured opportunities to design and practice teaching actual statistics lessons”. This was expressed by a third-year primary mathematics teacher who demonstrated moderate anxiety and moderate proficiency. They felt that having opportunities for practice in the classroom would help build confidence.

On the other hand, others noted the need for clear, step-by-step teaching materials to minimize confusion. One participant said, “I’d really benefit from step-by-step teaching guides that break everything down clearly” (Participant 2). This participant was a third-year secondary preservice teacher with high anxiety and low efficacy.

Access to concrete resources such as sample lesson plans and sample activities was also emphasized. For example, one participant said, “I think having access to sample lesson plans and example classroom activities would really help” (Participant 6). This was a third-year primary preservice teachers who reported moderate anxiety and efficacy. They had previously used organisational strategies. However, they required additional resources to feel more prepared.

Overall, these recommendations emphasized pre-service teachers' desire for guidance, practical modeling, and meaningful feedback to make teaching statistics more accessible. In summary, participants with higher anxiety and less efficacy, especially secondary preservice teachers such as P2, desired thorough step-by-step instructions. Those with moderate profiles, like P1 and P6, focused practice opportunities. According to these issues, teacher preparation programs need to adapt their strategies to reduce anxiety and increase self-efficacy of pre-service teachers.

5.3.3. Self-Efficacy in Teaching Statistics

This theme will illustrate pre-service teachers' self-efficacy in teaching statistics. Their general confidence levels and also the ways they build this confidence are discussed separately. Participants expressed their thoughts about their preparedness to teach statistical concepts. Many emphasized the role of previous teaching experience in developing self-confidence.

5.3.3.1. Self-Efficacy Level. When it came to teaching statistics, some participants felt more confident than others. Some said they were quite unprepared and anxious. One participant shared, "Very low. I feel unprepared and worried about confusing students" (Participant 2). This was a third-year secondary preservice teacher with a high SAS and low SETS profile, who had only taken SCED 301. Their lack of additional coursework and internship experience explains their low preparedness and anxiety.

On the other hand, others expressed moderate confidence. However, they emphasized the need for more practice before feeling ready. For example, one participant replied, "I'm sure of myself, but I think I need more practice first." (Participant 4). This was a third-year primary student with a moderate SAS and moderate SETS profile. Their perspective reflects the transitional position of students who understand basic concepts but lack sufficient teaching practice. Otherwise, preservice teachers demonstrated high self-efficacy in their ability to teach statistical concepts effectively. For example, one participant said that "Very confident. I think I could make it interesting for students" (Participant 3). This was a fourth-year primary preservice teacher with a low SAS and high SETS profile, who had both an elective statistics course and internship experience. Increased active participation in class

was directly related to increased self-confidence. These differences in self-efficacy reflect the influence of individual differences and participants' prior experiences. These differences in self-efficacy reflect the influence of individual differences and participants' prior experiences. Overall, program type and year of study were clear predictors of self-efficacy levels. Secondary preservice teachers in their third year (like P2) reported the lowest confidence, while primary preservice teachers in their fourth year with added coursework and internship experience (like P3) reported the highest. This aligns with the quantitative findings, where secondary preservice teachers showed lower efficacy scores than primary preservice teachers, and highlights how exposure to real teaching practice boosts self-efficacy. In addition, several participants who reported stronger coping strategies in other parts of the interviews—such as peer collaboration or using real-life examples were also those with higher SETS scores, showing that coping strategies and efficacy perceptions were mutually reinforcing. Taken together, these patterns show that the qualitative narratives do more than describe individual confidence levels. They also help explain why some profiles scored higher or lower in the quantitative results.

5.3.3.2. Confidence Development. Participants also discussed the opportunities to explain statistical ideas to others help them to increase their confidence. Teaching experiences are important for deepening understanding and developing a sense of preparedness. For example, one participant said, "It was actually very helpful and helped me simplify things in my head and make sure I really understood it" (Participant 1). This was a third-year primary preservice teacher with moderate anxiety and efficacy, who had no internship experience. Even without formal teaching, explaining to peers or family helped them gain clarity and reinforce their understanding. Others also said that helping peers or tutoring increased their confidence. For example, one participant said, "It really boosted my confidence and made me want to teach more" (Participant 3). This was a fourth-grade primary preservice teacher with low anxiety, high productivity, and internship experience. Their strong profile not only gave them confidence but also motivated them to continue teaching statistics.

These experiences are important for teaching readiness. Furthermore, practicing statistical concepts plays a significant role in developing preservice teachers' self-efficacy. In general, students with more advanced profiles (low anxiety, high efficacy, additional coursework, internship) reported greater benefits from teaching opportunities, while those

with only moderate profiles still relied on informal explanations to build confidence. This suggests that the implementation of structured instruction within programs can accelerate the development of trust among all participants.

5.4. Integration of Quantitative and Qualitative Findings

In this section, quantitative and qualitative findings are examined together. The relationship between statistical anxiety and self-efficacy in teaching statistics among preservice teachers is interpreted through these findings.

A strong negative Spearman correlation was found between statistical anxiety (SAS scores) and self-efficacy in teaching statistics (SETS scores) ($\rho = -0.890$, $p < 0.001$). Descriptive comparisons by program found that participants in the secondary mathematics education program reported higher anxiety and lower self-efficacy than those in the primary mathematics education program.

Qualitative phase supported these findings by adding contextual details about participants' experiences. Participants with high anxiety frequently mentioned themes such as anxiety and stress about teaching statistics, and avoidance behavior. These were most often secondary preservice teachers in their third year (e.g., P2, P5), who had only completed SCED 301 without additional coursework or internship. Their high SAS and low SETS profiles matched the quantitative results showing greater anxiety and lower efficacy among secondary program participants. The participants reported a fear of making mistakes or deliberately avoiding challenging tasks. On the other hand, participants with higher levels of self-efficacy reported using coping strategies such as reviewing materials, using visual aids, collaborating with peers, and seeking feedback from instructors.

Overall, there appears to be strong agreement between the statistical relationship and the qualitative findings. Combined, these results suggest that addressing statistical anxiety in teacher education programs will be important. For example, interventions such as creating supportive learning environments and using targeted teaching strategies can help increase pre-service teachers' self-efficacy for teaching statistics.

Overall, they highlight the role of program structure and practice opportunities. Third-year secondary preservice teachers teacher who do not take additional courses appear to be most vulnerable to high anxiety and low efficacy. In contrast, fourth-year primary preservice teachers with internship experience were the most confident group. These patterns suggest that teacher education programs should provide different kinds of support based on student profiles.



6. DISCUSSION AND CONCLUSION

6.1. Discussion of the Findings

This section interprets and discusses the study's findings along with the research questions and relevant literature. It highlights the significance of the results by integrating both quantitative and qualitative perspectives. It also offers recommendations for practice. The discussion is structured around the study's research questions. These are the relationship between statistical anxiety and self-efficacy, factors contributing to statistical anxiety and its impact on teaching self efficacy, and strategies to reduce anxiety and increase self-efficacy.

6.1.1. Relationship Between Statistical Anxiety and Self-Efficacy, and Differences by Program and Gender (*RQ2, RQ2a and RQ2b*)

This section addresses RQ2, RQ2a, and RQ2b by examining the relationship between pre-service teachers' statistical anxiety and their self-efficacy in teaching statistics. The study demonstrated a considerable negative correlation between preservice teachers' statistical anxiety and their self-efficacy in teaching statistics. Because the data wasn't distributed normally, Spearman's rank correlation was used and it showed a strong negative link ($\rho = -.890, p < .001$). In other words, high levels of statistical anxiety is closely related to low self-efficacy in teaching statistics.

These quantitative findings support previous studies (Onwuegbuzie & Wilson, 2003; Chew & Dillon, 2014). This study documented the relationship between statistical anxiety and self-efficacy in teaching statistics among pre-service mathematics teachers. This contribution is important because most earlier studies focused on how university students learn statistics. In contrast, this study examined preservice mathematics teachers, who are expected to teach these concepts in the future.

By focusing on this group, the findings highlight challenges that lie between learning content and preparing to teach it (Batanero et al., 2011; MEB, 2018).

Qualitative phase further supports these quantitative results. Participants experiencing high levels of anxiety generally reported very low self-efficacy in teaching statistics effectively. For example, one participant said feeling generally anxious in statistics classes. This anxiety led him to skip readings and avoid group work (Participant 2). Similarly, another participant described feeling "lost" while studying for SCED 301 (Participant 5). These examples show avoidance behavior and low confidence. They match the quantitative profile of high SAS scores and low SETS scores. In this way, the interviews added context to the statistical results by showing how anxiety appeared in real learning situations.

In contrast, participants reporting lower levels of anxiety demonstrated significantly higher self-efficacy. One participant stated that they enjoyed statistics. Participants emphasized that they felt confident even teaching probability topics to their peers (Participant 3). These statements show how positive mastery experiences help build self-efficacy. This idea fits with Bandura's structure from 1997. When preservice teachers were able to explain ideas to others, it made them feel more confident in their abilities and feel more prepared to teach in formal settings. These patterns in the qualitative closely align with the strong negative correlation in the quantitative data. These patterns in the qualitative responses closely align with the strong negative correlation observed in the quantitative data.

Overall, the findings indicate that statistical anxiety is related to low self-efficacy. This can also negatively affect preservice teachers' statistics learning processes. Anxiety can lead them to avoid learning tasks. The combination of quantitative and qualitative results makes this interpretation stronger. The statistical analysis showed the correlation. The interviews revealed the practical effects, such as skipping assignments or delaying preparation. Together, they show a cycle, anxiety reduces practice, and less practice prevents confidence from developing (Onwuegbuzie & Wilson, 2003; Chew & Dillon, 2014).

Generally, combining the quantitative results with coded interview themes strengthens these results. The strong negative correlation in the data was also evident in the participants' own statements. This suggests that teacher preparation programs should employ specific strategies, including mastery experiences and supportive environments, to reduce anxiety and increase prospective teachers' confidence in teaching statistics. These strategies should address not only statistical content but also provide structured practice in teaching. Both the

interviews and the Ministry of National Education's (MEB, 2018) curriculum framework highlight this need. Preservice teachers are expected to teach statistics from the early grades. However, their coursework provides limited attention to how statistics should be taught in practice. This gap may help explain why anxiety increases.

In addition to the negative correlation, subgroup analyses gave detailed insights (RQ2a and RQ2b). Gender comparisons showed that there was no significant difference between male and female preservice teachers. This suggests that, in this sample, gender was not a key factor for either anxiety or confidence. The result also matches earlier studies showing that gender differences in statistical anxiety are usually small among teacher candidates (Onwuegbuzie & Wilson, 2003).

Program-based comparisons, however, revealed a more substantial difference. Secondary preservice teachers reported significantly higher statistical anxiety than their peers in the primary mathematics program, and their self-efficacy scores were somewhat lower. One possible explanation is the heavier curriculum load in secondary programs, which include more advanced statistics, probability, and algebraic content. These requirements may create pressure on preservice teachers, especially if they lack strong pedagogical preparation (Zieffler et al., 2008). The MEB (2018) notes that teaching probability and data analysis in high school is very important. Teacher education programs, on the other hand, rely more on teaching strategies than on content knowledge. This gap can leave secondary preservice teachers feeling underprepared. In contrast, primary mathematics education students benefit from a curriculum that stresses conceptual understanding and practical teaching methods. This approach helps build greater confidence in instructional settings. The difference between primary and secondary preservice teachers is therefore not just a statistical result. It reflects real structural and curricular differences in teacher preparation.

Overall, the findings suggest that gender does not play a major role in shaping anxiety or self-efficacy. Program structure and curricular objectives significantly shape preservice teachers' experiences with statistics and their confidence in teaching it. This implies that reforms in teacher preparation programs particularly adding dedicated pedagogy for statistics, increasing practice opportunities, and aligning coursework with MEB curricular

expectations may be more effective in reducing anxiety than generic supports applied across genders.

6.1.2. Factors Contributing to Statistical Anxiety and Its Impact on Teaching Confidence (RQ1)

This section addresses the factors contributing to pre-service mathematics teachers' statistical anxiety. It also explains how these factors reduce their confidence in teaching statistics. A mixed-methods approach was used in the study. Quantitative analysis was combined with coded qualitative data to provide a full understanding of these issues.

The quantitative results showed that anxiety levels in the sample were moderate (Mean Value = 64.24, Standard Deviation = 22.60). Preservice teachers who are in secondary mathematics education program showed higher mean anxiety scores (Mean Value = 74.15) than preservice teachers who are in the primary mathematics education program (Mean Value = 59.64). This may be occurred due to differences in curriculum familiarity, expectations, or teaching approaches. In Türkiye, secondary mathematics education programs include advanced probability, distributions, and inferential statistics. Primary programs, in contrast, focus more on descriptive and intuitive approaches (MEB, 2018). Anxiety may also increase due to the higher emphasis placed on abstract skills in secondary education. This is particularly evident in situations where pedagogical preparation is limited. Previous research has also shown that content-heavy curricula lacking instructional support increase anxiety (Macher et al., 2015; Chew & Dillon, 2014).

The qualitative analysis provided a deeper understanding of specific sources of anxiety. Many participants described statistical concepts and formulas as complex and challenging. They worry about correctly explaining statistical concepts to students. For example, One participant said they're nervous about data interpretation. Another reported feeling "lost" while studying statistics. This confirms previous research' findings (Chew and Dillon, 2014; Hood et al., 2022). These comments demonstrate that challenges exist not only with statistical knowledge but also in the process of teaching it. Without training to integrate content and pedagogy, preservice teachers may feel unprepared for student questions. This lack of preparation exacerbates their anxiety (Garfield & Ben-Zvi, 2008).

Participants also reported a fear of making mistakes while teaching. This concern about oversimplifying or misrepresenting ideas often led to avoidance. Some said they skipped readings and avoided difficult problems. Such behaviors are well documented in academic anxiety research. This can stem from a feeling of inadequacy, and this feeling can worsen as the process progresses (Macher et al., 2015). The interviews confirm that avoidance was not random but tied to specific triggers such as exams, group discussions, or complex topics. This reinforces the cycle identified in the literature, where avoidance behaviors both stem from and reinforce anxiety, leaving preservice teachers with fewer mastery experiences and weaker self-efficacy (Chew & Dillon, 2014).

Another significant factor was the lack of structured opportunities for statistics teaching practice. Several participants said they felt unprepared without rehearsal or guided practice. They stated that they needed more opportunities to explain concepts in low-pressure environments. This suggests that anxiety is not only about learning statistics but also about being observed and evaluated while teaching it. In SCED 301, the focus is mostly on procedural tasks. However, the course does not regularly include microteaching or peer-feedback activities. Bandura (1997) stressed that mastery experiences are the most effective way to build self-efficacy. Without these opportunities, preservice teachers may begin practicum or internship work with high anxiety and low preparedness. These findings suggest that anxiety is not merely a personal trait. Courses which has heavy procedure without pedagogical help might increase preservice teachers' anxiety and limit their motivation to tackle challenging topics.

Participants' anxiety clearly influenced their teaching confidence. Those with higher anxiety generally showed lower confidence. Conversely, participants with lower anxiety showed higher confidence. These participants reported enjoying learning statistics and being able to make statistical concepts engaging for students. This pattern aligns with the strong negative correlation ($\rho = -.890$) seen in the quantitative results. For example, participants who successfully explained statistical concepts to peers described feeling more confident and even motivated to teach more. This reflects how experiential practice, whether in tutoring or informal peer teaching can transform anxiety into self-efficacy. Overall, it can be argued that the presence of anxiety fosters avoidance. Thus, the behaviour limits statistical practice and instructional preparation.

Taken together, these findings highlight the need for integrated interventions in teacher education. Reducing statistical anxiety through supportive environments and explicit practice opportunities can help pre-service teachers develop the self efficacy to teach statistics effectively (Hood et al., 2022; Chew & Dillon, 2014). In addition to this, teacher education programs should focus on both content and pedagogy. Courses should include methods for teaching statistics. Programs should also provide rehearsal opportunities, such as microteaching, and supervised internships that highlight statistics instruction. In the teacher education process, it is particularly critical to align with national curriculum expectations (MEB, 2018), which require teachers to deliver significant statistical content. Without such reforms, preservice teachers may continue to enter classrooms with anxiety that undermines their teaching confidence.

6.1.3. Strategies to Reduce Anxiety and Improve Self-Efficacy (RQ3)

The study findings provide important insights into strategies suggested by pre-service mathematics teachers to reduce statistics anxiety and build self-efficacy in teaching statistics. The results bring together two sources of evidence. Firstly, the quantitative analysis showed a clear inverse relationship between statistics anxiety and teaching self-efficacy ($\rho = -0.890$, $p < 0.001$). The strength of this result comes from the high correlation value, and its agreement with earlier research. Together, these factors increase confidence in the finding.. Combinig these provides practical teacher education program suggestions. It should be noted that these are suggestions derived from participants' experiences and supported by patterns in the data, rather than definitive prescriptions, which ensures that the interpretation remains cautious and grounded. In other words, these strategies also align with Bandura's (1997) sources of self-efficacy, particularly mastery experiences, social persuasion, and emotional regulation, which suggests that they are theoretically grounded rather than incidental coping responses.

6.1.3.1. Structured Practice Teaching. One of the findings from the interviews was the lack of practice opportunities. Many preservice teachers saw this as a major source of their anxiety. It is known that rehearsal tasks like microteaching and lesson simulations help teachers get better at putting what they learn into practice in the classroom (Grossman et al., 2009). Without them, preservice teachers often feel unprepared to answer students' questions

or explain statistical ideas with confidence. This shows the need to embed structured practice into teacher preparation, especially in statistics education.

Participants valued practicing statistics teaching in low-pressure settings. They found workshops, hands-on teaching, and guided lesson planning useful for reducing anxiety. Teaching in the real classes helps preservice teachers feel more comfortable with teaching statistics. In this study's context, adding more practical opportunities to SCED 301 could also help the Ministry of National Education meet teacher expectations (MEB, 2018).

6.1.3.2. Step-by-Step Instructional Supports. Many participants said their anxiety came from the complexity of statistics when it was taught without clear guidance. Research shows that novice teachers benefit from structured support, such as worked examples, sequenced lessons, and guided practice. These methods reduce cognitive load and help learners focus on the main ideas (Sweller, 1988; van Merriënboer & Kirschner, 2018).

In mathematics and statistics education, step-by-step supports improve clarity. They also build a sense of preparedness and control, which are key for teaching self-efficacy (Bandura, 1997; Tschannen-Moran & Hoy, 2007). This suggests that structured resources are not just helpful. They are an essential part of teacher training programs.

The participants having high anxiety recommended detailed and structured materials. Lesson plans and worked examples were suggested to build self-efficacy in teaching statistics. Clear, step-by-step resources were found to be helpful for planning lessons effectively. This can reduce cognitive load for beginning teachers and also support self-efficacy. These comments are consistent with research showing that it reduces cognitive load and builds confidence in new teachers (Sweller, Ayres, & Kalyuga, 2011). Such support is especially important for secondary preservice teachers, who face advanced statistical topics but have limited pedagogical preparation.

6.1.3.3. Peer Collaboration and Mentorship. Participants emphasized the benefits of working with classmates. They suggested mentoring or peer tutoring. Peer collaboration facilitates learning and helps to look at statistical concepts from different perspectives. Personal comments reduced statistical anxiety as well. This finding aligns with Vygotsky's idea of

social learning, where peers act as “more knowledgeable others.” Research in teacher education also shows that peer learning communities lower feelings of isolation and build teaching confidence (Lave & Wenger, 1991; Tschannen-Moran & Hoy, 2007).

6.1.3.4. Conceptual Understanding. Participants explained that much of their anxiety stemmed from focusing on procedures without sufficient attention to underlying concepts. Statistics classes should include real-life examples, they said. This method emphasises learning more deeply than memorisation. Conceptual teaching reduces statistical anxiety and increases self-efficacy in teaching statistics. This finding is consistent with Garfield and Ben-Zvi (2008), who argued that excessive focus on procedures in instruction increases anxiety. In contrast, a focus on concepts builds self-efficacy in teaching statistics.

6.1.3.5. Integration of Real-Life Examples and Applications. Another common theme in the interviews was the value of real-life applications in lowering anxiety. Research in mathematics education shows that authentic and contextual examples help students connect abstract ideas to meaningful situations. This reduces both cognitive barriers and emotional resistance (Gal, Ginsburg, & Schau, 1997; Garfield & Ben-Zvi, 2008). Preservice teachers who used real-world contexts said they felt more confident and were able to engage students more effectively. This supports evidence that authentic applications not only build statistical literacy but also improve teaching self-efficacy. They give teachers concrete strategies to make learning relevant (Harrell-Williams et al., 2015).

Participants with higher self-confidence reported that they often use real-life examples to make statistics topics more engaging. A contextualised teaching approach decreases statistical anxiety by simplifying abstract concepts. Connecting statistical ideas to real-world applications improves preservice teachers' understanding and their self efficacy in teaching statistics. This reflects the MEB's (2018) curriculum reform, which highlights data literacy and encourages teachers to use authentic contexts. Research also shows that real-world applications raise engagement and lower statistics-related anxiety (Zieffler, Garfield, & Fry, 2018).

6.1.3.6. Supportive Learning Environments. Participants often stressed the value of supportive and non-judgmental environments. Previous research shows that safe classroom

climates, where mistakes are seen as learning opportunities, are key to reducing mathematics and statistics anxiety (Ashcraft, 2002; Pekrun, 2014). Such environments build resilience, persistence, and risk-taking, which are closely linked to stronger teaching self-efficacy (Putwain & Symes, 2018). For preservice teachers, supportive peers and encouraging instructors not only lower immediate anxiety but also create the emotional base for long-term teaching confidence.

Participants highlighted that supportive learning environments is crucial for reducing statistical anxiety. Such places promote statistics learning more deeply. Anxiety in general increases with judgement or failure fears. Supportive settings let preservice teachers take intellectual risks without fear of ridicule. This reflects the literature on psychological safety in classrooms (Edmondson, 1999). For preservice teachers, this means that teacher educators should deliberately treat mistakes as part of learning, not as signs of incompetence.

These recommendations align with quantitative result. Teacher education programs can help reduce anxiety and improve more confident preservice teachers by these strategies. In this study, the strategies were directly expressed by pre-service teachers' opinions, highlighting their practical importance.

6.2. Implications for Teacher Education

The results of this study have important implications for teacher education programs. These programs should help preservice mathematics teachers build the skills and confidence needed to teach statistics. There is a strong negative link between statistical anxiety and self-efficacy. In other words, higher anxiety is connected to lower teaching confidence. Because of that, it is important to reduce anxiety. Building confidence is key for meaningful and effective statistics education. This issue is especially important because the MEB curriculum (2018) requires more focus on statistics across grade levels. Preservice teachers will therefore be responsible for teaching these concepts. Without proper support, the anxiety shown in this study may turn into avoidance in real classrooms.

One key takeaway is the need to integrate anxiety reduction strategies directly into teacher education curricula. Structured and supportive learning experiences that gradually

increase in complexity can help students achieve mastery without feeling overwhelmed. In statistics education, this means creating activities that begin with simple descriptive ideas and then move step by step toward inferential reasoning. When preservice teachers experience this kind of scaffolded progression, they gain confidence in both learning and teaching statistics. Active learning strategies like problem-based and collaborative projects can improve engagement. When applied to statistics, these approaches lower anxiety about abstract concepts. At the same time, they increase self-efficacy in teaching statistical content. These approaches reduce anxiety while simultaneously increase self-efficacy. This suggests that statistics should not be limited to one methods course. Instead, it should be integrated across several stages of teacher preparation. This would give preservice teachers repeated practice in low-stakes settings.

Insights from the qualitative themes also highlight the value of statistics-focused practical teaching experiences. Microteaching, peer tutoring, and simulated classrooms allow pre-service teachers to practice explaining concepts in supportive, low-pressure environments. These kinds of experiences improve self-confidence and reduce anxiety by giving preservice teachers chances to succeed. This finding supports Bandura's (1997) view that mastery experiences are the strongest predictor of self-efficacy. Teacher education programs could formally include such practices. This would ensure that every preservice teacher has several chances to "teach statistics before teaching statistics."

Mentoring is also an important strategy to reduce anxiety. Pairing pre-service teachers with experienced people can reduce anxiety and increase self efficacy in teaching process. Mentors model effective teaching and provide emotional support. These relationships help learning process and provide personalised guidance. These relationships help learning process and provide guidance. Research shows that mentorship can reduce anxiety and support professional identity development (Tschannen-Moran & Hoy, 2007). In Türkiye, pairing preservice teachers with experienced statistics educators could help them reduce their anxiety.

According to the differences in programs, preservice teachers in secondary mathematics education program may need targeted interventions. Besides that, this group needs extra help due to high anxiety and low self-efficacy. These can be additional

workshops to translate complex statistical concepts into classroom activities. Another can be internship experiences focused on statistics. In contrast, primary preservice teachers showed lower anxiety and higher self-efficacy in teaching statistics.

The subgroup analyses give useful guidance for improving teacher education. The lack of significant gender differences suggests that general interventions for all preservice teachers are enough, without gender-specific programs. However, the clear program-based differences require more targeted support. preservice teachers in secondary mathematics education program reported higher anxiety and lower self-efficacy. They may need an additional support system. Expanded pedagogical training in statistics and structured rehearsal opportunities are examples of these supports. Meanwhile, pre-service teachers in primary mathematics education programs can design creative lessons to maintain their existing confidence. They can also enhance their teaching skills by effectively integrating technology into their lessons. They may need extra scaffolding. Expanded pedagogical training in statistics and structured rehearsal opportunities are examples of these supports. Meanwhile, pre-service teachers in primary mathematics education programs can design creative lessons to maintain their existing confidence. They can also enhance their teaching skills by effectively integrating technology into their lessons. By addressing these program-specific needs, both groups can develop balanced competence. Preservice teachers in secondary mathematics education program can build confidence while handling demanding content. Preservice teachers in primary mathematics education program can sustain their confidence by broadening their pedagogical skills.

Finally, creating a supportive and non-judgmental classroom environment is essential. For pre-service teachers, environments should be created where asking questions and making mistakes are viewed as a normal part of learning. Encouraging risk-taking and reducing fear of failure can reduce anxiety. This can support the development of confident and thoughtful teachers. Faculty members' attitudes influence how pre-service teachers feel and respond emotionally (Onwuegbuzie & Wilson, 2003).

Overall, these findings support calls for transformation in statistics teaching. The goal is to transform statistics teaching from an anxiety-provoking subject into an engaging learning experience. Teacher education programs using anxiety-reduction strategies, active

pedagogy, mentoring, and differentiated support can increase pre-service teachers' knowledge and confidence, which can lead to better learning outcomes for their future students. These reforms fit the expectations of the Turkish national curriculum (MEB, 2018). They also align with global research on self-efficacy and reducing anxiety. Together, this study offers clear guidance for strengthening teacher preparation in statistics.

6.3. Limitations of the Study

While this study provides important insights into the relationship between statistical anxiety and self-efficacy among pre-service mathematics teachers, several limitations should also be considered. Recognizing these limitations clarifies the implications of the results and the need for future research.

First limitation can be the small sample size. Participants were pre-service students in the primary and secondary mathematics education program at highly ranked public university. This limits how well the findings can be applied to other contexts, institutions, or regions. In other words, the results may not be representative of all pre-service teachers. Future research could use larger and more diverse samples. Thanks to that, more generalisability and stronger comparisons may result. There was also an unequal distribution between the two programs (28 primary vs. 13 secondary). This imbalance may have weakened program-based comparisons.

Moreover, qualitative data has limits also. The interviews provided rich and thorough information, although only eight were done due to participant shortages. While valuable themes emerged, a larger sample size would have provided greater thematic saturation. In other words, more interviews would have increased confidence that the findings apply to other settings. The interview sample also lacked diversity. Six participants were from the primary program, while only two were from the secondary program. This imbalance reduced the representation of secondary mathematics preservice teachers' voices in the qualitative phase.

The study's cross-sectional design is another limitation. This design does not allow for conclusions about the causality or direction of the relationship between anxiety and self-

efficacy. Thus, it cannot demonstrate which element affects the other over time. Longitudinal or experimental studies may be helpful in testing interventions to reduce statistical anxiety and increase self-efficacy in teaching statistics.

Finally, focusing on pre-service mathematics teachers can be also the limitation of this study. This focus is important. However, it means that the results can only be used for one group. In other words, the results may not apply to in-service teachers or preservice teachers in other disciplines. Different groups may be included in future research to increase impact and validity.

Even though there are some limitations in the study, it is important to understand the relationship between statistical anxiety and self-efficacy in teaching statistics among pre-service teachers. It also shows important areas for improvement. Teacher education programs can help more the preservice teachers learn statistics better.

6.4. Recommendations for Future Research

Based on the findings and the limitations of this study, Future researches could focus on several important issues. One of them is to expand the sample size and diversity. Including pre-service teachers from different teacher education institutions across different regions and cultures would increase generalizability. This diversity would also allow for meaningful cross-cultural comparisons. This could provide richer insights into how statistical anxiety and self-efficacy show in different educational contexts. Future studies should aim to balance subgroup sizes. Having similar numbers of primary and secondary participants would allow stronger and fairer comparisons.

Longitudinal research designs are also needed to extend this study. Following pre-service teachers over a period of time can provide a clearer picture of how statistical anxiety and self-efficacy develop.

Future studies could also utilize richer qualitative methods like longer interviews or classroom observations. Such approaches would provide a more understanding of pre-service teachers' experiences and coping strategies. In other words, they would help explain

the challenges teachers face with statistical anxiety. Combining qualitative data to quantitative results will make the research more detailed and stronger. Future studies should also include more interview participants. A more balanced distribution across program types would lead to stronger thematic saturation and improve the credibility of qualitative findings.

It's also important for further research to focus on targeted interventions to expand the study. Experimental or quasi-experimental studies can test strategies such as mastery experiences, peer mentoring, or new teaching methods. These studies will provide evidence about what kinds of things help reduce anxiety and increase preservice teachers' self efficacy in teaching statistics. In other words, they could guide the design of better teacher education programs.

Exploring individual differences is also important. A person's math background, personality, and the program's curriculum can affect their anxiety and self-efficacy. Understanding these differences can help to be more effective for different groups of pre-service teachers. Future research could also gather more detailed information about participants' prior coursework and teaching practice. These factors strongly influenced their anxiety and self-efficacy levels in this study.

Finally, the research should also include in-service teachers and educators in other fields that teach statistics, such as the social sciences or health sciences. This will broaden how the findings can be used. In other words, it will help meet professional development needs beyond the pre-service stage. Addressing these areas in future research will deepen understanding and support better strategies for improving statistics education among pre-service teachers and teachers of diverse backgrounds.

6.5. Conclusion

This study examined the relationship between statistical anxiety and self-efficacy in teaching statistics. It focused on preservice mathematics teachers. The findings showed a strong negative Spearman correlation ($\rho = -0.890$, $p < 0.001$). In other words, higher anxiety is connected to lower confidence in teaching statistics. This inverse relationship highlights that teacher education programs need to deal with statistical issues. Reducing anxiety is

crucial for building self-efficacy and supporting better learning outcomes. In addition, subgroup analyses gave additional insights. Gender differences were not statistically significant. Program-based comparisons, however, showed clear differences. Secondary preservice teachers had higher anxiety and somewhat lower self-efficacy than primary preservice teachers. This suggests that program structure and curricular demands influence confidence and anxiety more than gender does.

The combined quantitative and qualitative results indicate that pre-service teachers' experiences with statistics are diverse and complex. Participants said they were anxious about things like understanding data, using concepts in teaching, and dealing with questions from students that they didn't expect. At the same time, many of them said that they can develop their skills through structured practice, supportive environments, and practical teaching experiences.

Moreover, the study suggests that targeted interventions can help reduce statistical anxiety and build self-efficacy in teaching statistics. Strategies have strong potential to reduce anxiety. These strategies are like mastery experiences, collaborative learning, mentoring, and supportive practice. These approaches can improve motivation and increase self-efficacy in teaching statistics. By focusing on these methods, teacher education programs can prepare preservice teachers more effectively to teach statistical concepts in the future.

Even though this research provides valuable insights, it also has some limitations. These include sample size and a focus on a specific group. Despite these limitations, the findings provide useful guidance for teacher educators seeking to improve statistics education in teacher education programs.

In conclusion, helping pre-service teachers overcome statistical anxiety and gain self-efficacy in teaching statistics is vital. Support helps them to become confident mathematics educators in the future. Preservice teachers can engage students more meaningfully with statistical reasoning. In the long run, this can improve students' mathematical skills and data literacy both in the classroom and beyond.

REFERENCES

- Araki, L.T. and K.S. Shultz, 1995, “Students’ Attitudes Toward Statistics and Their Retention of Statistical Concepts”, *Western Psychological Association*, Los Angeles, CA.
- Asare, P. Y., 2025, “Effect of Preservice Management Teachers’ Teaching Passion in Moderating Their Teaching Self-Efficacy–Anxiety Nexus: Implications for Teacher Development”, *Journal of Education for Business*, Vol. 100, No. 3, pp. 109-115.
- Auzmendi, E., 1991, “Factors Related to Attitudes Toward Statistics: A Study with a Spanish Sample”, *American Educational Research Association*, Chicago, IL.
- Bach, A., & Hagenauer, G., 2022, “Joy, Anger, and Anxiety During the Teaching Practicum: How Are These Emotions Related to Dimensions of Pre-Service Teachers’ Self-Efficacy?”, *Zeitschrift für Bildungsforschung*, Vol. 12, No. 2, pp. 295-311.
- Baloglu, M., 2002, “Psychometric Properties of the Statistics Anxiety Rating Scale”, *Psychological Reports*, Vol. 90, No. 2, pp. 315–325.
- Baloglu, M., 2003, “Individual Differences in Statistics Anxiety among College Students”, *Personality and Individual Differences*, Vol. 34, No. 5, pp. 855–865.
- Baloglu, M., 2004, “Statistics Anxiety and Mathematics Anxiety: Some Interesting Differences”, *Educational Research Quarterly*, Vol. 27, No. 3, pp. 38–48.
- Bandura, A., 1997, *Self-efficacy: The Exercise of Control*, New York: Freeman.
- Barroso, C., Ganley, C. M., McGraw, A. L., Geer, E. A., Hart, S. A., & Daucourt, M. C., 2021, “A Meta-Analysis of the Relation between Math Anxiety and Math Achievement”, *Psychological Bulletin*, Vol. 147, No. 2, pp. 134-140.

- Bates, A. B., Latham, N., & Kim, J. A., 2011, “Linking Preservice Teachers' Mathematics Self- Efficacy and Mathematics Teaching Efficacy to Their Mathematical Performance”, *School Science and Mathematics*, Vol. 111, No. 7, pp. 325-333.
- Batur, A., B. Güven and K. Akoğlu, 2020, “Ortaokul Düzeyi İstatistik Öğretimine Yönelik Öz-Yeterlik Ölçeğinin Türkçeye Uyarlanması”, *Turkish Journal of Mathematics Education*, Vol. 1, No. 1, pp. 10–30.
- Bieg, M., M. Jansen and M. Lüftenegger, 2023, “Longitudinal Relations between Teacher Self-Efficacy and Student Motivation: A Multilevel Cross-Lagged Panel Model”, *European Journal of Psychology of Education*, Vol. 38, No. 1, pp. 55–75.
- Biehler, R., D. Frischemeier and C. Reading, 2021, “Preparing Teachers to Teach Statistics: International Perspectives”, *Statistics Education Research Journal*, Vol. 20, No. 2, pp. 1–18.
- Bursal, M., & Paznokas, L., 2006, “Mathematics Anxiety and Preservice Elementary Teachers' Confidence to Teach Mathematics and Science”, *School Science and Mathematics*, Vol. 106, No. 4, pp. 173-180.
- Chang, C. and R. Evans, 2020, “Understanding Statistical Anxiety: Implications for Preservice Teachers”, *Journal of Mathematics Teacher Education*, Vol. 23, No. 4, pp. 345–362.
- Cohen, J., 2013, *Statistical Power Analysis for the Behavioral Sciences*, New York: Routledge.
- Cohen, J., 2021, “Statistical Anxiety among Teacher Candidates: A Meta-Analysis”, *Educational Psychology Review*, Vol. 33, No. 2, pp. 567–589.
- Cheon, J. and J. Reeve, 2015, “A Classroom-Based Intervention to Help Teachers Decrease Students' Amotivation”, *Contemporary Educational Psychology*, Vol. 40, pp. 99-111.

- Chew, P.K.H. and D.B. Dillon, 2014, “Statistics Anxiety Update: Refining the Construct and Recommendations for a New Research Agenda”, *Perspectives on Psychological Science*, Vol. 9, No. 2, pp. 196–208.
- D'Andrea, L. and C. Waters, 2002, “Teaching Statistics Using Active Learning Strategies that Reduce Statistics Anxiety”, *Journal of Instructional Psychology*, Vol. 29, No. 3, pp. 168–173.
- D'Andrea, L. and C. Waters, 2002, “Teaching Statistics Using Short Stories: Reducing Anxiety and Changing Attitudes”, *Proceedings of the Sixth International Conference on Teaching Statistics*, Cape Town, South Africa, pp. 1–4.
- Durak, İ. and Y. Karagoz, 2021, “Adaptation of Statistics Anxiety Scale to Turkish: Validity and Reliability Study”, *International Journal of Assessment Tools in Education*, Vol. 8, No. 3, pp. 667–683.
- Field, A., 2013, *Discovering Statistics Using IBM SPSS Statistics*, London: Sage.
- Finney, S.J. and G. Schraw, 2003, “Self-Efficacy Beliefs in College Statistics Courses”, *Contemporary Educational Psychology*, Vol. 28, No. 2, pp. 161–186.
- Franklin, C., Kader, G., Mewborn, D., Moreno, J., Peck, R., Perry, M., & Scheaffer, R., 2007, *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report: A Pre-K–12 Curriculum Framework*, American Statistical Association, Alexandria, VA.
- Gal, I. and L. Ginsburg, 1994, “The Role of Beliefs and Attitudes in Learning Statistics: towards an Assessment Framework”, *Journal of Statistics Education*, Vol. 14, No. 3, pp. 1-18.
- Gal, Y., 1997, *The Assessment Challenge in Statistics Education*, Amsterdam: IOS Press.
- Garfield, J. and D. Ben-Zvi, 2008, *Developing Students' Statistical Reasoning: Connecting Research and Teaching Practice*, New York: Springer.

- Gillen-O’Neel, C., 2021, “Creating Supportive Learning Environments to Reduce Academic Anxiety”, *Educational Psychologist*, Vol. 56, No. 3, pp. 191–207.
- Gorospe, J.D., 2022, “Pre-service Teachers' Teaching Anxiety, Teaching Self-Efficacy, and Problems Encountered during the Practice Teaching Course”, *Journal of Education and Learning*, Vol. 11, No. 4, pp. 84–94.
- Hagger, H. and L.E. Malmberg, 2021, “Teacher Self-Efficacy and Mental Health—Their Intricate Relation to Professional Development: A Longitudinal Study”, *Frontiers in Psychology*, Vol. 12, pp. 1-10.
- Harrell, P. and M. Bower, 2022, “Gender Differences in Statistics Anxiety and Self-Efficacy among Preservice Teachers”, *International Journal of STEM Education*, Vol. 9, No. 1, pp. 12-14.
- Harrell-Williams, L., et al. 2015, “Identifying Statistical Concepts Associated with High and Low Levels of Self-Efficacy to Teach Statistics in Middle Grades”, *Journal of Statistics Education*, Vol. 23, No. 1, pp. 1-19.
- Harrell-Williams, L.M., M.A. Sorto, R.L. Pierce, L.M. Lesser, and T.J. Murphy, 2015, “Validation of the Self-Efficacy to Teach Statistics (SETS) Instrument”, *Statistics Education Research Journal*, Vol. 14, No. 2, pp. 86 –114.
- Hoegler, S. and M. Nelson, 2018, “The Influence of Anxiety and Self-Efficacy on Statistics Performance: A Path Analysis”, *Psi Chi Journal of Psychological Research*, Vol. 23, No. 5, pp. 478 – 488.
- Hood, M., P.A. Creed and D.L. Neumann, 2022, “Teaching Statistics for Reducing Anxiety and Increasing Self-Efficacy: A Systematic Review”, *Educational Psychology Review*, Vol. 34, pp. 100 –103.
- Keeley, J., R. Zayac and C. Correia, 2008, “Curvilinear Relationships between Statistics Anxiety and Performance among Undergraduates: Evidence for Optimal Anxiety”, *Statistics Education Research Journal*, Vol. 7, No. 1, pp. 4–15.

- Lai, Y. and O. Murray, 2023, “Addressing Statistical Anxiety in Teacher Education: Innovative Approaches”, *Journal of Educational Research and Practice*, Vol. 13, No. 1, pp. 99–117.
- Liu, Y. and Z. Szabo, 2023, “Using a Mindset Intervention to Reduce Anxiety in the Statistics Classroom”, *Psychology Learning & Teaching*, Vol. 22, No. 1, pp. 85–98.
- Macher, D., M. Paechter, I. Papousek and K. Ruggeri, 2015, “Statistics Anxiety, Trait Anxiety, Learning Behavior, and Academic Performance”, *European Journal of Psychology of Education*, Vol. 30, No. 4, pp. 385–398.
- Macher, D., M. Paechter, I. Papousek and K. Ruggeri, 2012, “Statistics Anxiety, Trait Anxiety, Learning Behavior, and Academic Performance”, *Frontiers in Psychology*, Vol. 3, pp. 52-54.
- MEB, 2018, Matematik Dersi Öğretim Programı (İlkokul ve Ortaokul 1-8. Sınıflar), Milli Eğitim Bakanlığı, Ankara.
- Nolan, M., T. Beran and K. Hecker, 2012, “Surviving the First Statistics Course: Student Perspectives and Implications for Instructors”, *Teaching of Psychology*, Vol. 39, No. 4, pp. 251–256.
- Onwuegbuzie, A.J., 1998, “The Dimensions of Statistics Anxiety: A Comparison of Prevalence Rates among Mid-Southern University Students”, *Louisiana Educational Research Journal*, Vol. 23, pp. 23–40.
- Onwuegbuzie, A.J. and M.A. Seaman, 1995, “The Effect of Time Constraints and Statistics Test Anxiety on Test Performance in a Statistics Course”, *Journal of Experimental Education*, Vol. 62, pp. 115–124.
- Onwuegbuzie, A.J. and V.A. Wilson, 2003, “Statistics Anxiety: Nature, Etiology, Antecedents, Effects, and Treatments”, *Teaching in Higher Education*, Vol. 8, No. 2, pp. 195–209.

- Onwuegbuzie, A.J., D. Da Ros and J.M. Ryan, 1997, “The Components of Statistics Anxiety: A Phenomenological Study”, *Focus on Learning Problems in Mathematics*, Vol. 19, No. 4, pp. 11–35.
- Ortiz, M. and A. Alcazar, 2024, “Reducing Statistical Anxiety Through Microteaching: Evidence from Preservice Teacher Programs”, *Statistics Education Research Journal*, Vol. 23, No. 1, pp. 45–60.
- Ozonur, M., 2021, “Determining Preservice Teachers' Levels of Self-Efficacy and Occupational Anxiety”, *Education Quarterly Reviews*, Vol. 4, No. 1, pp. 1–12.
- Öner, D., 2021, “The Effect of Statistical Anxiety on Teaching Self-Efficacy among Preservice Teachers”, *European Journal of Teacher Education*, Vol. 44, No. 5, pp. 740–754.
- Papanastasiou, E.C., 2005, “Statistics Anxiety and Performance”, *Studies in Educational Evaluation*, Vol. 31, No. 2, pp. 105–115.
- Paechter, M., et al., 2017, “Mathematics Anxiety and Statistics Anxiety: Shared but Also Unshared Components and Antagonistic Contributions to Performance in Statistics”, *Learning and Individual Differences*, Vol. 23, pp. 72–79.
- Peker, M. and E. Ertekin, 2011, “The Relationship between Mathematics Teaching Anxiety and Self-Efficacy Beliefs toward Mathematics Teaching”, *Education and Science*, Vol. 36, No. 161, pp. 3–10.
- Pekrun, R., T. Goetz, W. Titz and R.P. Perry, 2017, “Academic Emotions in Students' Self-Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research”, *Educational Psychologist*, Vol. 52, No. 1, pp. 1–13.
- Perepiczka, M., N. Chandler and M. Becerra, 2011, “Relationship between Graduate Students' Statistics Self-Efficacy, Statistics Anxiety, Attitude Toward Statistics, and Social Support”, *The Professional Counselor*, Vol. 1, No. 2, pp. 99–108.

- Putwain, D.W. and W. Symes, 2018, "The Role of Fear of Failure in the Development of Students' Approaches to Learning", *British Journal of Educational Psychology*, Vol. 88, No. 1, pp. 85–99.
- Sarıkaya, Ö. and B. Akkoyunlu, 2019, "Preservice Teachers' Statistical Anxiety and Academic Performance: A Longitudinal Study", *International Journal of Science and Mathematics Education*, Vol. 17, No. 3, pp. 453–470.
- Schneider, W.J., 2011, "The Effects of Statistics Anxiety and Self-Efficacy on Statistics Performance in Graduate Students", *International Journal of Education and Social Science*, Vol. 1, No. 2, pp. 92–102.
- Sciutto, M.J., 1995, "Student-Centered Methods for Decreasing Anxiety and Increasing Interest Level in Undergraduate Statistics Courses", *Journal of Instructional Psychology*, Vol. 22, No. 3, pp. 277–280.
- Shulman, L.S., 1986, "Those Who Understand: Knowledge Growth in Teaching", *Educational Researcher*, Vol. 15, No. 2, pp. 4–14.
- Senler, B., 2016, "Pre-Service Science Teachers' Self-Efficacy: The Role of Attitude, Anxiety and Locus of Control" *Australian Journal of Education*, Vol. 60, No.1, pp. 26-41.
- Stanton, M., N. Roser and S. Carlson, 2018, "Effective Strategies for Reducing Statistical Anxiety in Preservice Teachers", *Teaching Statistics*, Vol. 40, No. 3, pp. 123–130.
- Sweller, J., & Chandler, P., 1991, "Evidence for Cognitive Load Theory", *Cognition and Instruction*, Vol. 8, No. 4, pp. 351-362.
- Tatlı, Z. and S. Bulut, 2021, "Teachers' Views about the Integration of Data Science in Secondary School Mathematics Curriculum", *International Journal of Education in Mathematics, Science and Technology*, Vol. 9, No. 2, pp. 239–253.

- Tsai, Y.M. and S.C. Chuang, 2023, “Reducing Statistics Anxiety and Enhancing Statistics Learning Achievement: Effectiveness of a One-Minute Strategy”, *Journal of Statistics Education*, Vol. 31, No. 1, pp. 15–26.
- Tschannen-Moran, M. and A.W. Hoy, 2001, “Teacher Efficacy: Capturing an Elusive Construct”, *Teaching and Teacher Education*, Vol. 17, No. 7, pp. 783–805.
- Tschannen-Moran, M. and A.W. Hoy, 2007, “The Differential Antecedents of Self-Efficacy Beliefs of Novice and Experienced Teachers”, *Teaching and Teacher Education*, Vol. 23, No. 6, pp. 944–956.
- Vigil-Colet, A., U. Lorenzo-Seva and L. Condon, 2008, “Development and Validation of the Statistics Anxiety Scale”, *Psicothema*, Vol. 20, No. 1, pp. 174–180.
- Williams, A.S., 2010, “Statistics Anxiety and Instructor Immediacy”, *Journal of Statistics Education*, Vol. 18, No. 2, pp. 1-18.
- Zeidner, M., 1991, “Statistics and Mathematics Anxiety in Social Science Students—Some Interesting Parallels”, *British Journal of Educational Psychology*, Vol. 61, No. 3, pp. 319–328.
- Zhang, L., Y. Chen and H. Zhao, 2021, “The Role of Mentorship in Reducing Statistics Anxiety among Preservice Teachers”, *Journal of Teacher Education*, Vol. 72, No. 4, pp. 432–445.
- Zieffler, A. and E. Fry, 2018, “Improving Prospective Teachers’ Statistical Knowledge for Teaching”, *Statistics Education Research Journal*, Vol. 17, No. 1, pp. 25–44.

APPENDIX A: FORMS

Demografik Bilgiler

Cinsiyetiniz: ☐ Kadın ☐ Erkek

Yaşınız: _____

Kayıtlı olduğunuz öğretmenlik programı (ör. İlköğretim/Ortaöğretim Matematik Öğretmenliği):

Öğretmenlik programınızın kaçınıcı sınıfında öğrenim görüyorsunuz?

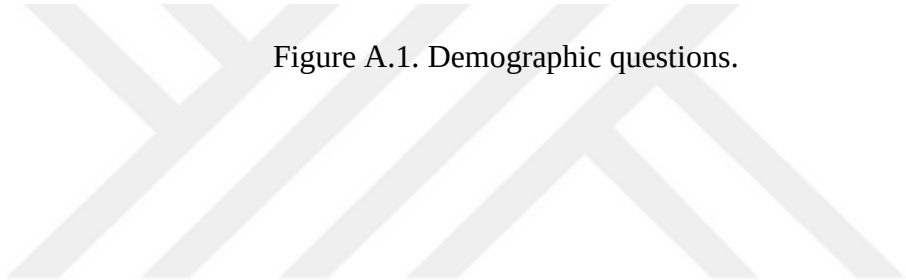


Figure A.1. Demographic questions.

İstatistik Kaygı Ölçeği

	Lütfen aşağıdaki ifadeleri dikkatlice okuyunuz ve size en yakın hissettiğiniz seçeneği işaretleyiniz. Bu anket, istatistikle ilgili hissettiğiniz kaygıyı değerlendirmeye yönelik bir çalışmanın parçasıdır. Yanıtlarınız anonim tutulacak ve yalnızca bilimsel araştırma amacıyla kullanılacaktır.	Hiç kaygılanmam	Çok az kaygılanırım	Orta düzeyde kaygılanırım	Oldukça kaygılanırım	Çok fazla kaygılanırım
1.	Bir istatistik dersinin sınavı için çalışırken	☐	☐	☐	☐	☐
2.	Bir ders kitabındaki/ders notundaki tablonun anlamını yorumlarken	☐	☐	☐	☐	☐
3.	İstatistik hocasından anlamakta zorlandığım bir ders kitabı/ders notu hakkında bireysel yardım isterken	☐	☐	☐	☐	☐
4.	Sınavdan bir gün önce, kolay sandığım bazı soruları yapamadığımı fark ettiğim zaman	☐	☐	☐	☐	☐
5.	İstatistiksel analizler içeren bir ders kitabı/ders notu okurken	☐	☐	☐	☐	☐
6.	Bir olasılık tablosunun (z, t, ki kare vb.) nasıl kullanılacağını dersin hocasına sorduğum zaman	☐	☐	☐	☐	☐
7.	Bir matematiksel formülü anlamaya çalışırken	☐	☐	☐	☐	☐
8.	Bir istatistik dersinin final sınavındayken	☐	☐	☐	☐	☐
9.	Bir otomobil reklamında yakıt tüketimi, yasal düzenlemelere uygunluk vb. özelliklerle ilgili şekilleri/oranları incelerken	☐	☐	☐	☐	☐
10.	İstatistik sınavı olmak için sınıfa doğru giderken	☐	☐	☐	☐	☐
11.	İstatistikle ilgili bir alıştırmanın nasıl yapılacağını dersin hocasına sorarken	☐	☐	☐	☐	☐
12.	Derste işlediğimiz tüm konuları gözden geçirmeden sınavdan önceki gün geldiğinde	☐	☐	☐	☐	☐
13.	İstatistik sınavının olacağı günün sabahında uyandığımda	☐	☐	☐	☐	☐

Figure A.2. Statistics Anxiety Scale (SAS) – Turkish version.



İstatistik Kaygı Ölçeği

		Hiç kaygılanmam	Çok az kaygılanırım	Orta düzeyde kaygılanırım	Oldukça kaygılanırım	Çok fazla kaygılanırım
14.	Sınava girmeden hemen önce belli bir konuya hazırlanmadığımı fark ettiğimde	☐	☐	☐	☐	☐
15.	İstatistik hocamın tahtaya yazılan matematiksel bir alıştırmaı açıkladığı esnada onu deftere geçirirken	☐	☐	☐	☐	☐
16.	İstatistiksel bir analizin sonuç çıktısını anlamak için istatistik hocamdan yardım istediğimde	☐	☐	☐	☐	☐
17.	Bir şans oyununda (piyango, zar vb.) kazanma olasılıklarını anlamaya çalışırken	☐	☐	☐	☐	☐
18.	Çözdüğü bir problemin sonuç tablosunu dikkatle inceleyen bir sınıf arkadaşımı gördüğümde	☐	☐	☐	☐	☐
19.	Çalışmak için yeterince zaman bulamadan bir istatistik sınavına girdiğimde	☐	☐	☐	☐	☐
20.	Bir istatistiksel sonuç tablosunu yorumlamak için istatistik hocamdan yardım istediğimde	☐	☐	☐	☐	☐
21.	Bir gazete, kitap, makale vb. kaynakta yer alan istatistiksel analizleri anlamaya çalışırken	☐	☐	☐	☐	☐
22.	Soru sormak için istatistik hocamın odasına giderken	☐	☐	☐	☐	☐
23.	Bir istatistiksel alıştırmanın nasıl yapılacağını anlatması için bir istatistik uzmanından ücret karşılığı yardım istediğimde	☐	☐	☐	☐	☐

Figure A.2. Statistics Anxiety Scale (SAS) – Turkish version (cont.).

İstatistiği Öğretmeye yönelik Öz yeterlik Ölçeği

	Lütfen aşağıdaki ifadeleri dikkatlice okuyunuz ve her biri için kendinizi ne kadar yeterli hissettiğinizi en iyi yansıtan seçeneği işaretleyiniz. Bu anket, istatistik öğretmeye yönelik öz-yeterlik düzeyinizi değerlendirmeye yönelik bir çalışmanın parçasıdır. Yanıtlarınız anonim olarak toplanacak ve yalnızca bilimsel araştırma amacıyla kullanılacaktır.	Hiç güvenmiyorum	Çok az güvenmiyorum	Biraz güvenmiyorum	Güvenmiyorum	Çok güvenmiyorum	Tamamen güvenmiyorum
1.	Ortaokul öğrencilerini ilgilendiren istatistiksel bir soruya yanıt vermek için veri toplayabilirim.	☐	☐	☐	☐	☐	☐
2.	Bireyler üzerinde yapılan gözlemler arasında doğal bir değişkenlik olacağını fark edebilirim.	☐	☐	☐	☐	☐	☐
3.	Bireyleri birbirleriyle ve bir grupla karşılaştırmak için uygun grafik gösterimlerini ve sayısal özetleri seçebilirim	☐	☐	☐	☐	☐	☐
4.	Dağılımları özetlemek için grafikler (sütun, çizgi vs.) ve tablolar oluşturabilirim.	☐	☐	☐	☐	☐	☐
5.	Dağılımları tasvir etmek için grafikler (sütun, çizgi vs.) ve tablolar oluşturabilirim.	☐	☐	☐	☐	☐	☐
6.	Dağılımları özetlemek için kutu grafikleri oluşturabilirim.	☐	☐	☐	☐	☐	☐
7.	Dağılımları tasvir etmek için kutu grafikleri, medyan ve açıklığı kullanabilirim.	☐	☐	☐	☐	☐	☐
8.	Serpilme diyagramını kullanarak iki değişken arasındaki ilişkiyi belirleyebilirim.	☐	☐	☐	☐	☐	☐
9.	Bir istatistiksel sonucu küçük bir gruptan büyük bir gruba genelleleyebilirim.	☐	☐	☐	☐	☐	☐
10.	İstatistiksel sonuçların başka bir sınıf veya grupta farklı olabileceğinin farkındayım.	☐	☐	☐	☐	☐	☐
11.	Bir sınıftan elde edilen veri setinden hareketle sınıf dışındaki herhangi bir popülasyona genelleme yapmanın sınırlılıklarını fark edebilirim.	☐	☐	☐	☐	☐	☐
12.	Verilerde değişkenliğin olduğu bir soru ile kesinlik içeren modele dayalı bir soru (örneğin; hız ve zamanın belli olduğu $x=v \times t$ modelinde, uzaklığın değerini bulmak) arasında ayırım yapabilirim.	☐	☐	☐	☐	☐	☐

Figure A.3. Self-Efficacy to Teach Statistics (SETS) – Turkish version.

İstatistiği Öğretmeye yönelik Öz yeterlik Ölçeği

		Hiç güvenmiyorum	Çok az güveniyorum	Biraz güveniyorum	Güveniyorum	Çok güveniyorum	Tamamen güveniyorum
13.	Bir istatistiksel soruyu açıklarken ne tür değişkenlerin ölçüleceğini ve bu değişkenlerin nasıl ölçüleceğini belirleyebilirim.	☐	☐	☐	☐	☐	☐
14.	Aynı grupta yer alan bireyler arasındaki değişkenliği sayısal olarak ifade edebilirim.	☐	☐	☐	☐	☐	☐
15.	Aynı grupta yer alan bireyler arasındaki değişkenliği sayısal olarak ifade edebilirim.	☐	☐	☐	☐	☐	☐
16.	Dağılımları karşılaştırmak için histogramları kullanabilirim.	☐	☐	☐	☐	☐	☐
17.	Dağılımları özetlemek için çeyrekler açıklığı ve 5-sayı özetlerini (minimum ve maksimum değer, alt ve üst çeyrek, medyan) hesaplayabilirim.	☐	☐	☐	☐	☐	☐
18.	Dağılımları karşılaştırmak için çeyrekler açıklığı, 5-sayı özetlerini (minimum ve maksimum değer, alt ve üst çeyrek, medyan) ve kutu grafiklerini kullanabilirim.	☐	☐	☐	☐	☐	☐
19.	Bir popülasyondan rastgele alınan örnekleme dayalı bir sonuca varırken örnekleme hatasının rolünü fark edebilirim.	☐	☐	☐	☐	☐	☐
20.	Lineer modelleri kullanarak iki değişken arasındaki ilişkinin gücünü sayısal olarak ifade edebilirim.	☐	☐	☐	☐	☐	☐
21.	İki ya da daha fazla grup arasındaki farklılıkları dağılımların merkezi, yayılımı ve şekli açısından açıklayabilirim.	☐	☐	☐	☐	☐	☐
22.	Bir örneklemin geniş bir popülasyonu temsil edip etmeyeceğini fark edebilirim.	☐	☐	☐	☐	☐	☐
23.	İlişki ölçümelerini yorumlayabilirim.	☐	☐	☐	☐	☐	☐
24.	Gözleme ve deneye dayalı çalışmalar arasında ayırım yapabilirim.	☐	☐	☐	☐	☐	☐

Figure A.3. Self-Efficacy to Teach Statistics (SETS) – Turkish version (cont.).

Note. The online version of this survey form can be accessed via the following link:

<https://forms.gle/y4DnVuScy63pdNui6>

Görüşme Formu

Bu ek, bu çalışmanın nitel veri toplama sürecinde kullanılan görüşme formunu içermektedir. Görüşmelerin amacı, öğretmen adaylarının istatistikle ilgili yaşadıkları kaygılar ve istatistik öğretimine yönelik öz-yeterlik algılarına dair daha derinlemesine bilgi edinmektir. Sorular, Gorospe (2022) tarafından önerilen çerçeve doğrultusunda oluşturulmuş ve dört ana başlık altında yapılandırılmıştır: demografik bilgiler, istatistik kaygısının nedenleri, kaygıyı azaltmaya yönelik öneriler ve istatistik öğretiminde öz-yeterlik. Görüşmeler, anket uygulamasına katılan öğretmen adayları arasından seçilen 15–20 katılımcı ile gerçekleştirilmiştir.

Tüm görüşmeler katılımcıların bilgilendirilmiş onamları doğrultusunda gerçekleştirilmiş, veriler gizli tutulmuş ve yalnızca bilimsel amaçlarla kullanılmıştır.

1. İstatistik Kaygısının Nedenleri

İstatistik öğrenmeyle ilgili genel deneyiminizi nasıl tanımlarsınız?

İstatistik öğrenme/öğretmenin hangi yönleri sizi en çok kaygılı hissettiriyor?

Hiç kaygı nedeniyle istatistiksel içeriklerden kaçındınız mı?

2. Kaygıyı Azaltmaya Yönelik Öneriler

Kaygıyı azaltmak için hangi stratejileri kullandınız?

Programınızda istatistiklerin nasıl öğretildiğiyle ilgili bir şeyi değiştirebilseydiniz, bu ne olurdu?

3. İstatistik Öğretiminde Öz-Yeterlik

İstatistiksel kavramları öğretme konusunda ne kadar kendinize güveniyorsunuz?

Hiç istatistiksel bir kavramı öğrettiniz veya açıkladınız mı? Bu güveninizi nasıl etkiledi?

İstatistik öğretmek için kendinizi daha hazır hissetmenize ne yardımcı olurdu?

Figure A.4. Interview questions.

APPENDIX B: TESTS OF NORMALITY

The appendix contains Table E.1, which shows the tests of normality for SAS_TOTAL and SETS_TOTAL scores using the Shapiro-Wilk test.

Table B.1. Tests of normality for SAS_TOTAL and SETS_TOTAL scores.

Variable	Test	Statistic	df	p-value
SAS_TOTAL	Shapiro-Wilk	.884	40	< .001
SETS_TOTAL	Shapiro-Wilk	.908	40	.003