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PERCEIVED CHALLENGES AND THREATS IN MATH SETTINGS: INVESTIGATING THE EFFECTS OF COGNITIVE REAPPRAISAL INSTRUCTIONS ON MATH ANXIETY

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A THESIS SUBMITTED

FOR

THE DEGREE OF MASTER OF ARTS

IN

CURRICULUM AND INSTRUCTION

İHSAN DOĞRAMACI BILKENT UNIVERSITY

ANKARA

SEPTEMBER 2022

2022

This study is wholeheartedly dedicated to my beloved family, my father İlimdar Sarı, my mother Sevim Sarı, my brother Ömür Can Sarı and my uncle Erkan Sarı who have been my source of inspiration and gave me strength when I thought of giving up, who continually provide endless love, support, encouragement, and patience.

Perceived Challenges and Threats in Math Settings: Investigating the Effects of Cognitive Reappraisal Instructions on Math Anxiety

The Graduate School of Education

of

İhsan Doğramacı Bilkent University

by

İzel Sarı

In Partial Fulfilment of the Requirements for the Degree of

Master of Arts

in

Curriculum and Instruction

Ankara

September 2022

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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum & Instruction.

Asst. Prof. Dr. Aikaterini Michou (Advisor)

Assoc. Prof. Dr. Jennie Farber Lane (2^{nd} Advisor)

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum & Instruction.

Asst. Prof. Dr. İlker Kalender (Examining Committee Member)

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum & Instruction.

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Approval of the Graduate School of Education

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ABSTRACT

PERCEIVED CHALLENGES AND THREATS IN MATH SETTINGS:

INVESTIGATING THE EFFECTS OF COGNITIVE REAPPRAISAL

INSTRUCTIONS ON MATH ANXIETY

İzel Sarı

MA in Curriculum and Instruction

Advisor: Asst. Prof. Dr. Aikaterini Michou

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September 2022

It's widely accepted in all cultures and educational systems around the world that math anxiety negatively impacts people's lives. However, anxiety is not always negative. When stress increases, "fight or flight" reaction is triggered to prepare our body's response to a challenge or threat. Once you learn how stress responses can be used as an adaptive tool, it provides the student with ambition and motivation on the road to success. According to laboratory studies, cognitive reappraisal interventions can help students to alter their negative thoughts about anxiety. It can even improve students' math performance by reducing math anxiety. In this study, I investigated whether cognitive reappraisal interventions applied before the mathematics exams affect students' mathematics anxiety, perceived coping resources and academic performance. Forty undergraduate students from social sciences department of a non-profit private university in Turkey participated. In the pretest, students completed questionnaires about math anxiety and stress appraisals before Math Exam-1. In the posttest, students were randomly assigned to two conditions: treatment or control. While students in the treatment group (n = 26) were taught how stress can be used as an adaptive tool by focusing on its positive effects (cognitive reappraisal), students in the control group (n = 14) were asked to ignore stress. I found that while math exam anxiety was reduced in the treatment group, it increased in the control group, but this difference wasn't statistically significant. No effect on students' coping resources and academic achievement found. Limitations and implications for further research are discussed.

Keywords: math anxiety, cognitive reappraisal, coping resources, academic performance.

ÖZET

MATEMATİK ORTAMINDA ALGILANAN ZORLUKLAR VE TEHDİTLER: BİLİŞSEL YENİDEN DEĞERLENDİRME YÖNERGELERİNİN MATEMATİK KAYGISI ÜZERİNDEKİ ETKİLERİNİN İNCELENMESİ

İzel Sarı

Eğitim Programları ve Öğretim Yüksek Lisans Programı

Danışman: Dr. Öğr. Üyesi Aikaterini Michou

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Eylül 2022

Dünyadaki tüm kültürlerde ve eğitim sistemlerinde yaygın olarak kabul edildiği üzere matematik kaygısı insanların yaşamlarını olumsuz yönde etkilemektedir. Ancak bahsettiğimiz bu kaygı her zaman olumsuz düşünülmek zorunda değildir. Stres altındayken vücud, meydan okuma veya tehdide karşı tepkisini hazırlamak için "savaş ya da kaç" reaksiyonunu tetikler. Eğer bu stres tepkileri bir araç olarak uyarlanabilir ve nasıl kullanılacağı öğrenilirse, kişiye başarıya giden yolda hırs ve motivasyon sağlayabilir. Yapılan laboratuvar çalışmalarına göre, bilişsel yeniden değerlendirme müdahaleleri, kişilerin kaygı hakkındaki olumsuz düşüncelerini değiştirmelerine yardımcı olmaktadır. Hatta matematik kaygısını azaltarak öğrencilerin matematik performansını iyileştirebilir. Bu deneysel çalışmada, matematik sınavlarından önce uygulanan bilişsel yeniden değerlendirme müdahalelerinin öğrencilerin matematik kaygılarını azaltarak ve başa çıkma kaynaklarını artırarak akademik performanslarını iyileştirip iyileştirmediğini araştırılmıştır. Araştırmaya Türkiye'de kar amacı gütmeyen bir vakıf üniversitesinin sosyal bilimler fakültesinde öğrenim gören kırk lisans öğrencisi katılmıştır. Ön-testte 1. Matematik Sınavı'ndan önce katılımcılara matematik kaygısı ve stres değerlendirmeleri ile ilgili anketler dağıtıldı. Son-testte ise katılımcılar rastgele iki koşula atandılar: uygulama veya control grubu. Uygulama grubundaki öğrencilere (n = 26) stresin olumlu etkilerine odaklanılarak (bilişsel yeniden değerlendirme), stresin uyum sağlayıcı bir araç olarak nasıl kullanılabileceği öğretilirken, kontrol grubundaki öğrencilerden (n = 14) stresi görmezden gelmeleri istendi. Matematik sınav kaygısı uygulama grubunda azalırken, kontrol grubunda arttığı ancak bu farkın istatistiksel olarak anlamlı olmadığı bulundu. Ayrıca bilişsel yeniden değerlendirme materyallerinin öğrencilerin başa çıkma kaynakları ve akademik başarıları üzerinde hiçbir etkisi bulunamadı. Daha fazla araştırma için çalışmanın kısıtlamaları ve çıkarımları tartışıldı.

Anahtar kelimeler: matematik kaygısı, bilişsel yeniden değerlendirme, başa çıkma kaynakları, akademik performans.

ACKNOWLEDGEMENTS

First and foremost I would like to extend my deepest appreciation to my thesis advisor Asst. Prof. Dr. Aikaterini Michou who continuously supported me with her great knowledge and always encouraged me throughout my entire research and who provided me an opportunity to join TUBITAK project as a graduate research assistant. I am grateful and feel incredibly lucky to have Assoc. Prof. Dr. Jennie Farber Lane as my second advisor. She continuously provided encouragement, understanding and was always enthusiastic to help in any way. I could not have imagined having better advisors and mentors for my research study. Without their guidance and persistent help this dissertation would not have been possible.

I would like to express my sincere gratitude to Prof. Dr. Fatihcan Atay and Dr. Yosum Kurtulmaz who continuously supported me and have shared the effort in order to make this experimental research a reality.

I would like to thank my committee members Asst. Prof. Dr. İlker Kalender and Assoc. Prof. Dr. Serkan Arıkan for making my defense a pleasurable experience for me and for their valuable suggestions.

A special thanks to my learning partners, Çağdaş Aydın, Müge Fidan, Nazan Günbükü and Ezgi Polat who played such important roles along the journey.

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CHAPTER 1: INTRODUCTION

Introduction

Math anxiety is known as feeling nervous about math-related tasks. This is a major phenomenon that can cause distress and may lead to a fear and avoidance of mathematics. Students' earlier negative math experiences frequently follow them throughout their adult life and can have long-term consequences in terms of competencies in mathematics. Despite these negative connotations, anxiety actually has a constructive function for humans. The feelings and symptoms caused by anxiety are part of our natural stress response, such as fight-or-flight reactions, which are necessary for survival.

This study focuses on the math anxiety of university students and explores if students can recognize the constructive role of anxiety for their studies in mathematics. Chapter 1 gives some background information about the study including the problem, the purpose of the research, the research question that the study considers the significance, the limitations and definition of key terms.

Background

Feeling the world by reacting within the framework of changing events is an unconscious action in human creation. According to how humans appraise the events, positive or negative feelings can be experienced. Especially negative feelings leave may leave a long lasting-impression. These enduring feelings may be necessary for survival; they help us remember the events and avoid them in the future.

However, sometimes we overreact to negative events. For example, we may have an embarrassing experience and imagine it was much worse than it really was. Sometimes, despite having had a negative experience we know we will need to

repeat it throughout our lives, such as speaking in front of a large audience or navigating a foreign landscape. If our reactions are extremely negative, these feelings can affect almost all aspects of life; disrupting mental and physical stability and wellbeing. We may even start having anticipatory negative feelings, where we dread something even if we have not experienced it yet.

Negative emotional states that are generalized in an individual's reactions could lead to emotional disorders. Anxiety is one of the most common mental disorders in the world (World Health Organization, 2017). Regarding negative emotional responses and the relation between fear and anxiety, Brooks and Schweitzer (2011) stated that "anxiety is a state of distress and/or physiological arousal in reaction to stimuli including novel situations and the potential for undesirable outcomes" (p.44).

Anxiety is perceived to have a negative effect on our daily living; this same perception is true for students in educational settings. Students who suffer from anxiety experience changes in their behavioral, physical, and cognitive development. According to Hembree (1990), the most common types of anxiety in educational settings are test anxiety and math anxiety. Indeed, since mathematics seems to be one of the hardest subject areas to understand and master, math anxiety is very common among students.

Math anxiety is expressed as feeling uncomfortable when encountering mathematical situations and being unwilling to be involved in mathematics (Buxton, 2017). Math anxiety shows up even during basic operations such as addition or subtraction; for example, many of us have started to feel anxious when balancing our bank accounts or dividing a restaurant bill. Many of these anxious feelings we

experience as adults towards mathematics may have originated from negative experiences in math classes when we were children.

Ashcraft (2002) states that the negative perceptions of highly math anxious students may lead to their rejecting math in any situation. He also claims that there is a negative relation among math anxiety, self-confidence and motivation. For example, when students lack confidence to perform in mathematics, they develop feelings of anxiety, and consequently lack of motivation to participate in mathematical challenges. When they are required to complete assignments in mathematics, they start to find excuses to not do the work and get in the habit of procrastination. When they miss out or do not experience essential supportive feelings for a mathematical task, their ability to complete subsequent tasks is compromised. Thus, math anxiety affects math competence (Ashcraft, 2002).

Continually feeling anxious and displaying avoidance behaviors towards mathematics may affect students' working memory and cause disruptions in brain functioning. Ashcraft (2002) points out that neural activity associated with math anxiety involves the same neurons that activate stress in general. Regarding underlying neurocircuitry and emotional components, there is significant overlap between stress and anxiety and their cognitive consequences appear to be similar (Lukasik, 2019). Intrusive thoughts and avoidance reactions that occur in response to stressful situations impair cognition, resulting in decreased performance in the working memory, increased high arousal, which are the main features of experiencing anxiety or negative stress, motivation problems, and reduced attentional control (Lukasik, 2019). Stress causes feelings of fear and anxiety, with the main difference being that anxiety appears to be based on uncertainty for possible,

upcoming negative events; whereas fear is based on recognized real or perceived dangers (Fink, 2016; Steimer, 2002).

The location in the brain that processes many of our fears is called amygdala, which has matching sets in the temporal lobes (which are located on both sides of brain, near our ears). According to a study on fear processing in the brain, the size of the right amygdala in individuals with higher levels of mathematical anxiety is smaller than in people with less anxiety (Kucian, 2018). It seems, therefore, that there are neural underpinnings to math anxiety that are being investigated by neuroscientists and cognitive psychologists. With some evidence that the structure of the brain may be associated with anxiety, it is possible that people with certain neural developments are more prone to anxiety. In other words, math anxiety may be related to genetic factors as well as to individual experience (Wang, 2014).

Considering possible physiological reasons for certain behaviors, it is still important to acknowledge experiences that can contribute to feelings of anxiety towards mathematics. For example, students' ability in math and their attitudes toward math may be affected by social stereotypes and parents' expectations. Their teachers' and friends' attitudes can also be considered as factors that could influence math anxiety. Math anxiety is caused by a combination of stress or mental fatigue and external variables such as gender, stereotype, or socioeconomic status.

The causes of this mental disorder can vary from person to person, individual's express different symptoms in response to various events and situations. The exact reasons for math anxiety are difficult to be identified. Moreover, math anxiety is associated with using math in everyday situations, performance anxieties about being monitored while using math, such as taking tests, using computers, and problem-solving (Campbell, 2005). Mathematics anxiety impairs both children's and

adults' mathematical learning and performance, and it leads to avoidance of mathematical activities by overloading and disrupting working memory during mathematical tasks (Dowker, 2016). This has serious consequences for mathematical development, mathematics education, and future participation in mathematics-related activities. The purpose of diagnosis is to help students to cope effectively with the anxiety of mathematics which frequently influences students' career choices and their life paths. Since understanding and mastering mathematics is critical for students' academic success as they need a certain level of mathematics to gain academic success, reducing or eliminating math anxiety can improve students' academic lives to some extent.

Therefore, anxiety in mathematics could also have a constructive role; rather than denigrating anxiety, perhaps its role in education should be reappraised. Even though the causes can vary, there are reliable tests that can detect the disorder to help individuals who suffer from math anxiety. According to Brooks (2014) "reappraisal is the most effective strategy for mitigating the experience of state anxiety" (p. 1145). Reappraising anxiety focuses on demonstrating the adaptive benefits of this emotion and how responses can be modified. Reappraising is a coping tool that encourages individuals to re-conceptualize anxiety (Jamieson, 2016). When anxiety appears before the person's emotional response is fully activated, cognitive reappraisal techniques allow reframing a negative emotional impact. When this technique was adapted to the math classroom setting, it was associated with higher math test scores. (Jamieson, 2016).

When anxiety is manifested at manageable levels, it may help to motivate people to stop procrastinating and to act. Instead of ignoring or dismissing anxiety, it might be seen as a mechanism designed to effectively improve individuals' focus and

performance. This approach can make math anxiety more adaptive and integrate it into students' optimal functioning that will make them more successful in mathematics.

Problem

A negative emotional variance toward mathematics may cause long-term destructive consequences for students. The continuity of unpleasant experiences such as mathematical anxiety affects the integration of the cognitive and affective aspect of mathematics. Compromised integration of these aspects could eventually affect students' career choices and academic or personal success (Wang et al., 2014).

While it is almost impossible to eliminate stress arousal that leads to anxiety, as stress is the result of several biological and social factors, it could be possible to minimize its effects. Especially, for adolescent students who are about to make important choices for their career, to minimize the effects of extreme math anxiety is very important.

However, how can this reduction be accomplished? Jamieson (2016) showed that when adult students were instructed to reappraise their math test anxiety as an adaptive state that could facilitate them to focus on the exam, they reported less math test anxiety and performed better compared to adult students who had been instructed to ignore their stress arousal. Such an approach might be useful not just for adults, but also for college and high school students. Many students of this age, in particular, experience anxiety as they study for high-risk examinations while pursuing degrees in higher education.

Purpose

This study will investigate to what extent reappraisal instructions can be used as a strategy to change students' negative perceptions toward math when they are

preparing for mathematics examination. Research has shown that cognitive processes, such as reappraisal, can shift negative stress to positive stress (Jamieson, 2013).

In mathematics, this reappraisal can be referring to considering the positive consequences of stress arousal before math exams. The purpose of this study, therefore, is to investigate whether using cognitive reappraisal of stress before math exams reduces math anxiety and stress appraisals and increases their performance on a mathematics exam. As this study focuses on the effectiveness of a psychosituational intervention on cognitive stress assessments (Jamieson, 2016), an experiment with two groups of non-mathematics major undergraduate students from non-profit private university will be conducted.

Research Questions

Does providing cognitive reappraisal instruction before math exams to non-major mathematics students' regarding the positive consequences of stress arousal

- reduce math anxiety and task demands?
- increase appraisals of coping resources?
- affect academic performance?

Significance

This research will show whether instructions describing the adaptability of stress and the benefits of this adaptability can be beneficial in reducing math anxiety, thereby improving math performance. These social-psychological interventions can be used to provide a positive change in educational settings. The findings of the study could offer a chance of improving the academic outcomes of students suffering from excessive mathematics anxiety by integrating anxiety in their optimal function in educational practice.

Large-scale assessments such as the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) report that Turkey falls behind its international counterparts in mathematical accomplishment. Considering that Turkish students struggle with mathematics, it is imperative to investigate all the possible factors that could contribute to math performance improvements. Among these factors are the negative experiences that may have long-term effects on students' emotional, physical, and biological well-being. Students who fail math exams appear to be able to enhance their abilities by controlling their anxiousness.

Thus, students who develop academic resilience towards anxiety, with the help of the instructions of stress reappraisal, are better equipped to be successful against challenges. The results would enable students to incentive for intimidating and overwhelming experiences by providing them with a positive feeling about their potential for learning and achieving.

Definition of Key Terms

Academic performance: Knowledge obtained by an instructor by conducting a process evaluation in order to determine whether the determined educational goals have been achieved in a certain time period.

Exam anxiety: The emotional, cognitive, and behavioral responses that accompany anxiety about the potential negative consequences of performance in an exam situation (Donaldson, 2002).

Cognitive reappraisal: Reinterpreting an emotionally charged situation in such a way that its meaning and emotional impact are altered by reconsidering the meaning of affectively charged stimuli or events (Cutuli, 2014; Sakakibara, 2016)

Coping resources: Intentional or unintentional strategies to manage stressful situations and avoid psychological distress (Taylor, 2007).

Math anxiety: Feeling of tension, apprehension, or fear when confronted with mathematical situations, and unwillingness to participate in mathematics (Ashcraft, 2002; Buxton, 2017).

Learning anxiety: Concerned about the possibility of poorer learning outcomes as a result of decreased sensitivity to environmental signals, ineffective information encoding and processing, increased cognitive distraction, and decreased working memory capacity (Warr, 2000).

Stress appraisal: A mechanism by which people assess and handle a stressful circumstance (Baumeister, 2007).

Task demands: The impact of a task's aspects, such as its divisibility and difficulty, on the processes that determine how people must work to complete the task (American Psychological Association Dictionary, 2022).

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

This study explores how cognitive reappraisal instructions can be used to transform anxious students' negative perceptions toward mathematics. Anxiety typically causes undesirable negative effects on students' cognitive, physical and social wellbeing. Under stress, they may face physical symptoms like sweating, headaches or high blood pressure. These symptoms can also lead to cognitive and social problems, such as depression, constant worrying and panic attacks.

Studies have found that positive consequences of stress arousal during mathematics exams can change students' perception about anxiety and help them to reframe their perceptions of anxiety thus providing opportunities for greater math achievement (Hangen, 2019; Liu, 2019; Jamieson, 2016). Cognitive reappraisal instructions prevent the damaging effects of mathematics anxiety by helping students to promote the benefits of anxiety. The instructions help students to be more conscious about the symptoms and help them to reduce the negative habits caused by anxiety. Students capitalize on anxiety's resources and use anxiety for their advantage. Thus, a series of positive effects occur that will result in students' improved mathematics performance. Students, who have adapted to this practice, ensure continuity in academic performance as well.

Mathematics Anxiety and Its Origin

Anxiety has long been a topic of discussion for educational researchers. Different goal structures, academic abilities, and family backgrounds of students can trigger anxiety. According to Hashempour (2014), anxious students often experience high and uncontrollable anxiety about tough situations that have occurred in the past

or may occur in the future. Being anxious disrupts the working memory by affecting the students' learning and information processing negatively. This can lead to worse academic performance, school failure or dropout (Hashempour, 2014).

The first recordings of math anxiety in the literature appeared in the 1950s when a classroom teacher observed her students and stated that the students suffering from mathematics had "mathemaphobia"; a later study described college students with similar traits as having "numerical anxiety" (Campbell, 2005). Although students display commonly-recognized traits of anxiety, researchers in this field believe that math anxiety differs from general anxiety: Math anxiety (MA) is considered as feeling stressful under mathematical conditions. Richardson and Suinn (1972) defined this kind of stress as ". . . a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 551).

In 1999, the researcher Ma conducted a meta-analysis to highlight the intercorrelation of different anxiety varieties to math anxiety. The correlations between math anxiety and other types of anxiety ranged from approximately .30 to .50, which explains why highly math-anxious individuals also have high levels of test and general anxiety. However, the data in the correlation show that math anxiety should not be classified as test or general anxiety, but rather as a completely different type of anxiety. All subscales of math attitudes and math anxiety were negatively correlated. This means that people who suffer from math anxiety not only find math less enjoyable, but their self-confidence suffers as well, affecting their motivation. Table 1 lists a few of these crucial findings.

From Table 1, results demonstrate that attitudes toward the mathematics teacher were not strongly correlated. However, it is possible to argue that

mathematics anxiety is related to both the mathematics teacher and the classroom situation, attitudes, and behaviors of the students. A math-anxious teacher may give instructions implying that not everyone will be good at math (Ramirez, 2018). Previous research has shown that math-anxious teachers had lower expectations for their students' academic performance (Mizala, 2015). According to Ramirez (2018), teachers who lack process-oriented teaching strategies send the message to their students that not everyone has the ability to understand difficult math concepts. Ramirez (2018) also concluded that the indirect messages that teachers feel in the classroom and convey through their practices can be an important factor in shaping students' mathematical learning, understanding, and interpreting. Students affected by this environment may fall into an endless cycle. Campbell (2005) explains the situation as follows: If students with math anxiety receive lower math grades than their peers, this indicates that these students do not actually meet the objectives of the math curriculum; a student who does not complete the math proficiency of a specific grade level, will struggle at the next level and will be subject to failure in this case. This means they are far behind the math curriculum that they are supposed to cover. Therefore, highly math-anxious students mostly receive lower grades in math exams. It does not seem inevitable that they will constantly experience this anxiety and build their future on it.

Table 1

Selected Correlations with Math Anxiety Among College Students

Variable	*r*
Measures of anxiety	
Test anxiety	.52
General anxiety	.35

Table 1 (cont'd)

Selected Correlations with Math Anxiety Among College Students

Variable	*r*
Math attitudes	
Enjoyment of math	–.47
Self-confidence in math	–.65
Motivation	–.64
Usefulness of math	–.37
Math teachers	–.46
Avoidance	
Extent of high school math	–.31
Intent to enroll in more math	–.32
Performance measures	
IQ	–.17
Math achievement (college)	–.31
High school math grades	–.30
College math grades	–.27

Note. Adapted from "Handbook of Mathematical Cognition" by Campbell, I. D., 2004, *Psychology Press*, p. 317.

Once math anxiety was recognized as a unique type of stress related to the discipline, researchers began to report how negative emotional reactions of math anxiety could affect educational outcomes. These consequences may cause successive chain of events: Math anxious students are more likely to avoid any math related situation, may affect opportunities to develop their educational attainment and personal gain, resulting in worse academic performance and consequently an

increase in math anxiety. In fact, transferring this anxiety to future generations is another research area for educational researchers. It is well known that parents have an impact on their children's values, beliefs, expectations and performance (Casad, 2015, Eccles, 1986; Gunderson, 2012). Students' mathematical abilities, perceptions of mathematics lessons, and their mathematics anxiety levels predict their plans to continue math-related choices (Eccles, 1986). According to Eccles' studies (1986), these student beliefs are most strongly associated with their parents' (especially mothers') beliefs about the difficulty and importance of mathematics. Similarly, this idea is supported by the study of Casad (2015). His study showed that parents' perceptions of math play an important role in children's math anxiety. Moreover, it examined that they interact to predict various math education outcomes, including math self-efficacy, math GPA, math behavioral intentions, math attitudes, and math devaluation (Casad, 2015). This was evident for parents to conceptualize math anxiety as a moderator that determines the strength and direction of the relationship between children's math anxiety and math education outcomes (Casad, 2015, Gunderson, 2012).

According to the literature, when we first started learning mathematics in primary school years, it shows that children have very positive attitudes towards mathematics. A more comprehensive study was done by National Assessment of Educational Progress (NAEP), 9-year-olds ranked math as their favorite subject and 13-year-olds ranked it as their second-best subject, but 17-year-olds placed it as their least favorite subject (Stodolsky, 1985). This means that, while their perception of the importance of mathematics during their school years does not reduce as they approach adulthood, they perceive it as a difficult subject that they personally struggle to study (Stodolsky, 1985). Understanding the reasons behind dislike for

other academic subjects may be based on understanding the causes of negative attitudes toward math, reluctance to study math, and math anxiety.

Positive and negative experiences on students' experiences in learning and their motivation can be affected by math anxiety. To see the statistical evidence between students' motivation, achievement and their math anxiety levels, Zakaria (2008) conducted an experiment involving 88 students. In this study, students' motivation and achievement were classified according to their math anxiety levels. Findings of his study revealed that math anxiety and motivation strongly correlated. Basically, students who struggle with math anxiety perform poorly on their assignments, which lead to a lack of motivation. If this situation continues, students with high math anxiety will be less motivated to study math or do math-related things.

Diagnosis of Math Anxiety

In order to prevent students from consequences of math anxiety, the first step is diagnosis of math anxiety. According to Ashcraft (2002) and Faust (1992) who claim the math anxiety as phobia, there are some standardized diagnostic criteria like stating anxiety reactions. People who deal with math anxiety report that when they take standardized math tests or balancing their checkbooks, they usually encounter difficulties and feel anxious in both academic and non-academic contexts (Ashcraft, 2005). Therefore, testimony is the key indicator in identifying this negative feeling.

To obtain more accurate results from students' testimony, which was based on discourses and expressions of feelings, educational researchers developed a variety of questionnaires and rating scales to systematically assess mathematics anxiety. As with all self-reporting measures, the accuracy of respondents' self-perceptions and their honesty in reporting can affect the survey results (Dowker,

2016). Dowker's study (2016) also stated that several researchers have made an effort to address this issue by utilizing physiological indicators of anxiety when exposed to mathematical stimuli, such as heart rate and skin conductance, cortisol release, and particularly brain imaging measures like EEG recordings and functional MRI. This leads to the conclusion that diagnosing math anxiety will benefit from the assessment of neurophysiological measures in addition to highly reliable tests. Information about one of these scales is reported below.

The Abbreviated Math Anxiety Scale (AMAS)

The Abbreviated Math Anxiety Scale is one of the useful tools for defining math anxiety both for adults and adolescents which was developed by Hopko et al. (2003). The 9-item scored on a Likert-type AMAS scale has high test-retest reliability and internal consistency. There are two elements that make up the AMAS's total score which are the Learning Math Anxiety (LMA) and the Math Evaluation Anxiety (MEA). These two useful subscales are, in essence, defined as follows; math exam anxiety, which relates more to assessment situations, such as worrying about a math test that is scheduled for the following day, and math learning anxiety, which relates to anxiety about the learning process, such as paying attention to a lecture in a math class (Caviola, 2017).

There are a number of factors that keep AMAS relevant globally. The most important one is the AMAS was effectively adapted to cultures that are vastly different from the US; Iranian adaptation of AMAS, Polish adaptation of AMAS, and Italian adaptation of AMAS all indicate that the AMAS is appropriate for testing math anxiety in a variety of cultural and linguistic contexts (Caviola, 2017; Cipora, 2015; Primi, 2014; Vahedi, 2011).

Addressing Students' Math Anxiety

For years, educators have tried to find a variety of techniques to help students who are anxious about math. The first step in development and application of these techniques is to identify the students who are suffering from math anxiety. According to Woodard's findings (2004), students with math anxiety complain of things like an inability to concentrate, a blank mind, and a feeling of sickness or irritability when they take a math test. Whatever the cause or reflection, it is undeniable that math anxiety has a significant relationship with math performance and any math-related things. Some researchers have found that, even if math anxiety cannot be completely eliminated, math anxiety can be trained or minimized.

With the development of brain-computer interface (BCI) devices, it can be thought that these devices will have a potential use in education and reducing math anxiety. Verkijika and De Wet (2015), argued that combining computer games with the BCI device's potential to provide real-time neuro-feedback on physiological arousal could serve as a solution for effectively monitoring, training, and reducing mathematics anxiety. They prepared a BCI-based mathematics educational game for their short-term longitudinal research. The study examined math anxiety by providing feedback to participants and indicated that the BCI mathematics educational game can effectively assist students reduce their math anxiety (Verkijika & De Wet, 2015). Huang (2016) investigated the effectiveness of computer-based strategies used to reduce students' math anxiety in a similar study. In his study, a coping message presented during the course as students learn a math subject in a computer-based learning environment. Students were asked to summarize their thoughts and feelings as part of an online pedagogical advisor course on how to manage their anxiety (Huang, 2016). According to the study, adding anxiety-

reducing features to a computer-based lecture may motivate students, resulting in improved learning outcomes. A significant point has been raised in these two investigations, particularly in terms of applicability. Unlike traditional cognitive psychology methods, BCI-based games or computer-based programs can be used at home by students or their parents with little or no expert help.

A mindfulness-based strategy supports students in controlling their behavior by shifting their focus away from their anxiety and improving their concentration on their tasks (Samuel, 2021). Building on this idea, Samuel (2021) investigated the impact of combined mindfulness and growth mindset intervention in student's math anxiety. This intervention was followed by a one-minute deep breathing exercise at the beginning of each lesson, as well as five positive math affirmations read aloud and in unison. According to the study's findings, students who received the intervention reported decreased math anxiety and increased math self-efficacy. Even the students recognized that throughout each class period and the whole semester, the intervention increased their self-confidence.

According to Jamieson et al. (2013), arousal during stressful situations may be beneficial; sympathetic activation may be higher during approach-motivated challenge stages than during danger states. As a result, they applied the biopsychosocial model of threat and challenge, which explains how appraisals interact to reframe stress. They concluded that participants who reinterpret stress-related signals in connection to their own bodies and minds, performed better than those who did not after using the model.

Biopsychosocial Challenge and Threat Type Responses

In the context of motivational theory, challenge and threat theory has been used to study stress and emotion research. Personal resources for appraisals and

coping with situational demands combine to elicit either a general motivational challenge situation, an approach-oriented response, or a threat, an avoidance response (Mendes, 2014). Basically, challenge, typically inspires approach motivation, whereas threat, avoidance (Oveis, 2020). Therefore, the biopsychosocial (BPS) model of challenge and threat attempts to explain stress responses in motivated performance situations that necessitate instrumental cognitive responses (Jamieson, 2012, 2016, 2018). Since both challenge and threat responses cause sympathetic arousal, physiological measures are required to differentiate a person's stress responses; the challenge increases cardiac efficiency, facilitating the delivery of oxygenated blood to the brain, whereas the threat increases vascular resistance in anticipation of social defeat (Jamieson, 2016). As a result, challenge and threat experience predicts better results in performance.

The biopsychosocial challenge and threat model has been used in recent studies to try and improve acute stress reactions and alter arousal appraisal (Jamieson, 2010, 2013, 2013b). Participants in these studies who reframed the meaning of physiological signals, which were considered as the first signs of stress, performed better than those who did not. Stress reappraisal interventions have expanded studies on emotion regulation and cognitive behavioral therapy as a result of research on reframing arousal (Jamieson 2013, 2013b).

Stress Reappraisal

It is generally accepted that staying calm and putting an effort to reduce your stress levels is the greatest method to enhance performance in a crisis. However, it is often overlooked that the adrenaline provided by stress or anxiety means keeping the body and mind fit. Therefore, it's critical to focus on this period of time when the body is essentially on alert and create effective coping strategies. Reappraising stress

as functional and adaptive can help to improve outcomes of the stressful situation (Oveis, 2020). The goal here is not to persuade individuals that stress is not tough or harmful (Jamieson, 2016). It aims to emphasize the adaptive benefits of stress by encouraging people to rethink stress as a coping mechanism.

The origins of this approach can be found in Cognitive Behavioral Therapy. Cognitive Behavioral Therapy (CBT) is a type of therapy that is frequently used to treat stress and depression related diseases. The goal of this form of treatment is to alter the thinking and behavior of patients with both mental and physical health. The cognitive reappraisal approach based on CBT, usually takes place in three steps: identifying, evaluating, and changing automatic thoughts or underlying beliefs (Wenzel, 2018).

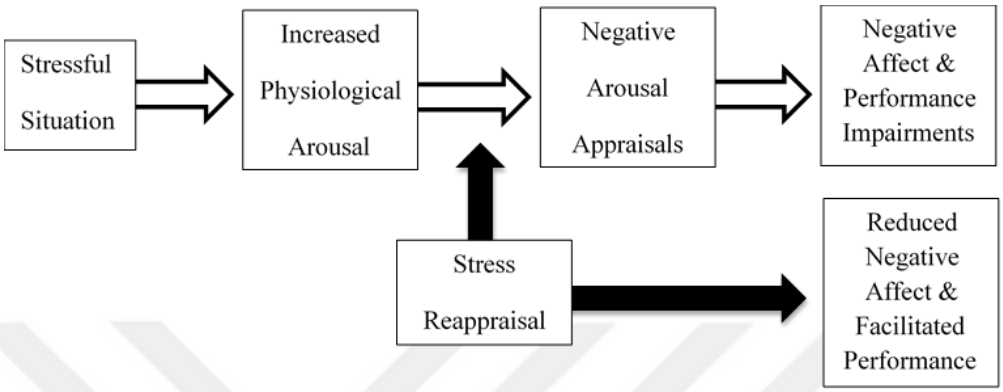
The central aspect of the approach is that stress reactions can vary which means that emotional regulations are adaptable by altering how people interpret internal and external cues (Jamieson, 2012). For instance, even the feeling of anxiousness, which is often regarded as a negative feeling, can be viewed as helpful (Jamieson, 2012). Jamieson (2012) argued that reappraising arousal during acute evaluative stress has physiological and cognitive benefits. Participants in their experiment were instructed to reappraise or "rethink" arousal, so those who showed more adaptable physiological responses also had less threat-related attentional bias.

In another study that investigated the effects of reappraisal, participants were randomly assigned to one of three manipulated conditions: reappraisal, ignoring external cues, or no intervention (Jamieson, 2010). While the participants in the first group were told that arousal improved performance, those in the ignorant group were trained to ignore any clues, and the final group was designed to serve as a control

group and received no intervention. They concluded that participants who were in the reappraisal group performed better than controls (Jamieson, 2010).

Figure 1

The effect of stress reappraisal on the negative consequences of arousal



Note. Adapted from "From Improving Acute Stress Responses: The Power of Reappraisal." by Jamieson J. P., 2013, *Current Directions in Psychological Science*, 22(1), p. 51. Copyright 2013 by the SAGE Publications.

In Figure 1, at the beginning of stress physiological arousal, which is typically viewed negatively increases. A highly anxious person experiences negative outcomes as a result of these unfavorable impacts of arousal, such as weak performance and a rise in the intensity of negative thoughts. When stress reappraisal cuts the relationship changes it into positive outcomes.

Negative emotion regulations can take root in students' minds. There are many strategies to cope with them. Liu (2019) revealed the results of active/adaptive coping strategies and their consequences using a meta-analysis and systematic review study among 36 articles. The articles included 82 independent samples. Their study explored the efficacy of reappraisal strategies on stress arousal by comparing all reappraisal interventions within different experimental methodologies. According to their review, the authors emphasize that cognitive reappraisal strategies help to

reframe beliefs about stress. Findings conclude that the reappraisal process enables anxious people to control their affective, cognitive, and physiological outcomes.

A study was conducted by Liu et al. (2019), where almost 77 university undergraduate students enrolled in Introductory Psychology courses at Ryerson University to investigate how stress appraisal methods can help to hinder negative consequences of emotion regulations. Through experimental study, students were randomly assigned to reframing conditions which includes both positive and negative stress consequences too. This research supports the adaptation of reappraisal-based interventions. At the end of the study, the authors concluded that participants' perception about stress did not change. However, the control group's self-reported stress outcomes were increased after being under pressure compared with the other groups.

Hangen et al. (2019) investigated how instructing appraisals can change students' perceptions about stress as a functional and adaptive tool during pressured times. This study considered reappraising stress arousal affects students' unpleasant outcomes of anxiety in physiological functioning and academic performance. They conducted the study with 279 participants who were randomly assigned to three different coping resources. In this study, a stress reappraisal strategy was used to ensure that participants educate themselves about positive consequences of stress. However, stress-is-debilitating strategies have certain goals to make participants more conscious about rejecting stress. The authors also tested cardiovascular effects during reappraising stress arousal. They concluded that this approach works in physiological functioning.

Conclusion

Anxiety affects almost all students when they worry about past and future events and expectations. In the field of mathematics, researchers have noted that mathematics anxiety is particularly prevalent and has far-reaching implications. Educators emphasize it is important to address the negative aspects of mathematics anxiety as habitual and reoccurring stress can debilitate students' performance not only while in school, but when dealing with math-related activities in daily life.

Ironically, researchers do not condone eliminating math anxiety altogether. Anxiety is not always negative; it often provides the student with ambition and motivation on the road to success. Therefore, rather than avoiding or denying feelings related to anxiety, one solution is to recognize how the symptoms of anxiety can be transformed – reappraised – and used to students' advantage rather than disadvantage.

The goal of this chapter was to provide a general overview of math anxiety and to review prior research that investigated how it can be reappraised. The studies concurred that cognitive reappraisals are a form of active coping methodology. These coping methods can help students who suffer from math anxiety to rethink their fears; they can regulate their emotions to ameliorate the negative effects of stress. Conscious awareness of such coping mechanisms among mathematics students is an excellent tool for reducing the psychological and psychological pains associated with classroom mathematics learning (Khiat, 2013).

In the current study, anxiety is considered to be a natural human reaction. It can be used as an activation tool whenever students feel under pressure, like during stressful exam situations. Reconsidering the role of anxiety in their emotions can

help students to better manage their reactions during exams and could ultimately help to improve their academic performance.

CHAPTER 3: METHOD

Introduction

The study investigated whether cognitive reappraisal instruction about the positive consequences of stress arousal helps reduce students' stress appraisal and mathematics anxiety. Furthermore, the study analyzed whether these manipulations improved students' academic performance. The randomized pretest-posttest control group design was developed for the study. This chapter provides details about the experimental design methodology.

Research Design

Experimental Design: The Randomized Pretest-Posttest Control Group Design

In experimental research the researcher purposefully controls and changes the factors or variables that determine the events of interest. The control and change involve the researcher introducing an intervention and measures its effect. In other words, the basis of an experiment is changing the value of one variable (the independent variable) and observing the effect on another variable (the dependent variable; Cohen, 2020).

Following the generation of a research question, the researcher stated a testable hypothesis containing an interaction or effect, determine how to control variability during the experimental process, and select or develop conditions for intervention (Bell, 2009). The control variable in the experiment for the current study was generated by distributing placebo materials to a control group, while intervention materials were developed for the treatment group. As a result, there are two groups: an experimental group (treatment group), which experienced the changes, and a control group, which experienced none.

The intervention materials for this study were designed with the intention that they would influence the dependent variables in some way during the experiment.

Specifically, this study tested whether the cognitive reappraisal materials (i.e., the intervention materials) work better compared to the placebo materials to reduce stress appraisal and math anxiety and increase performance in math exams.

The experimental design used in the current study is the randomized pretest-posttest control group design. This is a design where random assignment is used to form the two groups (control and treatment), and both groups are measured or observed twice (pretest - posttest); the measurements and observations for both groups take place at the same time (Fraenkel, 2006). In the present study, for the pretest (before Math Exam 1), math anxiety, stress appraisals and academic performance (i.e., exam grades) were measured as dependent variables. Prior to Math Exam 2, students were randomly assigned to control or treatment group by giving them randomly either placebo or cognitive reappraisal reading materials. For the posttest (after Math Exam 2), anxiety, stress appraisals and academic performance were measured again.

This method allows the researcher to examine the effect of reappraisal manipulation that may be applicable through the consequence of comparisons and delineates. The first day of the experiment was scheduled to take place roughly 10 minutes before the math exam, which is believed to be at or near the start of stress arousals. The participants were then given the 9-item *Math Anxiety Scale* (Hopko, 2003; Jamieson, 2016) and the 12-item *Stress Appraisal Scale* (Jamieson et al., 2016) to complete (see Instrumentation below for more details). At this time, they were not assigned to experimental groups because in this trial their level of stress was

pretested; they were allocated to an experimental condition on the second experimentation day. This allocation involved being randomly assigned to groups.

The experimentation day began with three pages of written instructions on the benefits of reappraising arousal or ignoring stress, respectively. Some of the content was based on established scientific facts, while other information was based on emotion suppression techniques to serve as a placebo (Jamieson, 2016). It is not intended that the manipulation instructions effects, which are meant to be disregarded, have a negative or positive influence on the factors. The posttest step included reading articles, math anxiety and stress appraisal scales. The articles read by the treatment group serve as the intervention materials, and the instrument used to manipulate the participants about positive outcomes of the stress. In this manipulation, the participant was instructed to concentrate on the benefits of stress arousals just five minutes before the math exam in order to avoid negative outcomes. Figure 2 below presents a diagram of how this design was used in this study.

Figure 2

Outline of the Experimental Design

O	**R**	**X**	**O**
Pretest: students completed assessments of math anxiety and stress appraisals then attended Exam 1.	Students were randomly assigned to treatment group.	Treatment: reappraisal instruction materials.	Posttest: students completed assessments of math anxiety and stress appraisals then attended Exam 2.
O	**R**		**O**
Pretest: students completed assessments of math anxiety and stress appraisals then attended Exam 1.	Students were randomly assigned to control group.	Treatment: placebo instruction materials.	Posttest: students completed assessments of math anxiety and stress appraisals then attended Exam 2.

Note. In this schema, O denotes the dependent variable to be measured, X denotes the independent variable, which may include an experimental manipulation, intervention, or treatment, and R denotes a randomly assigned participant group.

Context

This study was conducted in a non-profit private university located in Ankara, Turkey. Approximately 13,000 students are enrolled at this university in a variety of fields. A major consideration for the context of this study was that there be differences among students' ability to do mathematics; these differences could contribute to students' anxiety, which was a variable needed for the experiment. Therefore, the researcher identified a mathematics course designed for non-mathematics majors. The mathematics department at the university offers two *Introduction to Calculus* courses (MATH 105 and MATH 106), which are required of all students during their freshman year. There is no prerequisite for these courses;

the content of the course is designed cumulatively, regardless of students' level of mathematics.

Introduction to Calculus I (MATH 105) provides a gentle introduction to understanding the importance of mathematics and it is a prerequisite for *Introduction to Calculus II* (MATH 106). Additionally, because these two courses are requirements for the ones that will be taken in the semesters that follow, students who don't pass them must still complete this course in order to enroll in another one the following academic year. For the Spring Semester of the academic year 2020-2021, five sections of MATH 106 were offered and a total of 298 students enrolled. Since this course was held during the COVID-19 period, all lessons took place online.

The current study focused on math anxiety regarding exams; however, because of the pandemic, face-to-face exams were not possible. Therefore, the department revised the course to use online three quizzes instead. The weight of the quizzes was increased to be comparable to the midterm exams for the students' overall grade. Students were warned that there would be no makeup exams for missed quizzes. The first quiz is easier than the second quiz, while the third one is the most difficult as the amount of topics has increased.

Participants

The sample of this study consists of students from non-major mathematics departments of this university such as Economics, Psychology and Philosophy. Students are placed in those departments based on their performance of university admission exam.

Students in these departments must take two mandatory courses, MATH 105 and MATH 106. This study's participants were from MATH 106. For the spring

semester of the academic year 2020 – 2021, MATH 106 was offered in five sections, with a total of 298 students enrolled. Three of the five sections were selected for this experiment. This was because all of these sections were taught by the same instructor. These three sections had a total of 182 students.

The researcher contacted the chair of the mathematics department to obtain permission to conduct the experiment during class time before the mathematics exam. The instructor, who agreed to provide time for the experiment, gave additional time for the experiment and allowed the experiment to be conducted in the Zoom environment where the researcher was present. Each participant took part in the experiment from their home by using their personal computers. During the experiment, participants were asked their school number, age, mother tongue, number of courses taken, and years of study. Even though the students were in different sections/classrooms, they received similar exams. This was the main reason for choosing the three sections where the same instructor taught. In this way, what happened in this sample at the same time and under the same conditions would be examined.

In the pretest, 115 students participated. Of the participants, 71 (61.7%) were female and 44 (38.7%) were male. In the posttest, 91 students participated. Of the participants, 61 (67%) were female and 30 (33%) were male. There were 46 participants in the control group; 32 (69.6%) were female and 14 (30.4%) were male. There were 45 participants in the treatment group; 29 (64.4%) were female and 16 (35.6%) were male.

To guarantee that the experiment's analysis of the data answers was methodologically correct, the primary participants were chosen for a range of

reasons. First, students who attended both sessions were identified; students who attended just one session or did not correctly write their ID numbers were excluded.

Regarding the latter, it was known that both Turkish and international students attend this university. The students began both sessions in English, and then they were given the option of choosing a language for the provided materials. As a result, students may respond to the contents in either Turkish or English. However, in order to ensure that the materials presented were completely comprehended, the participants' native language proficiency was assumed to be more advanced. Therefore, students were asked to continue the experiment in Turkish if their mother tongue was Turkish. Participants were warned not to switch to English once they had chosen a language. Those who chose English despite the fact that their mother tongue was Turkish or another language were eliminated. The main reason for this elimination is that their disregard of the instructions could have compromised the integrity of their responses.

Finally, attention check items (true-false and multiple choice) were added to the questionnaires to ensure that students understood the material and did not respond inappropriately. It was assumed that students who gave incorrect answers to these questions did not comprehend the reading and were eliminated from the study. After all of this was done, the final sample reduced to 40 participants. The control group consisted of 14 students, 9 (64.3%) were female and 5 (35.7%) were male. The treatment group consisted of 26 students, 19 (73.1%) were female and 7 (26.9%) were male.

Instrumentation

All materials for the current study were developed and adapted, with permission, from resources developed by Jamieson et al. (2016). The materials

included a text to induce stress reappraisal (treatment condition) or stress ignorance (placebo condition) and questionnaires to assess, through self-reports, students' stress appraisals and math anxiety.

The interrelationship between the items on each questionnaire was evaluated to check if they were consistent with one another. SPSS Statistics was used to determine Cronbach's alpha and hence the reliability of the variable items. A Cronbach's Alpha with value higher than .70 indicates a good internal consistency. (Cohen, 2018; Nunnally, 1994). A Cronbach's Alpha with value between .70 and .60 is considered as an acceptable internal consistency (Cohen, 2018; Nunnally, 1994).

Stress Appraisals

A validated measure of stress appraisals from the social stress literature was developed by Jamieson's study ($\alpha_{resource}$ = .78, α_{demand} = .86, 2016). The scale has two subscales: coping resources and task demands. Task demand appraisals assess participants' perceptions of danger, uncertainty, and required effort, whereas coping resource appraisals assess perceptions of safety and familiarity with the situation, as well as skills, knowledge, and abilities (Jamieson, 2016).

Table 2

Stress Appraisals Items and Subscale/Total Scale

Items	*M*	*SD*
Task Demands		
The upcoming math quiz is very demanding.	3.0	0.9
I am uncertain about how I will perform on the quiz.	3.6	1.2
The math quiz will take a lot of effort to complete.	3.0	1.1
The math quiz will be very stressful.	3.0	1.2
Poor performance on this quiz would be very distressing for me.	3.9	1.0

Table 2 (cont'd)

Stress Appraisals Items and Subscale/Total Scale

Items	*M*	*SD*
I view this math quiz as a positive challenge.	3.8	1.0
Coping Resources		
I feel that I have the abilities to succeed.	3.4	1.2
It is very important to me that I perform well on this test.	3.0	1.1
I'm kind of person that does well on these types of quiz.	3.3	1.2
I expect to perform well on the math quiz.	2.7	1.1
I think this math quiz is intimidating (frightened).	2.9	1.2

Note. The descriptive statistics data in this table show the pretest results of the 115 participants in the first phase of this study. Since the scale here is 5-point Linkert type, the score of each item can vary between 1 and 5.

As Table 2 indicates, there are six statements regarding task demands in the questionnaire. The internal consistency of the task demands items represented by Cronbach alpha, α = .82, indicating good internal consistency. The participant saw some statements regarding learning mathematics like below. They were asked to rate the level of anxiety elicited by each statement.

An example of one of the statements used to advocate the task demand is as follows: "*I am uncertain about how I will perform on the quiz.*" This statement emphasizes the impact of comprehensive feelings when a student has to complete the task in a math quiz considering its feasibility and difficulty.

There are five statements regarding coping resources in the questionnaire (See Table 2). The internal consistency of the coping resources items represented by Cronbach alpha, α = .63, indicating acceptable internal consistency. The participant

saw some statements regarding coping resources like below. They were asked to rate the level of anxiety elicited by each statement.

One of the phrases on the scale that refers to coping resources is as follows: "*I feel that I have the abilities to succeed.*" This phrase shows how students strive to cope with the demands of the stressful emotions they feel for the math test in a supportive way.

Math Anxiety Scale

The Abbreviated Math Anxiety Scale (AMAS), which was developed, validated, and replicated with a large student sample (α = .83, Jamieson et al., 2016; Hopko et al., 2003), was used to assess math anxiety levels of the participants before each exam. There are nine items in this scale which consists of two factors: learning anxiety and exam anxiety (see Appendix B).

Table 3

AMAS Items and Subscale/Total Scale

Items	*M*	*SD*
Learning Anxiety		
Having to use my notes from my math class or the math book.	2.1	1.3
Watching a teacher work an algebraic equation.	3.7	1.2
Listening to a lecture in math class.	3.5	1.3
Listening to another student explain a math formula.	3.5	1.3
Starting a new chapter in a math book.	4.3	1.1
Exam Anxiety		
Thinking about an upcoming math test one day before.	2.1	1.3
Taking an examination in a math course.	1.9	1.9

Table 3 (cont'd)

AMAS Items and Subscale/Total Scale

Items	*M*	*SD*
Being given a homework assignment of many difficult problems which is due the next class meeting.	2.1	1.2
Being given a "pop" quiz in a math class.	2.1	1.2

Note. The descriptive statistics data in this table show the pretest results of the 115 participants in the first phase of this study. Since the scale here is 5-point Linkert type, the score of each item can vary between 1 and 5.

As Table 3 indicates, there are five statements regarding learning anxiety in the AMAS scale. The participants saw some statements regarding their learning anxiety. They rated each of them in terms of how anxious they would feel during the specified event. The internal consistency of the learning anxiety items represented by Cronbach alpha, α = .79, indicating good internal consistency.

Participants were asked to rate their level of learning anxiety and one of the statements in the scale that refer to learning anxiety is: "Starting a new chapter in a math book." The statement was required to examine the participants' stress level while they are about to begin a new topic in a math lesson. Students could experience anxiety by feeling that they did not learn enough in the previous chapter. So, they might think their knowledge is insufficient to start to the next chapter and acquire new things. This could be the reason why most of the students feeling tension before starting new chapter in a math book.

As it can be seen in Table 3, there are four statements regarding exam anxiety AMAS scale. The internal consistency of the exam anxiety items represented by Cronbach alpha, α = .75, indicating good internal consistency. They were asked to rate the level of anxiety elicited by each statement.

Participants were asked to assess their degree of exam anxiety, and one of the phrases on the scale that refers to exam anxiety is “Thinking about an upcoming math test one day before.” This item focuses on negative thoughts about the upcoming math test/exam. The participants were asked to consider the upcoming math exam and assess their level of anxiety they felt the day before the exam.

Treatment Materials (Independent Variable)

Stress reappraisal instructions aim that stress is an adaptive function by increasing perceptions of performance, abilities, and psychological resilience (Jamieson et al., 2013b). The intervention materials utilized in this study were based on laboratory investigations developed by Jamieson (2012, 2013a) and revised by Beltzer (2014).

The students, who had been randomly allocated to the treatment group, were required to read summaries of scientific journals (modified depending on the original text). The core aim was to empower the reader on how stress functions contribute as an adaptive mechanism. The reader will have been aware that, even when arousal levels rise during an exam, this situation is not harmful in this way, and even these signs will aid their performance (Jamieson et al., 2012). On the other hand, by encouraging participants to reappraise arousal by giving similar scientific summaries, Jamieson et al (2012b) examined how arousal reappraisal promotes stress recovery. Based on this research, it is known that reappraising arousal exhibited not only more adaptive physiological responses during stress, but also returned to the baseline more quickly after the stressful situation (Jamieson et al., 2012).

In order to make sure participants had read the instructions and to encourage them to understand what was given, they were asked one multiple-choice and one true false question after each summary. Since this study was conducted on an online

platform, participants were allowed to switch between pages and change their responses, ensuring that their responses were accurate. The instructor was blind to the materials and it was essential to consider the time spent by the student on the materials. Considering the average time spent by the students, the students spent approximately ~5.5 minutes reading time.

Below is the excerpt where we will distinguish the independent variable:

"… When the "fight or flight" system activates, our brain searches for possible sources of harm… During stressful situations remember that your body's responses are beneficial. Increased heart rate, sweating, and heavy breathing are all signs that your body is delivering oxygen (fuel for thinking) to your brain."

When compared to no instruction materials, stress reappraisals had a more adaptive profile of physiological reactivity. The instructions aim to encourage approach-oriented patterns by informing participants that arousal can be viewed as a resource that can improve performance (Jamieson & Nock, 2013). This point of view stresses altering how people perceive stress arousal in order to maintain sympathetic activation and enhance reactions (Jamieson & Nock, 2013).

Placebo Materials

This condition includes some readings that suggested the best way to avoid stressful testing situations is to ignore stress. These instructions are not expected to any positive performance changes based on previous research using the same instructions (Jamieson, 2012) (see Appendix J).

All of the placebo instructions were supported by empirical research that showed they did not reduce cognitive function compared to "no instructions" (Jamieson, 2012). Thus, it was deemed appropriate in this study to offer placebo

materials to the control group rather than creating the no intervention group to equate the time both groups spent on the materials (Jamieson, 2016). The participants in the control group read summaries that started ignoring stress as the best strategy for enhancing performance in difficult testing circumstances. All of these materials, including the appearance, the photos and even writing style or fonts, have the same arrangement and design as the intervention materials. The purpose of this material is to show students how ignorance can be used in order to get rid of the unfavorable thoughts and emotions they would experience during the exam. All directives were based on emotion-suppression strategies, and individuals under supervision were instructed to ignore (suppress) negative thoughts according to research by Peters (2014) with similar materials and instructions. The participants are repeatedly reminded to concentrate on the word "ignore", despite the fact that it is mentioned as the key word of the material here and is written in bold letters in the articles. Based on an earlier study employing identical instructions, it was not anticipated that the "ignore" instructions would have a negative effect on performance (Jamieson, 2012). As with the Intervention materials, it was important and necessary to keep the instructor blind and take into account the time spent on the materials.

Below is the excerpt where we will distinguish the placebo materials:

"…If you find yourself feeling nervous during the quiz today, remember that you will not feel as bad if you do not pay attention to stress. Try to take some deep breaths, relax, and ignore feelings of stress, nervousness, or anxiety. This will help you succeed when you take your quiz today."

Confirmatory Check Questions

To gauge if the reader actually read the materials or understood their integrity and purpose, some additional questions were included. At the end of each of the

academic reading texts, two questions per page (a total of six questions) were added to ensure that participants had read the materials and to encourage them to confirm the information.

Academic Performance

In order to determine the academic performance variable, student's grades in Math Exam 1 and 2 were collected. The instructor provided the grade list containing only the ID numbers of each student and all IDs matched one by one. All exam papers were evaluated by the instructor. The average score of Math Exam 1 was M_{grade1} = 6.5 out of 10. The average score of Math Exam 2 was M_{grade2} = 5 out of 10.

In this study, it was expected that students' academic performance would improve as a result of the intervention materials. However, as the second exam was more difficult than the first, a decrease in academic performance might imply that the expected outcomes were not detected.

Formatting and Translation

The entire process of the study was conducted online due to COVID-19 limitations. For this reason, all adapted materials were transferred to the online Qualtrics platform and the logical flow of the software was designed in accordance with the study.

Considering the importance of the native language for comprehension, all materials were translated into Turkish, assuming that the native language of most students is Turkish. The researcher first translated all of the materials from English to Turkish, and the controls were provided by a translator with dual nationality both Turkey and England. Given that the translator is also an educator, the emphasis of the words especially in the intervention materials were carefully chosen. Also,

phrases that will manipulate the reader are repeated in capital letters enough times in the text to retain their significance and grab the reader's attention.

Method of Data Collection

The researcher participated in each of the online courses. She provided information about the research and sent participants the link that enables participants to access this platform. All participants were informed about the scope and the procedure of the study in both sessions. Especially before the pretest, participants were informed that there would be a second assessment (i.e., the posttest). Students participated voluntarily by signing a consent form (see Appendix A). There were participants who refused to participate in the research or did not complete the entire study, were not sent the link. Instead, they were put in the virtual waiting room until the class began.

Students only provided their university ID numbers, which were used to enable the researcher to match the data from the two exam sessions (pre-test/post-test) and to conduct all the investigations (cause and effect relationships between variables). Students and lecturers were not aware of which student they were in which group.

As noted above, this was an experimental study. This approach will be used to test the effectiveness of a psychosituational intervention targeting cognitive stress assessments (Jamieson, 2016). The study was conducted during two exam sessions: pretest and posttest, which correspond to quiz 2 (Math Exam 1) and quiz 3 (Math Exam 2) of the course, respectively. The materials prepared for the pretest were taken ~5 minutes to complete, and the materials to be given for posttest were taken ~10 minutes to complete. This timing was conveyed to the course instructor, and the exam duration was adjusted accordingly.

Details for each of these times are provided below. The pretest was administered on the day of Math Exam 1 and before to the exam, students completed assessments of math anxiety and stress appraisals, as well as their exam scores (pre-test). The posttest was completed on the day of Math Exam 2. Prior to Math Exam 2, students were randomly assigned to one of two groups: treatment or control. Treatment group was instructed by a passage to consider stress as the necessary condition for success in the upcoming math exam. The second group, known as the control group, was instructed to ignore stress by reading a passage of the same length of the treatment passage. Students were given around five minutes to read their assigned text. After the allotted reading time, the AMAS and stress appraisal scales were administered. After they submitted their responses to the scales, they took their second exam.

Following the treatment, academic performance results were compared to each other and to the pre-treatment results. Regarding this information, the researcher received the data from the instructor, who sent only the students' ID numbers along with the exam results to protect students' anonymity.

Pretest

Data Collection

After students signed the consent form, the instruments for the experiment were distributed to students prior to the two exams to allow them enough time to complete the study materials.

When participants accessed the link, they were greeted with a welcome message. This message informed them about the researcher including contact information, the study procedure, and clarified for any questions that may arise about why university ID numbers were needed. It also indicated that participants could

leave the experiment whenever they wished and that no phase of this experiment would positively or negatively impact the course grade they were attending. After that, participants had the consent form to read and agree in order to continue. If the participant did not sign the consent form, they cannot pass the page. Participants who approved the Consent Form continued to the next section where they could enter their ID numbers.

To minimize the possibility of the participants for entering random numbers, a restriction was placed on the input to be consisting of 8 characters and numbers. These pages were given in English considering the language of instruction of the University. On the next page, the participants were faced with a multiple-choice option, where they could choose their preferred language for the rest of the experiment. The students were instructed to choose Turkish if their mother tongue is Turkish.

Regardless of which language was chosen in that option, each participant was asked to complete the Stress Appraisal material on the next page. The participants were asked to complete a 12-item questionnaire on a 5-point Likert Type scale from 1 (Strongly disagree) to 5 (Strongly agree). Participants were prevented from going to the next page without answering all questions.

After completing the *Stress Appraisal* material, they were shown a page where they were asked to complete *Math Anxiety Scale* including a 9-item questionnaire on a 5-point Likert type scale from 1 (Low anxiety) to 5 (High Anxiety). Participants who completed this phase received a message on the next page where the researcher thanked them and stated that the first phase had been completed.

Participants who had completed the questionnaires left the site and began preparing for the exam they were about to take. Since Qualtrics allowed the researcher to see how many participants were in progress or how many had completed the entire process, the researcher waited in the classroom until all participants had completed the experiment. After verifying that all participants had completed the experiment, the instructor was informed, and the math exam could begin.

Posttest

Data Collection

In posttest, which started with a similar procedure to pretest, the participants were informed by the researcher that this was the second part of the study; the first part was done about 1.5 months ago, and this part could take more time. The researcher informed the participants that this study included some academic readings and some related questions that needed to be considered.

When participants accessed the link, they were greeted with a welcome message. This message informed them about the researcher including contact information and the procedure of the study.

Similar to pretest, participants were directed to the page where they could choose their language after marking the consent form. Qualtrics has a randomizer that allows to randomly assign participants to either placebo or intervention materials. After the participants chose the language, the Qualtrics platform randomly assigned them into two groups as evenly distributed as possible, taking into account the total number of participants: the control group and the treatment group.

Participants in the treatment group read the intervention materials, whereas participants in the control group were given placebo materials that had the same

design as intervention materials. Each of the materials consists of three-page academic reading passages. At the end of each page, one multiple choice and one true-false question were asked to assess the participants. As noted in the confirmatory section above, these questions were created to ensure participants read the materials accurately. The participants could still complete the questionnaire even if they answered these questions incorrectly; instead, they were removed from the sample after the instruments were submitted.

After completing the readings, each participant was asked to complete the Stress Appraisal questionnaire consisting of 12 items on a 5-point Likert type scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). Participants were prevented from going to the next page without answering all questions.

Next, participants were directed to respond to the Math Anxiety Scale, consisting of a nine items questionnaire on a 5-point Likert type scale from 1 (Low anxiety) to 5 (High Anxiety). Participants who completed this phase received a message on the next page where the researcher thanked them and stated that the second phase had been completed.

On the last page of the experiment, summary of the articles and the best wishes for upcoming math exam were also included. Summarizing the articles in one sentence just before the math exam helps them to remember what was instructed. Participants who had completed the questionnaires left the site and began preparing for the exam they were about to take. Since Qualtrics allowed the researcher to see how many participants were in progress or how many had completed the entire process, the researcher waited in the classroom until all participants had completed the experiment. After verifying that all participants had completed the experiment, the instructor was informed, and the math exam could begin.

Method of Data Analysis

Data for this study were collected via an online Software program called Qualtrics. After data collection, IBM SPSS Statistics 26 was used to analyze them. Descriptive statistics were generated for each variable and correlations among them were found in the preliminary analysis. Using Gravatter (2014) as a reference, correlations with *r* equal to 1.00 were considered perfect, while a value of .00 indicated no linear correlations. Correlations with *r* greater than .75 were considered strong, while those between .75 and .40 were considered moderate. Finally, correlations with *r* lower than .40 were considered weak.

In the main analyses, a mixed ANOVA was used to determine whether there were "between-subject" (i.e., between the two groups) or "within-subjects" (i.e., between pretest and posttest) changes in the dependent variables as well as whether the interaction of time and condition was significant.

For each dependent variable, before running the mixed ANOVA, the following four assumptions were tested:

1. Whether there are significant outliers regarding the scores of the dependent variable either in the two groups of pretest-posttest measures (the within-subject factor) or in the two groups of treatment and control measures (the between-subject factor).
2. Whether the dependent variable scores were normally distributed either in the two groups of pretest-posttest measures (the within-subject factor) or in the two groups of treatment and control measures (the between-subject factor).

3. Whether there was homogeneity of variances either in the two groups of pretest-posttest measures (the within-subject factor) or in the two groups of treatment and control measures (the between-subject factor).
4. Whether there was sphericity, which means that the variances of the differences between the related groups of the within-subject factor for all groups of the between-subjects factor were equal.

If one of the assumptions was violated, a non-parametric Mann-Whitney U test or independent sample t-test was also conducted.

CHAPTER 4: RESULTS

Introduction

The study investigated the effects of cognitive reappraisal instruction on non-major mathematics students' (a) math exam anxiety and learning anxiety, (b) appraisals of coping resources and task demands, and (c) academic performance.

Preliminary Analysis

Pretest

Prior to Math Exam 1, math anxiety (i.e., exam and learning anxiety) and stress appraisals (i.e., coping resources and task demands) were assessed. The grades that the students received from the Math Exam 1 were also considered. Table 4 provides the descriptive statistics of the variables measured in the pretest. For each variable, the number of participants, mean response, and standard deviations are provided.

Table 4

Descriptive Statistics of the Variables in Pretest

Variables	*N*	*M*	*SD*
Exam Score (scale: 1-10)	40	7.0	2.8
Math learning anxiety (scale: 1–5)	40	3.3	0.8
Math exam anxiety (scale: 1–5)	40	1.8	0.8
Resource appraisals (scale: 1–5)	40	3.1	0.9
Demand appraisals (scale: 1–5)	40	3.3	0.9

Following the descriptive statistical analysis, a bivariate correlation analysis was conducted (see Table 5)

Table 5

Bivariate Correlations of the Variables in Pretest

Variables	1	2	3	4	5
1. Exam Score	-				
2. Math learning anxiety	-.20	-			
3. Math exam anxiety	-.15	.49**	-		
4. Resource appraisals	.38*	-.39*	-.37*	-	
5. Demand appraisals	-.19	.71**	.46**	-.46**	-

*$p < .05$. **$p < .01$.

According to Pearson-product moment correlation, analysis found that the exam score was a moderate, positive correlation with coping resources ($r = .38$, $n = 40$, $p < .05$). This means that when coping resources were perceived high, students' performance in Math Exam 1 was also high. There was a moderate, positive correlation was between task demand and math learning anxiety ($r = .71$, $n = 40$, $p < .01$). Task demand was also positively and moderately correlated with math exam anxiety ($r = .46$, $n = 40$, $p < .01$) and negatively and moderately correlated with coping resources appraisal ($r = -.46$, $n = 40$, $p < .01$). When students perceived the upcoming quizzes as demanding, their math anxiety was higher, while their coping resources were perceived lower.

Additionally, higher math learning anxiety was associated with higher math exam anxiety as the positive and moderate correlation between them indicates ($r = .49$, $p < .05$). Math exam anxiety and math learning anxiety had a weak and negative correlation with coping resources ($r = -.37$, $p < .05$; $r = -.39$, $p < .05$, respectively). Since math exam anxiety and math learning anxiety were moderately associated with each other they tend to increase together while decreasing coping resources.

Posttest

Prior to Math Exam 2, after the students were randomly divided into two groups (control or treatment) and exposed to placebo and treatment materials, their math anxiety and stress appraisals were again evaluated. The grades that the students received in the Math Exam 2 were also considered. Descriptive statistics and bivariate correlations were conducted for the preliminary analyses of the measured variables. Descriptive statistics consisted of the number of participants for corresponding variables, means, and standard deviations which are presented in Table 6.

Table 6

Descriptive Statistics of the Variables in Posttest

Variables	*N*	*M*	*SD*
Exam Score (scale: 1-10)	40	4.9	4.2
Math learning anxiety (scale: 1–5)	40	3.3	0.9
Math exam anxiety (scale: 1–5)	40	1.8	0.8
Resource appraisals (scale: 1–5)	40	3.0	0.8
Demand appraisals (scale: 1–5)	40	3.3	0.9

In Table 7 presents the correlations among the variables assessed in the posttest.

Table 7

Bivariate Correlations of the Variables in Posttest

Variables	1	2	3	4	5
1. Exam Score	-				
2. Math learning anxiety	-.18	-			
3. Math exam anxiety	-.33*	.35*	-		

Table 7 (cont'd)

Bivariate Correlations of the Variables in Posttest

Variables	1	2	3	4	5
4. Resource appraisals	.57*	-.35*	-.09*	-	
5. Demand appraisals	-.23	.69**	.36*	-.55**	-

*$p < .05$. **$p < .01$.

To analyze the linearity between variables in posttest, a Pearson correlation coefficient was generated. Students' exam score was the only variable that had a moderate, positive correlation with coping resources ($r = .57$, $n = 40$, $p < .05$). This means that the increase in coping resources in the posttest was reflected as an increase in the exam score. It is important to note that students' exam scores were very weakly and negatively correlated with math learning anxiety ($r = -.18$, $p > .05$), math exam anxiety ($r = -.33$, $p > .05$) and task demands ($r = -.23$, $p > .05$).

There was a moderate, positive correlation between task demand and math learning anxiety ($r = .69$, $p < .01$). Task demand was positively and weakly correlated with math exam anxiety ($r = .36$, $n = 40$, $p < .01$) and correlated with coping resource appraisal negatively and moderately ($r = -.55$, $n = 40$, $p < .01$).

Additionally, math learning anxiety was associated with math exam anxiety as shown by the weak positive correlation between them ($r = .35$, $p < .05$). Math exam anxiety and math learning anxiety had both negative, weak correlation with coping resources ($r = -.35$, $p < .05$; $r = -.09$, $p < .05$, respectively). Since math exam anxiety and math learning anxiety were associated with each other they tend to increase together while decreasing coping resources.

Main Analyses

I began to test the necessary assumptions for each of the dependent variables and then, selected the appropriate analysis for each. Outliers were identified by visualizing the data as a box plot. Outliers had more values than the lower or upper extremes. These outliers were omitted as they might impact the statistical power. Our main purpose in the analysis process was to test for mean differences in the dependent variables as a function of the time (pretest – posttest) or condition (treatment – control) or the interaction of both.

Stress Appraisals

Stress appraisals were assessed through coping resources and task demands. The results of these two dependent variables are presented separately below.

A mixed ANOVA was used to test whether there were mean differences in coping resources within a group (pretest-posttest differences in each group or, in other words, time differences in each group), between groups (treatment and control) or in both (whether the interaction of time and condition were significant). The condition that participants were randomly assigned was included as a between-subjects variable, whereas time was included as a within-subject variable expressed by the repeated pretest and posttest scores. Before running the analysis, the four assumptions mentioned in the data analysis (see Chapter 3) were tested.

No significant outliers were found in the pretest and posttest assessment of coping resources. Using the Shapiro-Wilk test of normality, I also found that the scores of coping resources were normally distributed in both time assessments (see Appendix M, p.102). The homogeneity of variance across the groups was tested through the Levene's test, which showed that the assumption was not violated for

both pretest and posttest. Sphericity was also fulfilled as there were only two time points.

The results of the mixed ANOVA showed for the within-subjects effects that there was no significant main effect of time. The mean of coping resources did not differ between pretest and posttest ($F(1, 38) = 0.38$, $p = .54$). The analysis showed also that the interaction between time (pretest-posttest) and condition (treatment and control) was not significant either ($F(1, 38) = 0.03$, $p = .85$). As for the between-subjects effects, the results showed that there is no significant difference in coping resources between treatment and control ($F(1, 38) = 3.7$, $p = .06$) (means plot can be found in Appendix L, p.99). These results are against my hypothesis as the intervention materials did not result in a difference of coping resource scores between pretest and posttest.[1]

For task demands, I tested the four assumptions of the lack of outliers in each group of participants, normal distribution of the values, homogeneity of variance, and sphericity (see Appendix M, p. 103). Inıtially, in both the pretest and posttest, there were 2 outliers that were exactly the same participants. These outliers were removed from the data as they could skew the correlation coefficients. When I removed the two outliers in the pretest and posttest, I found two more outliers in the scores of pretest task demands and two more outliers in the scores of posttest task demands. I also extracted these four outliers. The total number of participants fell from 40 to 34. Using the Shapiro-Wilk test of normality, I also found that the scores of task demands were normally distributed in both time assessments. The homogeneity of variance across the groups was tested through the Levene's test, which showed that the assumption of homogeneity of variance has been met in the in

[1] The analysis was also conducted with a larger sample by including Turkish students who completed the experiment in English, but the results remained the same.

the pretest only but not in the posttest. Taking this result into consideration as well as that the two groups were highly unequal after removing the outliers (n = 8 and n = 26, for the control and treatment group, respectively), I did not proceed to any comparison of the mean of task demands as not all the assumptions were satisfied.[2]

Math Anxiety

Math Anxiety was assessed through learning anxiety and exam anxiety. The results of these two dependent variables are presented separately below.

A mixed ANOVA was used to test whether there were mean differences in learning anxiety within a group (pretest-posttest differences in each group or, in other words, time differences in each group), between groups (treatment and control) or in both (whether the interaction of time and condition were significant). The condition that participants were randomly assigned was included as a between-subjects variable, whereas time was included as a within-subject variable expressed by the repeated pretest and posttest scores. Before running the analysis, the four assumptions mentioned in the data analysis (see Chapter 3) were tested.

No significant outliers were found in the pretest and posttest assessment of learning anxiety. Using the Shapiro-Wilk test of normality, I also found that the scores of coping resources were normally distributed in both time assessments (see Appendix M, p. 104). The homogeneity of variance across the groups was tested through the Levene's test, which showed that the assumption was not violated for both pretest and posttest. Sphericity was also fulfilled as there were only two time points.

The results of the mixed ANOVA showed for the within-subjects effects that there was no significant main effect of time. The mean of learning anxiety did not

[2] Running the mixed ANOVA without excluding the outliers did not change results on task requests.

differ between pretest and posttest ($F(1, 38) = 0.07$, $p = .79$). The analysis showed also that the interaction between time (pretest-posttest) and condition (treatment and control) was not significant either ($F(1, 38) = 0.51$, $p = .48$). As for the between-subjects effects, the results showed that there is a significant difference in learning anxiety between treatment and control ($F(1, 38) = 10.04$, $p = .003$). Inspection of the means of learning anxiety in the treatment ($M_{pretest} = 3.50$; $M_{posttest} = 3.55$) and control groups ($M_{pretest} = 2.8$; $M_{posttest} = 2.7$) showed that learning anxiety in the posttest decreased in the control group, but increased in the treatment group (means plot can be found in Appendix L, p.100). Although the effect size of the ANOVA was considered really small ($d = .01$) based on benchmarks suggested by Cohen (1988), these results showed that the placebo materials positively affected learning anxiety.[3]

For exam anxiety, I also tested the four assumptions of the lack of outliers in each group of participants, normal distribution of the values, homogeneity of variance, and sphericity. No significant outliers were found in the pretest and posttest assessment of exam anxiety. Using the Shapiro-Wilk test of normality, I also found that the scores of exam anxiety were not normally distributed in both time assessments (see Appendix M, p. 105). The homogeneity of variance across the groups was tested through the Levene's test, which showed that although the variance of exam anxiety in the treatment and control group was equal in the posttest, this was not true in the pretest. Taking the above results into consideration, mixed ANOVA could not be used as it does not provide a robust result for unequal variance. Moreover, taking into consideration that the two groups were unequal ($n = 14$ and $n = 26$ for the control and treatment group, respectively), I selected the non-parametric Mann-Whitney U Test to check for differences in exam anxiety between

[3] The analysis was also conducted with a larger sample by including Turkish students who completed the experiment in English, but the results remained the same.

the treatment and control group in the pretest and posttest. I also used paired sample t-tests to test for time differences within the same group. Unfortunately, with those tests I was not able to test whether the interaction of time by condition was significant.

A Mann-Whitney U test showed that there was no significant difference (U = 237, p = .12) between the treatment group compared to the control group during the pretest. For the posttest, it was showed that exam anxiety scores in the treatment group was not statistically significantly lower than the exam anxiety scores in the control group (U = 222, p = .25).

Paired Samples t-test showed that the difference in the means of treatment group's exam anxiety in pretest and posttest were not statistically different, $t(25)$ = 0.51, p = .75. However, inspection of the mean of exam anxiety in pretest ($M_{pretest}$ = 2.0) and posttest ($M_{posttest}$ = 1.9) showed that exam anxiety decreased in posttest although not significantly (means plot can be found in Appendix L, p. 100). Probably this was because Math Exam 2 was more challenging than Math Exam 1. It is noteworthy, however, that the effect size for this analysis was considered small (d = .05) based on benchmarks suggested by Cohen (1988).

Results of the Paired samples t-Test showed that the mean difference between the pretest and posttest exam anxiety scores among control group were also not statistically different, $t(13)$ = -0.41, p = .69. [4]

Academic Performance

Academic performance was represented by students' grade in Math Exam 1 and Math Exam 2.

[4] The analysis was also conducted with a larger sample by including Turkish students who completed the experiment in English, but the results remained the same.

A mixed ANOVA was used to test whether there were mean differences in academic performance within a group (pretest-posttest differences in each group or, in other words, time differences in each group), between groups (treatment and control) or in both (whether the interaction of time and condition were significant). The condition that participants were randomly assigned was included as a between-subjects variable, whereas time was included as a within-subject variable expressed by the repeated pretest and posttest scores. Before running the analysis, the four assumptions mentioned in the data analysis (see Chapter 3) were tested.

No significant outliers were found in the pretest and posttest assessment of learning anxiety. Using the Shapiro-Wilk test of normality, I also found that the scores of coping resources were normally distributed in both time assessments (see Appendix M, p. 106). The homogeneity of variance across the groups was tested through the Levene's test, which showed that the assumption was not violated for both pretest and posttest. Sphericity was also fulfilled as there were only two time points.

The results of the mixed ANOVA showed for the within-subjects effects that there was a significant main effect of time. The mean of academic performance differed between pretest and posttest ($F(1, 38) = 9.14$, $p = .004$) (means plot can be found in Appendix L, p. 101). Specifically, in both group of students, academic performance was reduced in the posttest ($M_{pretest} = 8.0$, $M_{posttest} = 5.9$). The effect size for this analysis ($d = .56$) was found to exceed Cohen's (1988) convention for a medium effect ($d = .50$). The analysis also showed that the interaction between time (pretest-posttest) and condition (treatment and control) was not significant ($F(1, 38) < .001$, $p = .985$). As for the between-subjects effects, the results showed that there is

no significant difference in academic performance between treatment and control group ($F(1, 38) = 168.63$, $p < .001$).[5]

[5] The analysis was also conducted with a larger sample by including Turkish students who completed the experiment in English, but the results remained the same.

CHAPTER 5: DISCUSSION

Introduction

This chapter summarizes the study's aims, methodology and major findings. It also provides interpretations of the findings and links them with the literature. The chapter also presents the educational implications of the findings as well as suggestions for further research. Finally, the study's limitations will be discussed.

Overview of the Study

This research aimed to investigate the benefits of cognitive reappraisals of stress on math anxiety. And learning anxiety, appraisals of coping resources and task demands and academic performance.

The following research questions were investigated in the current study:

- Does providing cognitive reappraisal instruction before math exams to non-major mathematics students' regarding the positive consequences of stress arousal reduce math anxiety?
- Does providing cognitive reappraisal instruction before math exams to non-major mathematics students' regarding the positive consequences of stress arousal increase appraisals of coping resources?
- Does providing cognitive reappraisal instruction before math exams to non-major mathematics students' regarding the positive consequences of stress arousal affect academic performance?

A randomized pretest-posttest control group design was applied to address these research questions. In the pretest, 115 students completed questionnaires about math anxiety and stress appraisals before a math exam (Math Exam 1). In the posttest, 91 students were randomly assigned to either the control or treatment group.

Students in the treatment group were instructed about how to use stress as an adaptive tool by focusing on its positive effects. In contrast, students in the control group were instructed to cope with stress by ignoring it. The instructions in both groups were provided through a reading passage. After reading the passages and before taking a math exam (Math Exam 2), students were asked to respond to questions to ensure they comprehended the content of the passage and completed a questionnaire to report on their math anxiety and stress appraisals. Finally, the students' exam scores in pretest and posttest were obtained from the course instructor. After matching the students who participated in both pretest and posttest and excluding students who did not answer correctly questions on the content of the instructional passages, the final sample of the study consisted of 40 students.

Discussion of Major Findings

Research question #1: Does Providing Cognitive Reappraisal Instruction Before Math Exams to Non-Major Mathematics Students' Regarding the Positive Consequences of Stress Arousal Reduce Math Anxiety?

Similar to Hopko (2003), learning math anxiety and exam anxiety were analysed as core elements of math anxiety. These two subcomponents were used in a two-factor exploratory study. Based on the work of Jamieson (2012, 2016), the current study aimed that the cognitive reappraisal materials would reduce feelings of math anxiety. One of his prior study indicated that the reappraisal manipulation reduced students' level of math exam anxiety, although learning anxiety did not change (Jamieson, 2016). A similar conclusion was reached by Pizzie's study (2021) where highly math anxious people were encouraged to concentrate on cognitive reappraisals efficacy which minimizes negative effects of math anxiety. Their

findings showed that encouraging students to reconsider their math anxiety was efficient in reducing stress arousal.

In the current study, math exam anxiety was reduced in the treatment group and it increased in the control group; but this difference was not statistically significant probably because of the small effect size. On the other hand, this study found a significant difference in learning anxiety scores between treatment and control group, but this difference was in favour of the control group. Although I did not expect any change in learning anxiety either in the treatment or the control group as both the stress reappraisal material and the placebo material focused on the exam anxiety, I found a positive effect of instructing ignorance of exam anxiety on being anxious while learning math. Further research is needed to explore whether this unexpected result was by chance due to the small effect size or whether ignoring anxiety could have any positive impact in the Turkish culture.

Research question #2: Does Providing Cognitive Reappraisal Instruction Before Math Exams to Non-Major Mathematics Students' Regarding the Positive Consequences of Stress Arousal Increase Appraisals of Coping Resources?

Previous studies have found that participants who reframed their arousal as an adaptive coping strategy during acute stress had better physiological and cognitive outcomes (Jamieson, 2010, 2012). Based on these findings, the current study hypothesized that participants in the treatment group would increase their appraisals of coping resources after reappraisal manipulation. Surprisingly, there was no significant increase in coping resources in the treatment group.

These findings did not support previous findings according to which intervention materials of stress reappraisal increased coping resources (Beltzer, 2014; Jamieson, 2012, 2013b, 2016). However, the findings of the present study are in line

with the experimental studies of Marr et al. (2021), who found that cognitive reappraisal interventions had no impact on coping resources.

This result may be explained by the fact that our participants used submissive acceptance as a coping tool during the exams. This possible explanation concurs with the ideas of Yerdelen (2016), who suggested that while participants with low levels of anxiety did not require coping mechanisms; those with high levels of anxiety tended to require more emotion-focused coping strategy like submissive acceptance. Other studies found that academic procrastination resulted in them taking longer to begin and complete important tasks, having less confidence in their abilities, and having less ability to organize their own strategies (Klassen, 2008).

Participants in Klassen's (2008) study came from several departments, and they took exams of varying difficulty, just like our participants. They discovered that the difficulty of the exam was an extrinsic factor in procrastination. Consequently, students who know the second exam will be more challenging will inevitably procrastinate their capacity to use coping strategies. The participants of the current study were aware that the Math Exam 2 was more difficult and this knowledge may have affected their anxiety levels. Therefore, the content of an exam my compromise any efforts given to try to ameliorate overanxious responses.

Research question #3: Does Providing Cognitive Reappraisal Instruction Before Math Exams to Non-Major Mathematics Students' Regarding the Positive Consequences of Stress Arousal Affect Academic Performance?

Previous research indicated that students who reappraised their anxiety to perceive it as a beneficial response improved academic performance (Jamieson, 2016). Subsequently, Jamieson's study (2016) concluded that cognitive arousal implementation improves academic performance. This conclusion was not found in

the current study, however. The instructions designed to alter students' stress responses through cognitive reappraisal did not help improve the academic performance of students in the treatment group.

Contrary to the findings of Jamieson (2016, 2010), I did not find any positive effect of intervention materials applied on academic performance. However, Pizzie (2020) found that reappraising stress arousal resulted in more adaptive challenge-like cardiovascular responses, but it did not improve math performance. Further investigation of the gender moderating role showed that reappraisal instructions did improve performance in men but not in women (Pizzie, 2020). This finding indicates the importance of considering gender to correctly interpret the results. Perhaps math performance was not affected because the majority of the participants in the treatment group were female (73.1%).

Implications for Practice

The findings of this study are context-dependent. The participants of the present study were undergraduate students from the faculty of social sciences at a private university who were completing their course online during Covid-19 restrictions. The implications of these findings will probably have various interpretations in different schools in different regions.

The main objective of this study was to examine the effects of cognitive reappraisals on math anxiety and academic performance. The applicability of this study helps to reduce potential negative aspects of anxiety, especially in terms of achieving goals, motivation and learning. Unfortunately, this study did not yield the positive results I expected.

Despite the disappointing results, useful information was gained from this study. One source of useful information is that the reliability of anxiety scales used

in were strengthened and this support has implications for future applications. For example, the scale can be used to classify students' math anxieties as either learning anxiety or exam anxiety. Professional development programs in mathematics can help teachers identify suitable approaches to address students' reactions.

With the challenges of emergency remote teaching and other aspects of the study's context, the current study was unable to control all the variables. In other words, it was not as precise as the original study (Jamieson, 2016). Nonetheless, this study showed that the cognitive psychology methods can be adapted for and applied online. Online interventions take less time and may be less costly than traditional processes. Another advantage of bringing this process online is that it improves the participant's ability to complete it on their own. As a result, the participant can make this application whenever he deems necessary, without requiring the assistance of anyone else. The effects of psychological interventions can be seen directly because they are used more frequently than in a traditional experimental design. Furthermore, the participant can be encouraged to self-assess by providing feedback on specific stages of the experiment. For example, following the given math anxiety scale, a result can be provided. The participant can be informed about their anxiety level or its sub-components using the appropriate rubric that has been prepared.

Implications for Further Research

The current study failed to prove that reappraisal strategies alter students' coping strategies and help improve students' academic performance. As noted, aspects of the study's context – the online format as part of emergency remote teaching, student perceptions that the second exam was more difficult, and gender differences – may have contributed to this failure. Therefore, this study should be

repeated and improved to refine and expand on findings both in terms of theory development and concept validation.

This study contributed to the literature by involving a different target audience than the original study. It was conducted with students enrolled in the social sciences faculty of a private, non-profit university in Ankara. Similar studies can be done in other cities, types of schools, and grade levels. It is essential to investigate the role of culture, values, and learning environments in math anxiety. In this direction, future studies could focus on how teachers, parents or peers affect students' anxiety about mathematics.

A related contribution of this study was the importance of considering language differences. The current study involved students whose mother tongue is Turkish were selected. Further research can be conducted in different languages to examine the responses of students who speak different languages. In this study, even if the same participant spoke different languages, they were asked to choose the study according to their mother tongue and proceed. Considering the dominant language and reading comprehension, this may affect the results. Further research may examine the impact of language in cognitive reappraisal instructions.

The small number of participants in this study, however, likely contributed to the unsuccessful results and prevents the findings from being generalizable. Therefore, future studies should ensure they have robust sample size. Further research could repeat this experimental study with a larger sample size to obtain a representative distribution of the population.

Another issue was that the treatment and control groups were not completely comparable. Their distribution of gender, size and baseline levels of dependent variables were not equal. As a result, this had an impact on the study's outcomes.

One should also consider distribution of the number of different dependent variables equally within the groups.

Regarding the study sample, it is important to consider students' varying levels of mathematics anxiety. The study's results can change in groups where the majority of students are highly anxious or low anxious. Further studies are advised to assess and classify students' anxiety levels prior to conducting the study. Future research could also examine whether initial levels of math anxiety could moderate the effects of cognitive reappraisal manipulations.

Regarding the study's context, future studies should make sure the pretest and posttest exams are comparable in difficulty. There is a chance that because students were nervous about the exams and could not fully internalize the reappraisal strategies.

Finally, future studies might want to vary how they apply the reappraisal strategies. Students can review the strategies at a different time or multiple times. Perhaps, after reflection students will consider the strategies more seriously. Along these lines, it would be important to investigate possible long-term effects of the reappraisal strategies. When this study is conducted in the future, it would be worthwhile to administer the mathematics anxiety scale and stress appraisal after the math exams, in addition to before the exams. Furthermore, longitudinal studies could be conducted to learn if students retain and apply some of the strategies in future exams.

Limitations

There are some limitations in this study that should be indicated. The study was limited to undergraduate students from only one non-profit private university in Ankara, Turkey. In this research, I only focused on reappraisals of non-major

mathematics students. Students' discipline of study could play a role in the strength of math anxiety. Therefore, stress reactivity may be due to external factors that were not considered in the present study. Moreover, the placebo control condition can also create a limitation for interpreting the results as placebo effects can be also the reason for mathematical resilience. The experiment was conducted online considering the restrictions related to COVID - 19. Because of the pandemic conditions, this experiment was carried out online at each participant's home, with no additional supervision required. This situation limited the researcher's ability to control the environment in which the data was collected. Although in total 145 students participated in the experiment, 105 were removed from the sample due to incorrect answers, not following the instructions or inability to participate in both pretest and posttest. As a result, instead of an online experiment, an experiment under lab conditions could help to control better the independent variable. Moreover, the exclusion of 105 students resulted in a small sample size that did not provide the necessary power to obtain statistically significant differences between treatment and control groups. Moreover, the size of the two experimental groups (treatment and control) was not equal after the core participants had been chosen. Lastly, the topics of Math Exam 2 were more challenging than the topics of Math Exam 1 making the two exam conditions non-equivalent. Even if the academic success of the students increased after the material, the difference may not have been seen because of this.

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APPENDIX A

Consent Form in English

Thank you for being a part of this study!

You have received this questionnaire because you are being asked to provide information for a graduate research study. My name is İzel Sarı and I am an MA student within the Graduate School of Education (GSE) at İ.D.Bilkent University. I am interested in learning your perceptions about math anxiety. You are being asked to participate because you are an undergraduate non major mathematics student in Introduction to Calculus II.
I would like you to participate in two sessions. These sessions will take place before your course quizzes. In each session, you will complete questionnaires about math anxiety. During the second session, you will receive some documents you will be asked to read and answer two short questions about them.
As part of the questionnaire, I need you to provide your student ID to be able to match your responses of session 1 with your responses in session 2. Please be assured that your data will be kept confidential. Your participation is voluntary, and you can withdraw at any time without giving a reason or having any consequences (in such a case, your data will be deleted). Participation or nonparticipation in this study will not affect your course grade.

A summary of the results will be presented in a seminar at the Graduate School of Education.

Please feel free to contact me (izel.sari@bilkent.edu.tr) or my supervisors Dr. Aliki Aikaterini Michou (aliki.michou@bilkent.edu.tr) & Dr. Jennie Farber Lane (jennie.lane@bilkent.edu.tr) with any questions or concerns.

By submitting this form, you are indicating that you have read the description of the study, are over the age of 18, and that you agree to the terms as described.

Please click on the agreement statement below to indicate your agreement and then click the arrow to proceed.

I agree to participate in the research study. I understand the purpose and nature of this study and I am participating voluntarily. I understand that I can withdraw from the study at any time, without any penalty or consequences.

→

APPENDIX B

Stress Appraisals Form in English

This questionnaire is adapted from Jamieson et al. (2016).

Please answer the following questions by focusing on today's math quiz. The questions refer to your personal experience and there are no right or wrong questions, so answer them sincerely.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
The upcoming math quiz is very demanding.	○	○	○	○	○
I am uncertain about how I will perform on the quiz.	○	○	○	○	○
The math quiz will take a lot of effort to complete.	○	○	○	○	○
The math quiz will be very stressful.	○	○	○	○	○
I feel that I have the ability to succeed.	○	○	○	○	○
It is very important to me that I perform well on this quiz.	○	○	○	○	○
I'm the kind of person that does well on these types of quizzes.	○	○	○	○	○
Poor performance on this quiz would be very distressing for me.	○	○	○	○	○
Please choose "somewhat disagree"	○	○	○	○	○
I view this math quiz as a positive challenge.	○	○	○	○	○
I think this math quiz is intimidating (frightening).	○	○	○	○	○
I expect to perform well on the math quiz.	○	○	○	○	○

APPENDIX C

Stress appraisals Form in Turkish

This questionnaire is adapted from Jamieson et al. (2016).

Lütfen bugünkü matematik quizine odaklanarak aşağıdaki soruları yanıtlayın. Sorular kişisel deneyiminizle ilgilidir ve doğru ya da yanlış soru yoktur, bu yüzden içtenlikle cevaplayın.

	Kesinlikle katılmıyorum	Katılmıyorum	Ne katılıyorum ne de katılmıyorum	Katılıyorum	Kesinlikle katılıyorum
Birazdan gireceğim quiz oldukça zorlu olacak.	○	○	○	○	○
Quizde nasıl bir performans göstereceğim konusunda emin değilim.	○	○	○	○	○
Matematik quizini tamamlamak çok çaba gerektirecek	○	○	○	○	○
Matematik quizi çok stresli geçecek.	○	○	○	○	○
Başarılı olabilmek için yeterli becerimin olduğunu hissediyorum.	○	○	○	○	○
Bu sınavda iyi bir performans göstermek benim için çok önemli.	○	○	○	○	○
Bu tür quizlerde iyi performans gösteren biriyim.	○	○	○	○	○
Bu quizde kötü performans göstermek beni çok üzer.	○	○	○	○	○
Lütfen "Katılmıyorum" seçeneğini seçiniz.	○	○	○	○	○
Bu matematik quizini olumlu bir meydan okuma olarak görüyorum.	○	○	○	○	○
Bu matematik quizinin göz korkutucu olduğunu düşünüyorum.	○	○	○	○	○
Bu matematik quizinde iyi performans göstereceğimi umuyorum.	○	○	○	○	○

APPENDIX D

Math Anxiety Scale Form in English

Scale:
1 = Low Anxiety
2 = Some Anxiety
3 = Moderate Anxiety
4 = Quite a bit of Anxiety
5 = High Anxiety

	1	2	3	4	5
Having to use my notes from my math class or the math book.	○	○	○	○	○
Thinking about an upcoming math test one day before.	○	○	○	○	○
Watching a teacher work an algebraic equation.	○	○	○	○	○
Taking an examination in a math course.	○	○	○	○	○
Being given a homework assignment of many difficult problems which is due the next class meeting.	○	○	○	○	○
Listening to a lecture in math class.	○	○	○	○	○
Listening to another student explain a math formula.	○	○	○	○	○
Being given a “pop” quiz in a math class.	○	○	○	○	○
Starting a new chapter in a math book.	○	○	○	○	○

APPENDIX E

Math Anxiety Scale Form in Turkish

Lütfen belirtilen etkinlikler sırasında ne kadar endişeli hissettiğinizi aşağıda ki maddeleri kullanarak derecelendiriniz.

Ölçek:

1 = Düşük Kaygı
2 = Çok az Kaygı
3 = Orta Düzeyde Kaygı
4 = Biraz Kaygı
5 = Yüksek Kaygı

	1	2	3	4	5
Quiz esnasında ders notlarımı ya da matematik ders kitabını kullanmak.	○	○	○	○	○
Bir gün önceden ertesi günkü matematik sınavını düşünmek.	○	○	○	○	○
Öğretmeni cebirsel işlem yaparken izlemek.	○	○	○	○	○
Matematik dersinde sınav olmak.	○	○	○	○	○
Bir sonraki derse zorlu soruların yer aldığı bir matematik ödevinin verilmesi.	○	○	○	○	○
Matematik dersini dinlemek.	○	○	○	○	○
Başka bir öğrencinin formül açıklamasını dinlemek.	○	○	○	○	○
Matematik dersinde “pop” quiz olmak.	○	○	○	○	○
Matematik kitabında yeni konuya başlamak.	○	○	○	○	○

APPENDIX F

Participant Info Form in English

Please write your Bilkent University ID number;

Gender: What is your gender?

- Female
- Prefer Not the Answer
- Male

Mother Tongue: What is mother tongue?

- Turkish
- English
- Other

Grade Level: What is your grade level?

- 1st Year or Freshman
- 2nd Year or Sophomore
- 3rd Year or Junior
- 4th Year or Senior

Age: What is your age?

How many lessons do you take this semester?

←

→

Please select a language.

Eğer ana diliniz Türkçe ise, lütfen Türkçe dil seçeneğini tercih edin.
If your mother tongue is Turkish, please select the Turkish.

(English version is only for facilitating the foreigner students but if they prefer the Turkish version they can go through it as well.)

English

Turkish

←

→

APPENDIX G

Experimental Conditions in English

This excerpt is adapted from Jamieson et al. (2016).

In stressful situations, people experience changes in their body. They might experience these as "unsettled feelings" or "butterflies in their stomach," and conclude that they are nervous. However, bodily changes that happen during stress can be good. For instance, scientists have found that feelings of "butterflies" indicate that the body is gathering resources to meet situational demands. In other words, the body needs energy to perform and stress helps deliver this energy to your brain.

Stress can be "good" or "bad," and depends on our perceptions and beliefs. For example, imagine you are a skier staring down a steep slope with no other way off the mountain than going down this dangerous trail. Regardless of whether you like skiing, this situation is stressful. Expert skiers experience the stress as "excitement" because they believe they can handle the difficult trail, whereas novices experience the stress as "fear" because the difficult trail exceeds their skill level. Thus, the skier's response (excitement vs. fear) depends on how they perceive stress.

Research from people with anxiety disorders indicates that STRESS DOES NOT HURT PERFORMANCE BUT CAN ACTUALLY HELP because our brain releases chemicals that help us think quickly. So, during the quiz today, TRY TO VIEW YOUR OWN STRESS AS A COPING TOOL.

The following questions are prepared to test how this information can help you perform well on your exam today, please choose the appropriate answer based on what you have read.

According to the text, stress can be seen as a coping tool that helps you think quickly.

- True
- False

According to the text, stress is useful because it helps you to

- get excited.
- deliver energy to your brain.

This excerpt is adapted from Nock et al.'s (2011)..

Stress is a normal reaction that helps you face the challenges in your life. It is not harmful. In fact, if we did not have stress reactions we could not survive. If stress is helpful, then why do most people see it as a negative experience?

Research indicates that negative reactions to stressful situations like taking an exam are the result of how we think about stress (also known as 'cognitive appraisals'). When the "fight or flight" system activates, our brain searches for possible sources of harm. However, in modern society there is often no physical threat. When no explanation can be found, the brain invents explanations such as, "There must be something wrong with me." Nothing could be further from the truth. STRESS IS ADAPTIVE AND GOOD.

During stressful situations remember that your body's responses are beneficial. Increased heart rate, sweating, and heavy breathing are all signs that your body is delivering oxygen (fuel for thinking) to your brain.

The following questions are prepared to test how this information can help you perform well on your exam today, please choose the appropriate answer based on what you have read.

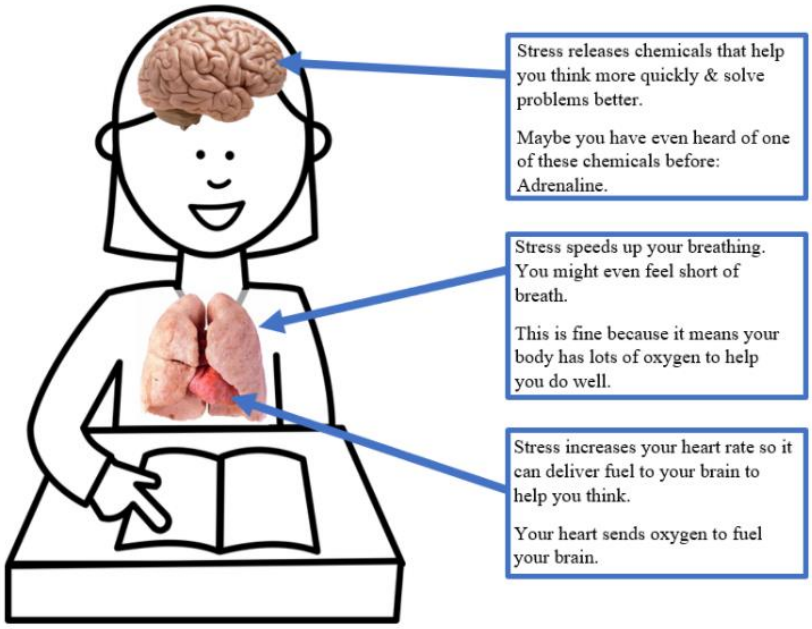
According to the text, stress is a normal reaction that is not harmful, and helps you face difficulties such as a math exam.

- True
- False

According to the text, your body's reactions (fast heart rate, heavy breathing etc.) in stressful situations such as a math exam…

- …signs that your body is supplying oxygen (fuel for thinking) to your brain to better focus on the exam and ensure success.
- …signs that your body is running out of sources to cope with the exam.

The following is an illustrative diagram that shows how shifting attention away from stress can help us perform well. Please take a minute to note where the changes occur and how these help us do well.



The following questions are prepared to test how this information can help you perform well on your exam today, please choose the appropriate answer based on what you have read.

According to the information, stress blocks Adrenaline and slow down your thinking.

- True
- False

According to the information, fast breathing under stressful situations such as a math exam…

- …is an indication that your body needs to relax.
- …is helpful for your performance.

Great job! You have finished the exercise. We would now like for you to answer some brief questionnaires before starting your test.

Remember during the quiz today, we ask that you try to remind yourself that your body's responses to the stressful testing situation will help you to perform well.

Good luck!

APPENDIX H

Placebo Conditions in English

This excerpt is adapted from Jamieson et al. (2016)

In stressful situations, people experience changes in their body. For instance, these feelings are perceived as "unsettled feelings" or "butterflies in their stomach," and accompany feelings of nervousness. Indeed, stress can harm performance on tests like the one you will complete today. Scientists have found that feelings of "butterflies" or nervousness indicate that the individual is worried about a negative outcome. In other words, stress is the body's way of alerting you that you are in a potentially harmful situation. For example, if a person is scared of spiders, our body informs that individual to get away from the spider.

However, if the individual does not attend to whatever it is in their environment that is the source of the stress, they will not experience anxiety. For instance, if someone is very afraid of spiders, he/she will not experience anxiety or fear if the spider is not noticed.

If you find yourself feeling nervous during the quiz today, REMEMBER THAT YOU WILL NOT FEEL AS BAD IF YOU DO NOT PAY ATTENTION TO STRESS. Try to take some deep breaths, relax, and IGNORE the feelings of stress, nervousness, or anxiety. This will help you succeed when you take your quiz today.

The following questions are prepared to test how this information can help you perform well on your exam today, please choose the appropriate answer based on what you have read.

According to the text, stress is harmful only when it is noticed.

True	False

According to the text, what will help me in succeeding on the quiz today is …

- To ignore my stress.
- To read carefully all the quiz questions.

This excerpt is adapted from Nock et al.'s (2011).

Stress is a common emotional reaction that helps protect us from potential sources of harm, but feelings of stress can be reduced by not paying attention to what makes us anxious. Ignoring stressful cues is not harmful. In fact, if we were not able to do this, we could not function in a modern society where there are many potential sources of anxiety.

Wondering about what others think of us or worries about how we will do during an exam, can impair our ability to complete tasks because we spend cognitive resources thinking about all the things that could go wrong. To reduce these thoughts, attention should be oriented inward and away from stressors like performance pressure. This helps us remain calm in the face of stressful situations.

If you find yourself experiencing stress or anxiety during today's quiz, try to "PUT THESE THOUGHTS OUT OF YOUR MIND." Not thinking about stress and possible negative outcomes can help people remain calm during difficult testing situations.

The following questions are prepared to test how this information can help you perform well on your exam today, please choose the appropriate answer based on what you have read.

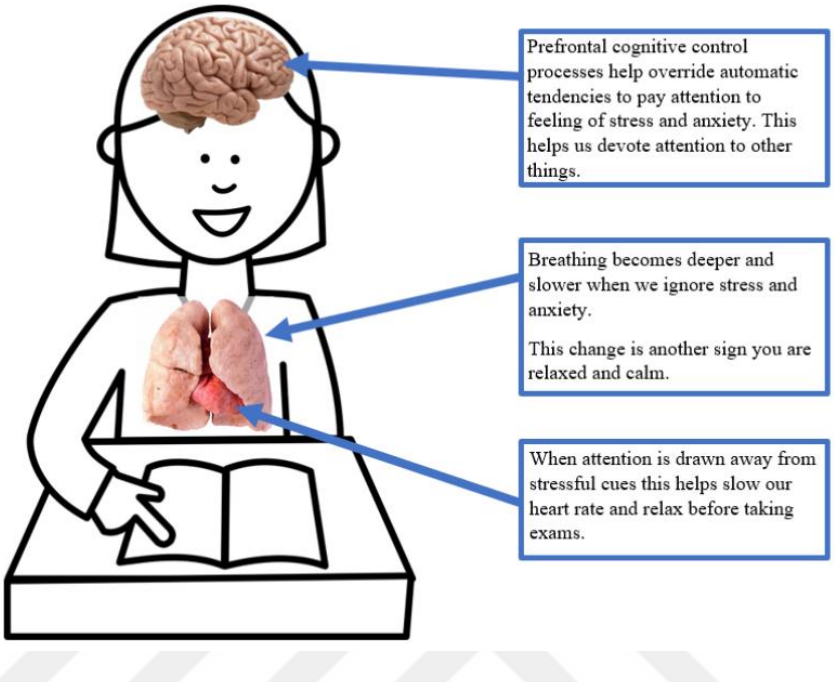
According to the text, thinking about stress reduces the cognitive resources that you can use for your quiz. Ignoring stress can keep you calm in stressful situations.

- True
- False

According to the text, in order to reduce your concerns about how you will do in an exam,

- You must focus your attention on stress and wait for it to pass.
- You must keep your attention away from stress factors.

The following is an illustrative diagram that shows how shifting attention away from stress can help us perform well. Please take a minute to note where the changes occur and how these help us do well.



The following questions are prepared to test how this information can help you perform well on your exam today, please choose the appropriate answer based on what you have read.

According to the information, one part of the brain where cognitive control processes occur, helps to override our automatic tendencies to focus on feelings of stress and anxiety.

True

False

According to the information, when you ignore stress

Your heart works too hard and blood pressure rises to help you hide your worries and stress.

Your heart beats slow down and your whole body relaxes as a result of deep and slow breathing.

Great job! You have finished the exercise. We would now like for you to answer some brief questionnaires before starting your test.

Remember during the quiz today, we ask that you try to ignore stress and anxiety during the testing situation. This will help you to perform well.

Good luck!

APPENDIX I

Experimental Conditions in Turkish

This excerpt is adapted from Jamieson et al. (2016).

İnsanlar stresli durumlarda vücutlarında bazı değişiklikler hissederler. Bunları "huzursuz hisler" veya "midede kelebekler uçuşması" olarak deneyimleyebilir ve gergin oldukları sonucuna varabilirler. Fakat aslında, stres sırasında meydana gelen bedensel değişiklikler iyi olabilir. Örneğin, bilim insanları "kelebekler uçuşması" hissinin vücudun herhangi bir duruma karşı ihtiyaçları karşılamak için kaynaklar topladığını gösterdiğini keşfettiler. Bir diğer deyişle vücut, çalışmak için enerjiye ihtiyaç duyar ve stress, bu enerjinin beyninize ulaşması için yol gösterici olur.

Stres algılarımıza ve inançlarımıza bağlı olarak "iyi" veya "kötü" olabilir. Örneğin, tehlikeli bir izi sürmekten başka çaresi olmayan keskin bir yokuştan aşağı bakan bir kayakçı olduğunuzu hayal edin.. Kayak yapmayı sevseniz de sevmeseniz de bu durum streslidir. Uzman kayakçılar stresi "heyecan" olarak deneyimliyorlar çünkü zor bir kayak yolunun üstesinden gelebileceklerine inanıyorlar, acemiler ise zor kayak yolunun onların beceri seviyelerini aştığı için stresi "korku" olarak deneyimliyorlar. Bu nedenle, kayakçının tepkisi (heyecana karşı korku) stresi nasıl algıladıklarına bağlıdır.

Anksiyete bozukluğu olan insanlarla yapılan araştırmalar gösteriyor ki STRES PERFORMANSA ZARAR VERMİYOR aksine beynimizin hızlı düşünmemize yardımcı olan kimyasalların serbest bırakılması konusunda aslında BİZE YARDIMCI OLUYOR. Bu nedenle, bugünkü sınav sırasında, STRESİNİZİ SINAV İLE BAŞA ÇIKMAK İÇİN KULLANACAĞINIZ BİR ARAÇ OLARAK GÖRMEYE ÇALIŞIN.

Aşağıdaki sorular, bu bilgilerin bugün sınavınızda iyi performans göstermenize nasıl yardımcı olabileceğini test etmek için hazırlanmıştır, lütfen okuduklarınıza göre uygun cevabı seçin.

Metne göre stres, hızlı düşünmenize yardımcı olan bir başa çıkma aracı olarak görülebilir.

- Doğru
- Yanlış

Metne göre stres faydalıdır çünkü sizin…

- heyecanlanmanıza yardımcı olur.
- beyininize enerji sağlanmasına yardımcı olur.

This excerpt is adapted from Nock et al.'s (2011)..

Stres, hayatınızdaki zorluklarla yüzleşmenize yardımcı olan normal bir tepkidir. Zararlı değildir. *Hatta stres kaynaklı* tepkilerimiz olmasaydı hayatta kalamazdık. Mademki stres bize yardımcı oluyor, o zaman neden çoğu insan bunu olumsuz bir deneyim olarak görüyor?

Araştırmalar, sınava girmek gibi stresli durumlara verilen olumsuz tepkilerin, stres hakkında nasıl düşündüğümüzün ("bilişsel değerlendirme" olarak da bilinir) bir sonucu olduğunu gösteriyor. "Savaş ya da kaç" sistemi devreye girdiğinde, beynimiz bize zarar verebilecek olası kaynaklarını arar. Bununla birlikte, modern toplumda genellikle fiziksel bir tehdit yoktur. Hiçbir açıklama bulunamayınca beyin, "Bende ters giden bir şeyler olmalı!" gibi sonuçlara varır. *Bunun gerçek olmakla yakından uzaktan ilgisi yoktur*. STRES BİZE UYUM SAĞLAR VE FAYDALIDIR.

Stresli durumlarda vücudunuzun tepkilerinin faydalı olduğunu unutmayın. Artan kalp atış hızı, terleme ve ağır nefes alma vücudunuzun beyninize oksijen (düşünmek için yakıt) sağladığının işaretleridir.

Aşağıdaki sorular, bu bilgilerin bugün sınavınızda iyi performans göstermenize nasıl yardımcı olabileceğini test etmek için hazırlanmıştır, lütfen okuduklarınıza göre uygun cevabı seçin.

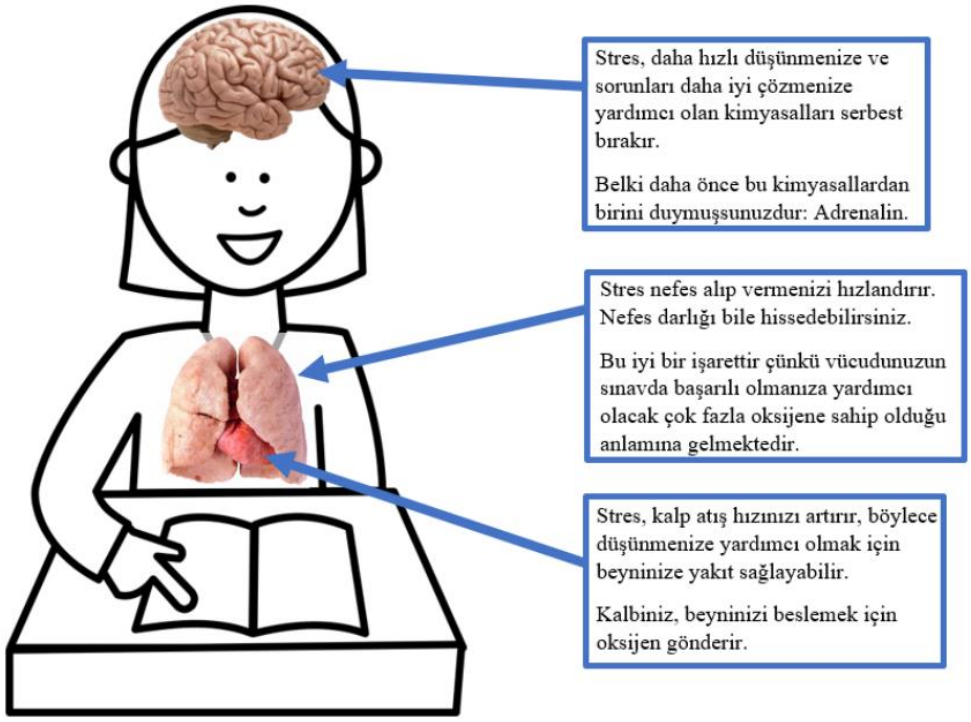
Metne göre stres, zararlı olmayan normal bir tepkidir, ve matematik sınavı gibi zorluklarla yüzleşmenize yardımcı olur.

- Doğru
- Yanlış

Metne göre matematik sınavı gibi stresli durumlarda vücudunuzun tepkileri (hızlı kalp atış hızı, derin nefes alma vb.) ...

- … sınava daha iyi odaklanmak ve başarıyı garantilemek için vücudunuzun beyninize oksijen (düşünmek için yakıt) sağladığını gösterir.
- … vücudunuzun sınavla başa çıkabilecek kaynakların tükenmekte olduğuna dair işaretlerdir.

Aşağıda dikkati stresten uzaklaştırmanın iyi performans göstermemize nasıl yardımcı olabileceğini gösteren açıklayıcı bir diyagram bulunmaktadır. Lütfen değişikliklerin nerede meydana geldiğini ve bunların başarılı olmamıza nasıl yardımcı olduğuna dikkat edin.



Aşağıdaki sorular, bu bilgilerin bugün sınavınızda iyi performans göstermenize nasıl yardımcı olabileceğini test etmek için hazırlanmıştır, lütfen okuduklarınıza göre uygun cevabı seçin.

Bu bilgilere göre stres, Adrenalini engeller ve *düşünmenizi* yavaşlatır

- Doğru
- Yanlış

Bu bilgilere göre matematik sınavı gibi stresli durumlarda hızlı nefes almak ...

- … vücudunuzun rahatlaması gerektiğinin bir göstergesidir.
- … performansınız için faydalıdır.

Great job! You have finished the exercise. We would now like for you to answer some brief questionnaires before starting your test.

Remember during the quiz today, we ask that you try to remind yourself that your body's responses to the stressful testing situation will help you to perform well.

Good luck!

APPENDIX J

Placebo Conditions in Turkish

This excerpt is adapted from Jamieson et al. (2016)

İnsanlar stresli durumlarda vücutlarında bazı değişiklikler hissederler. Örneğin, bu duygular "huzursuz hisler" veya "midede kelebekler uçuşması" gibi algılanır ve gerginlik hissine eşlik eder. Aslında stress, bugün gireceğiniz quiz gibi sınav durumlarında performansınıza zarar verebilir. Bilim adamları, "kelebekler uçuşması" hissinin veya gerginliğinin, bireyin olumsuz bir sonuçtan endişe duyduğunun bir göstergesi olduğunu keşfettiler. Başka bir deyişle, stres, vücudun potansiyel olarak zararlı bir durumda olduğu konusunda sizi uyarma yöntemidir. Örneğin bir kişi örümceklerden korkuyorsa vücudumuz o kişiye örümcekten uzaklaşması için uyarı gönderir.

Ancak birey, içinde bulunduğu ortamda stresin kaynağı olan şeyle ilgilenmezse kaygı yaşamayacaktır. Örneğin biri örümceklerden çok korkuyorsa, ama örümceği fark etmezse endişe veya korku yaşamayacaktır.

Bugünkü sınav sırasında kendinizi gergin hissederseniz, STRESE DİKKAT ETMEDİĞİNİZDE KÖTÜ HİSSETMEYECEĞİNİZİ UNUTMAYIN. Derin derin nefes almaya, gevşemeye ve stres, gerginlik veya kaygı duygularına ALDIRMAMAYA çalışın. Bu, bugün sınavınıza girdiğinizde başarılı olmanıza yardımcı olacaktır.

Aşağıdaki sorular, bu bilgilerin bugün sınavınızda iyi performans göstermenize nasıl yardımcı olabileceğini test etmek için hazırlanmıştır, lütfen okuduklarınıza göre uygun cevabı seçin.

Metne göre, stres sadece fark edildiği zaman zararlıdır.

Doğru	Yanlış

Metne göre, bugünkü quizde başarılı olmak için bana yardım edebilecek yöntem…

- Stresi yok saymaktır.
- Bütün sınav sorularını çok dikkatli bir şekilde okumaktır.

This excerpt is adapted from Nock et al.'s (2011).

Stres, bizi potansiyel zarar kaynaklarından korumaya yardımcı olan yaygın bir duygusal tepkidir, ancak stres duygumuzu bizi endişelendiren şeyleri görmezden gelerek azaltabiliriz. Stresin ipuçlarını görmezden gelmek zararlı değildir. Aslında, bunu yapamıyor olsaydık, pek çok potansiyel kaygı kaynağının olduğu modern bir toplumda yaşayamazdık.

Başkalarının bizim hakkımızda ne düşündüğünü merak etmek veya bir sınav sırasında sınavı nasıl yapacağımızla ilgili endişelenmek, yapabilme becerimizi zayıflatabilir çünkü bu tür durumlarda bütün bilişsel kaynaklarımızı olası kötü durumları düşünerek tüketiyoruz. Bu düşünceleri azaltmak için, dikkatimizi kendimize yönlendirilmeli ve kendimizi performans baskısı gibi stres faktörlerinden uzaklaştırmalıyız. Bu yöntem, stresli durumlar karşısında sakin kalmamıza yardımcı olur.

Bugünkü sınav sırasında kendinizi stres veya endişe yaşarken bulursanız, "BU TÜR DÜŞÜNCELERİ AKLINIZDAN ÇIKARMAYA" çalışın. Stresi ve olası olumsuz sonuçlarını düşünmemek, zorlu test durumlarında insanların sakin kalmasına yardımcı olabilir.

Aşağıdaki sorular, bu bilgilerin bugün sınavınızda iyi performans göstermenize nasıl yardımcı olabileceğini test etmek için hazırlanmıştır, lütfen okuduklarınıza göre uygun cevabı seçin.

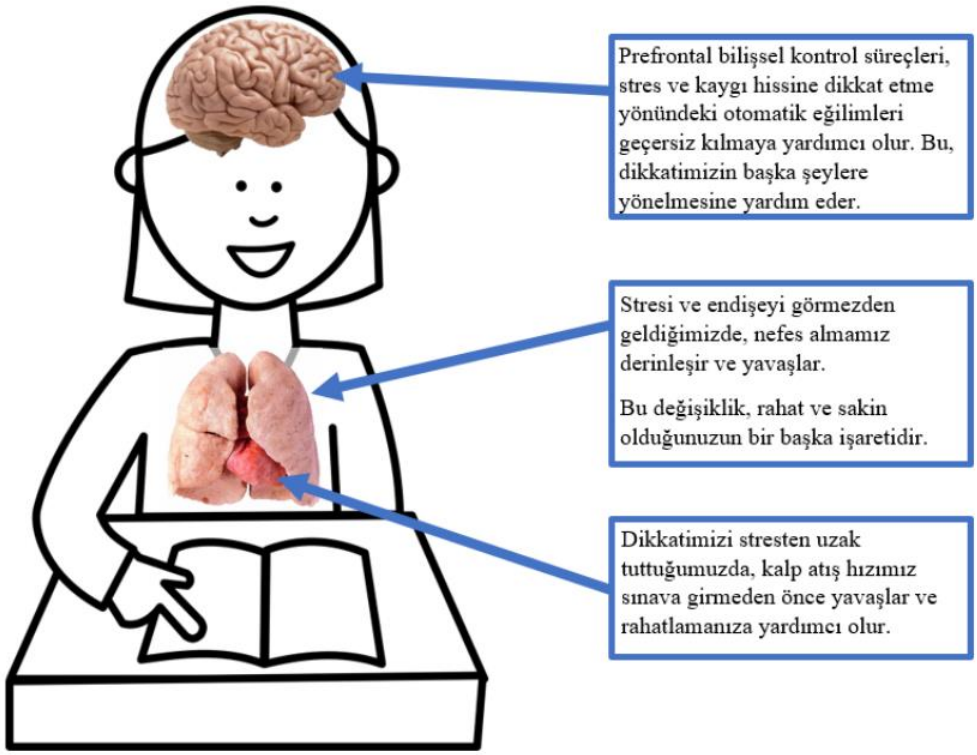
Metne göre, stres hakkında düşünmek, sınavınız için kullanabileceğiniz bilişsel kaynaklarınızı azaltır. Stresi görmezden gelmek, stresli durumlarda sakin olmanızı sağlayabilir.

- Doğru
- Yanlış

Metne göre, sınavı nasıl yapacağınızla ilgili endişelerinizi azaltmak için,

- Dikkatinizi strese odaklamalı ve geçmesini beklemelisiniz.
- Dikkatinizi stres faktörlerinden uzak tutmalısınız.

Aşağıda dikkati stresten uzaklaştırmanın iyi performans göstermemize nasıl yardımcı olabileceğini gösteren açıklayıcı bir diyagram bulunmaktadır. Lütfen değişikliklerin nerede meydana geldiğini ve bunların başarılı olmamıza nasıl yardımcı olduğuna dikkat edin.



Aşağıdaki sorular, bu bilgilerin bugün sınavınızda iyi performans göstermenize nasıl yardımcı olabileceğini test etmek için hazırlanmıştır, lütfen okuduklarınıza göre uygun cevabı seçin.

Bu bilgilere göre, beynin bilişsel kontrol süreçlerinin gerçekleştiği bir bölümü, stres ve kaygı duygularına odaklanma yönündeki otomatik eğilimlerimizi geçersiz kılmaya yardımcı olur.

- Doğru
- Yanlış

Bu bilgilere göre, stresi görmezden geldiğinizde,

- Kalbiniz çok çalışır ve endişelerinizi ve stresinizi gizlemenize yardımcı olmak için tansiyonunuz yükselir.
- Derin ve yavaş nefes alıp vermeniz sonucunda kalbiniz yavaşlar ve tüm vücudunuz gevşer.

Great job! You have finished the exercise. We would now like for you to answer some brief questionnaires before starting your test.

Remember during the quiz today, we ask that you try to ignore stress and anxiety during the testing situation. This will help you to perform well.

Good luck!

APPENDIX K

Ethical Approval

Bilkent Üniversitesi
Akademik İşler Rektör Yardımcılığı

Tarih : 15 Şubat 2021

Gönderilen : İzel Sarı

Tez Danışmanı : Aikaterini Michou, Jennie Farber Lane

Gönderen : H. Altay Güvenir
İnsan Araştırmaları Etik Kurulu Başkanı

Konu : *"Challenges In ..."* çalışması etik kurul onayı

Üniversitemiz İnsan Araştırmaları Etik Kurulu, 15 Şubat 2021 tarihli görüşme sonucu, *"Challenges In Math Settings: Investigating The Effects Of Cognitive Reappraisal Instructions On Math Anxiety"* isimli çalışmanız kapsamında yapmayı önerdiğiniz etkinlik için etik onay vermiş bulunmaktadır. Onay, ekte verilmiş olan çalışma önerisi, çalışma yürütücüleri ve bilgilendirme formu için geçerlidir.

Bu onay, yapmayı önerdiğiniz çalışmanın genel bilim etiği açısından bir değerlendirmedir. Çalışmanızda, kurulumuzun değerlendirmesi dışında kalabilen özel etik ve yasal sınırlamalara uymakla ayrıca yükümlüsünüz.

Kovid-19 salgını nedeniyle konulmuş olan kısıtlamaların yürürlükte olduğu süre içinde, tüm komite toplantıları elektronik ortamda yapılmaktadır; aşağıda isimleri bulunan Bilkent Üniversitesi Etik Kurulu Üyeleri adına bu yazıyı imzalama yetkisi kurul başkanındadır.

Etik Kurul Üyeleri:

Ünvan / İsim	**Bölüm / Uzmanlık**	
Prof.Dr. H. Altay Güvenir	Bilgisayar Mühendisliği	Başkan
Prof.Dr. Erdal Onar	Hukuk	Üye
Prof.Dr. Haldun Özaktaş	Elektrik ve Elektronik Müh.	Üye
Doç.Dr. Işık Yuluğ	Moleküler Biyoloji ve Genetik	Üye
Dr. Öğr. Üyesi Burcu Ayşen Ürgen	Psikoloji	Üye
Doç.Dr. Çiğdem Gündüz Demir	Bilgisayar Mühendisliği	Yedek Üye
Dr. Öğr. Üyesi A.Barış Özbilen	Hukuk	Yedek Üye

Kurul karar/toplantı No: 2021_02_15_01

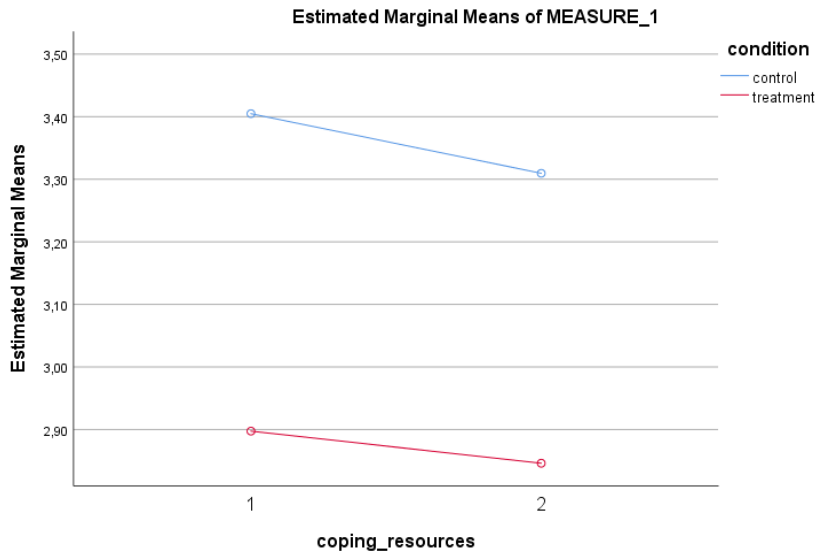
Bilkent Üniversitesi, 06800 Bilkent, Ankara • Telefon: (312) 290 12 13 • (312) 290 12 14 • Faks: (312) 266 41 52

APPENDIX L

Mean Plots

Figure 3

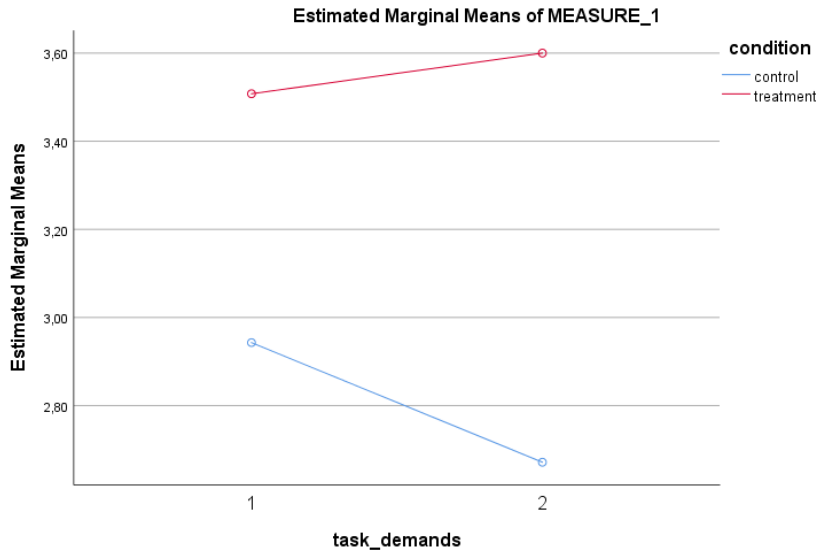
Means Plot of Estimated Marginal Means for Coping Resources



Note. 1 and 2 in the graph show two different times; pretest and posttest respectively.

Figure 4

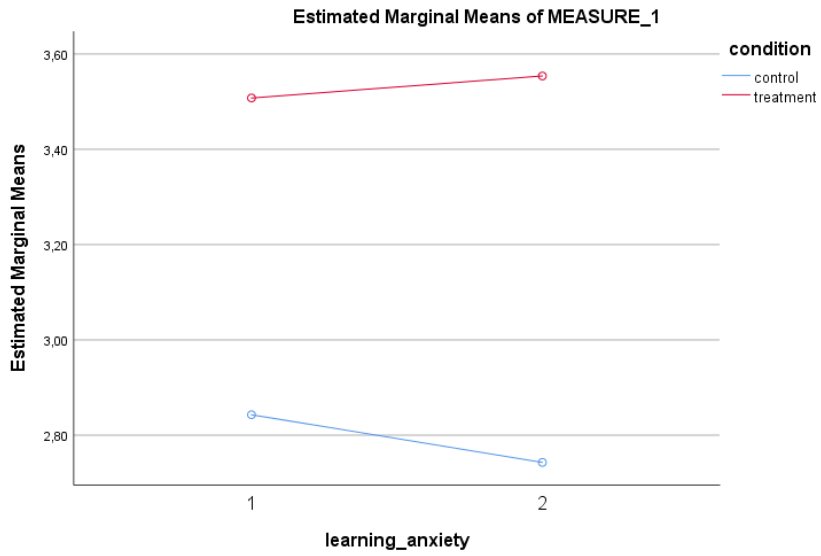
Means Plot of Estimated Marginal Means for Task Demands



Note. 1 and 2 in the graph show two different times; pretest and posttest respectively

Figure 5

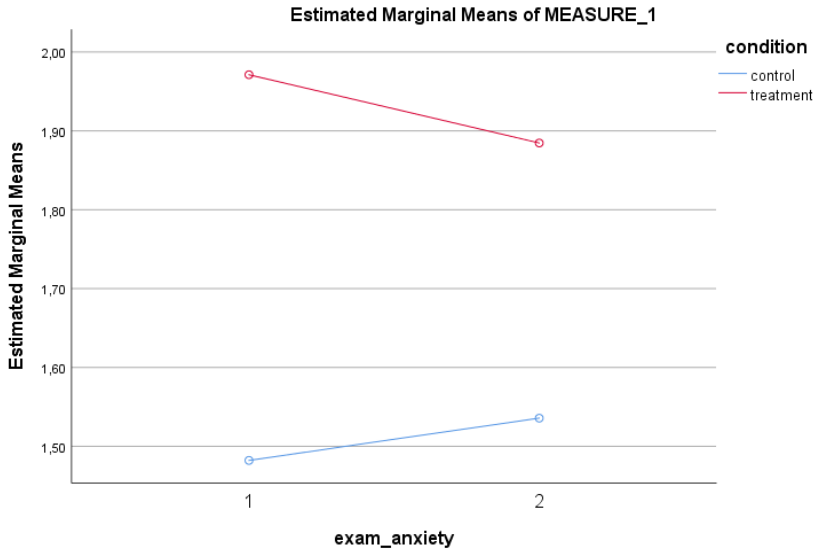
Means Plot of Estimated Marginal Means for Learning Anxiety



Note. 1 and 2 in the graph show two different times; pretest and posttest respectively.

Figure 6

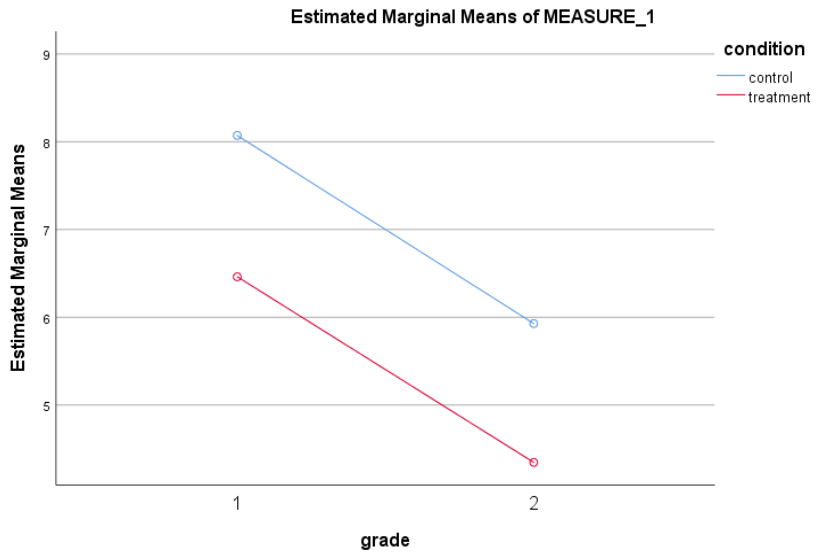
Means Plot of Estimated Marginal Means for Exam Anxiety



Note. 1 and 2 in the graph show two different times; pretest and posttest respectively.

Figure 7

Means Plot of Estimated Marginal Means for Academic Performance



Note. 1 and 2 in the graph show two different times; pretest and posttest respectively.

APPENDIX M

Histograms

Figure 8

Histogram for Normal Distribution of the Coping Resources in Pretest

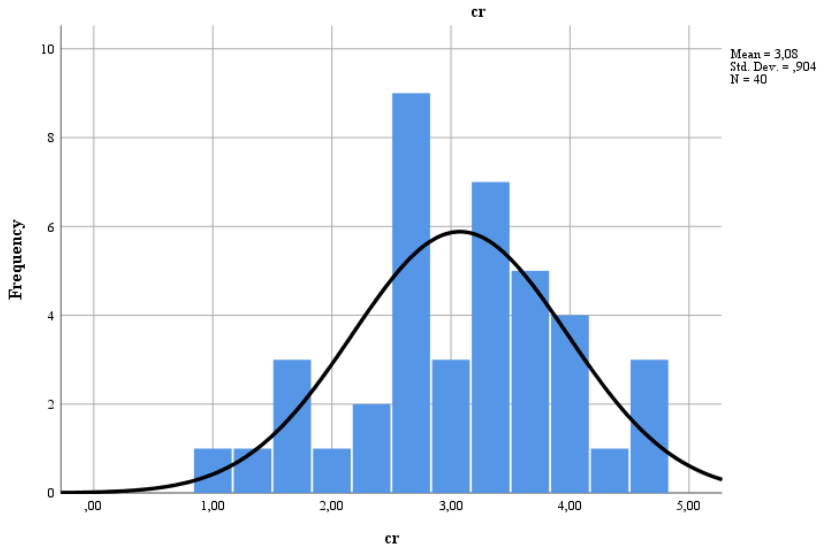


Figure 9

Histogram for Normal Distribution of the Coping Resources in Posttest

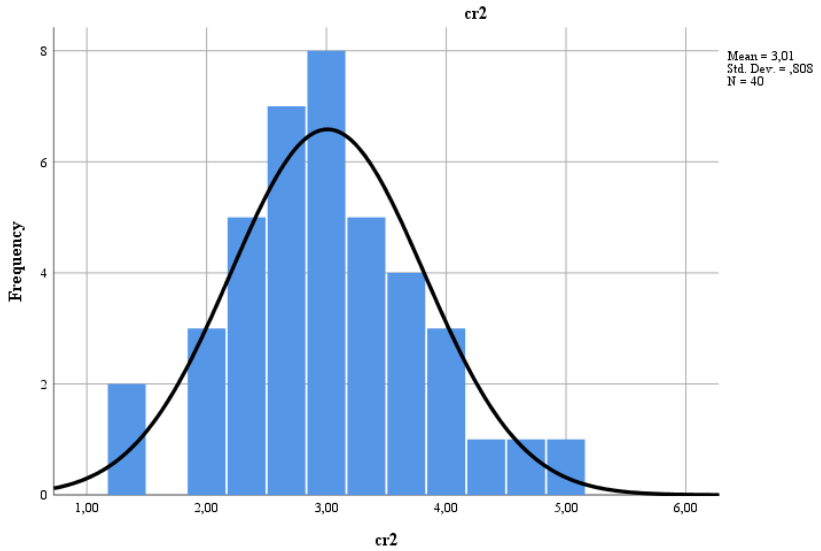


Figure 10

Histogram for Normal Distribution of the Task Demand in Pretest

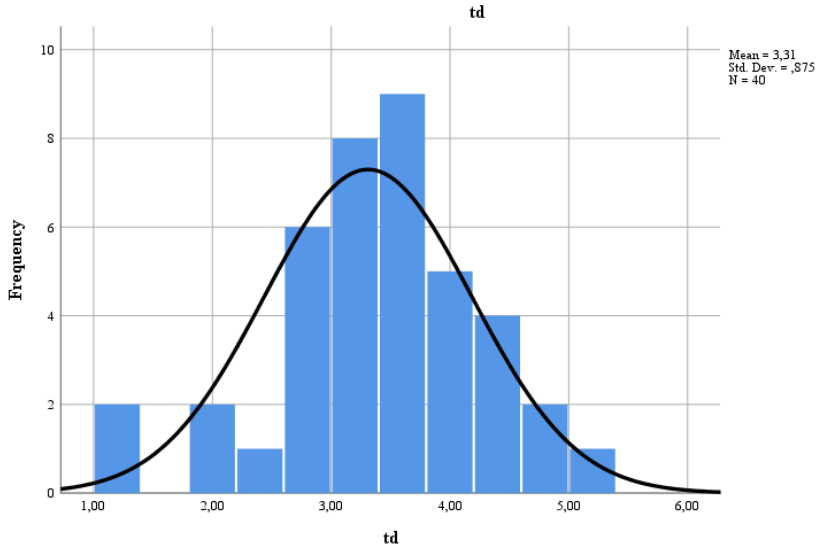


Figure 11

Histogram for Normal Distribution of the Task Demand in Posttest

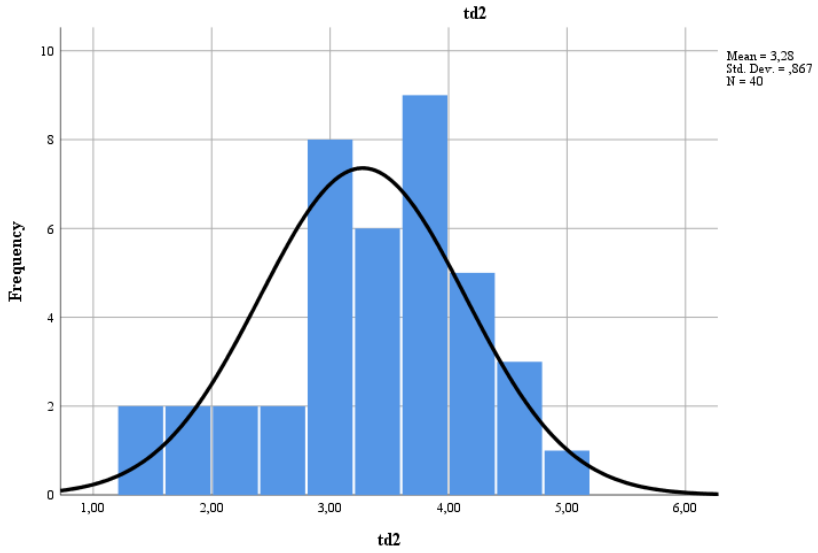


Figure 12

Histogram for Normal Distribution of the Learning Anxiety in Pretest

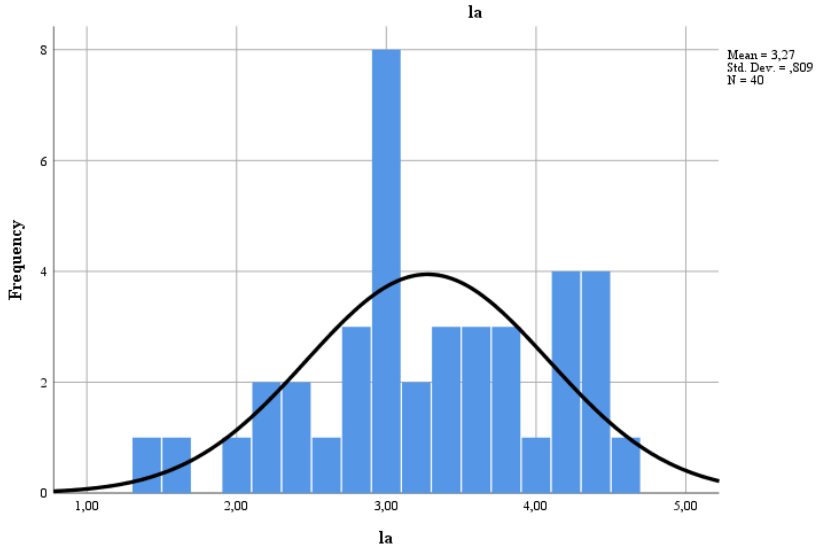


Figure 13

Histogram for Normal Distribution of the Learning Anxiety in Posttest

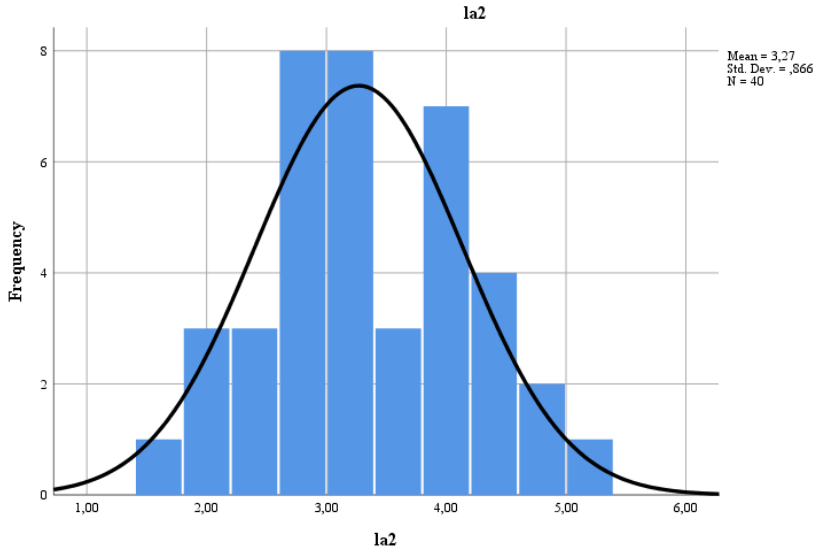


Figure 14

Histogram for Normal Distribution of the Exam Anxiety in Pretest

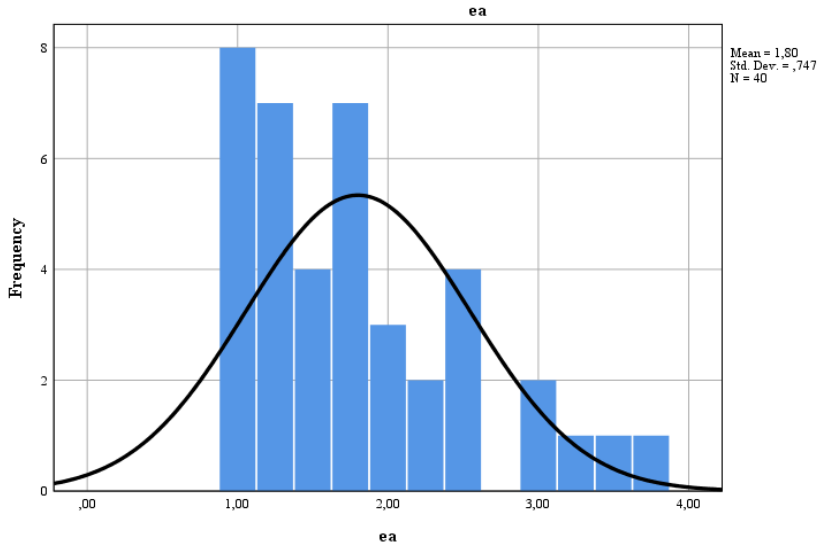


Figure 15

Histogram for Normal Distribution of the Exam Anxiety in Posttest

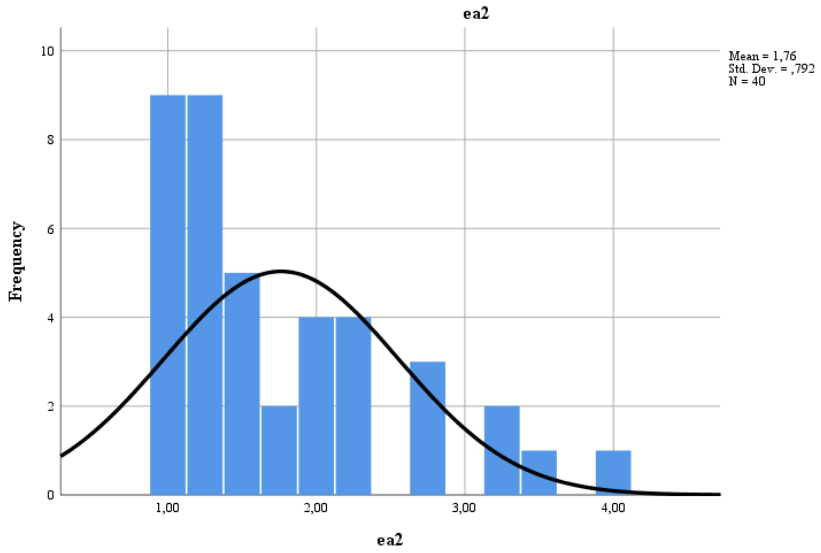


Figure 16

Histogram for Normal Distribution of the Academic Performance in Pretest

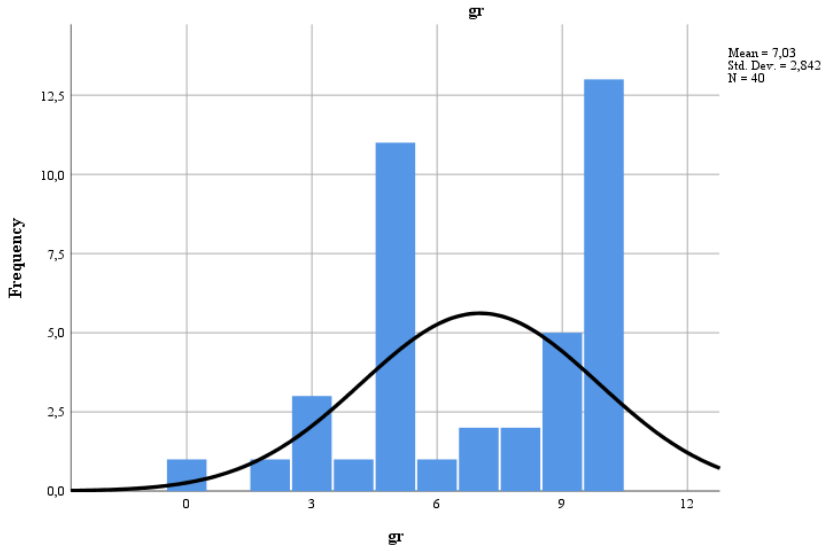


Figure 17

Histogram for Normal Distribution of the Academic Performance in Posttest