AN EXPLORATION OF AFFECTIVE AND DEMOGRAPHIC FACTORS THAT ARE RELATED TO MATHEMATICAL THINKING AND REASONING OF UNIVERSITY STUDENTS

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AN EXPLORATION OF AFFECTIVE AND DEMOGRAPHIC FACTORS THAT ARE RELATED TO MATHEMATICAL THINKING AND REASONING OF UNIVERSITY STUDENTS

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ABSTRACT

AN EXPLORATION OF AFFECTIVE AND DEMOGRAPHIC FACTORS THAT ARE RELATED TO MATHEMATICAL THINKING AND REASONING OF UNIVERSITY STUDENTS

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There are four major aims of this study: *Firstly*, factors regarding university students' approaches to studying, self-efficacy in mathematics, problem solving strategies, demographic profile, mathematical thinking and reasoning competencies were identified through the adopted survey and the competency test which was designed by the researcher. These scales were administered to 431 undergraduate students of mathematics, elementary and secondary mathematics education in Ankara and in Northern Cyprus and to prospective teachers of classroom teacher and early childhood education of teacher training academy in Northern Cyprus. *Secondly*, three structural models were proposed to explore the interrelationships among idenitified factors. *Thirdly*, among three models, the model yielding best fit to data was selected to evaluate the equality of the factor structure across Ankara and Northern Cyprus regions. *Lastly*, differences regarding pre-identified factors with respect to gender, region and grade level separately and dual, triple interaction effects were investigated through two two-way MANOVA and a three-way ANOVA analyses.

Exploratory and confirmatory factor analyses were employed to determine the factors; meaning orientation, mathematics self-efficacy, motivation, disorganized study methods and surface approach for the survey and 'expressing, extracting and computing mathematically'(fundamental skills) and 'logical

inferencing and evaluating conditional statements in real life situations'(elaborate skills) for the test.

The three models commonly revealed that while mathematics self-efficacy has a significant positive effect on both fundamental and elaborate skills, motivation which is a combination of intrinsic, extrinsic and achievement motivational items was found to have a negative direct impact on fundamental skills and has a negative indirect contribution upon elaborate skills.

The results generally support the invariance of the tested factor structure across two regions with some evidence of differences. Ankara region sample yielded similar factor structure to that of the entire sample's results whereas; no significant relationships were observed for Northern Cyprus region sample.

Results of gender, grade level and region related differences in the factors of the survey and the test and on the total test indicated that, females are more meaning oriented than males. 'Fourth and fifth (senior)' and third year university students use disorganized study methods more often than second year undergraduate students. In addition, senior students are more competent than second and third year undergraduate students in terms of both skills. Freshmen students outscored sophomore students in the elaborate skills. Students from Ankara region are more competent in terms of both skills than students from Northern Cyprus region. This last inference is also valid on the total test score for both regions. Males performed better on the total test than females.

Moreover, there exist region and grade level interaction effect upon both skills. Additionally, significant interaction effects of 'region and gender', 'region and grade level', 'gender and grade level' and 'region and gender and grade level' were detected upon the total test score.

Keywords: Affective, Demographic, Mathematical Thinking and Reasoning, Multivariate Analysis of Variance (MANOVA), Structural Equation Modeling (SEM)

ÖZ

ÜNİVERSİTE ÖĞRENCİLERİNİN MATEMATİKSEL DÜŞÜNME VE AKIL YÜRÜTME BECERİLERİYLE İLGİLİ DUYUŞSAL VE DEMOGRAFİK ETMENLERİN ARAŞTIRILMASI

Başaran, Seren

Doktora, Orta Öğretim Fen ve Matematik Alanları Eğitimi
Tez Yöneticisi: Prof. Dr. Giray Berberoğlu

Haziran 2011, 214 sayfa

Bu çalışmanın dört temel amacı vardır: *İlk olarak*, üniversite öğrencilerinin çalışma alışkanlıkları, öz yeterlik algıları, problem çözme stratejileri, demografik profilleri, matematiksel düşünme ve akıl yürütme yetkinlikleri uyarlanmış bir görüş ölçeği ve araştırmacı tarafından geliştirilmiş bir yeterlik testi ile belirlenmiştir. Ölçekler, Ankara ve Kuzey Kıbrıs'taki toplam 431 üniversitelerin matematik, ilk ve orta öğretim matematik eğitimindeki öğrencilere ve Kuzey Kıbrıs öğretmen akademisindeki okul öncesi ve sınıf öğretmenliğindeki öğretmen adaylarına uygulanmıştır. *İkinci olarak,* bu faktörlerden oluşturulan üç yapısal eşitlik modeli test edilmiştir. Üçüncü olarak, veriyi en iyi açıklayan bir yapaısal eşitlik modeli seçilerek Ankara ve Kuzey Kıbrıs bölgeleri için faktör yapısındaki benzerlik ve farklar bölgelere göre araştırılmıştır. *Son olarak*, çift yönlü MANOVA ve üç yönlü ANOVA analizleri kullanılarak cinsiyet, bölge ve sınıfa göre ayrı ayrı ve ikili, üçlü etkileşim etkilerine bakılarak önceden belirlenmiş faktörler arasındaki farklar saptanmıştır.

Açıklayıcı ve doğrulayıcı faktör analizleri kullanılarak belirlenen faktörler şunlardır: görüş ölçeği için; anlamaya odaklı öğrenme, matematik öz yeterlik algısı, motivasyon, düzensiz çalışma alışkanlıkları, yüzeysel öğrenme yaklaşımı; test içinse; matematiksel olarak ifade etme, çıkarım yapma, işlem yapma (temel beceriler) ve mantıksal çıkarımlarda bulunma ve gerçek yaşama dayalı durumlarda koşullu ifadelerin değerlendirilmesi (ileri düzey beceriler).

Test edilmiş üç modelin ortak bulguları; matematik özyeterlik algısının her iki beceriye anlamlı pozitif etkisi saptanamışken motivasyonun (içsel, dışsal ve başarı) temel becerilere negatif yönde direkt etkisi ve ileri düzey becerilere ise negatif indirekt katkısı olduğu belirlenmiştir.

Faktör yapısının bölgelerarası değişmezliği her iki bölge için de birkaç fark dışında benzerlik göstermektedir. Ankara bölgesi toplam örneklem için test edilen model yapsına benzer bir faktor yapısı gözlemlenirken Kuzey Kıbrıs bölgesi için modelde faktörler arası herhangi bir anlamlı ilişki saptanmamıştır.

Faktörler ve toplam test üzerindeki cinsiyet, sınıf ve bölge farklarıyla ilgili sonuçlar; kızların erkeklere göre daha anlamaya odaklı olduğu; üniversite dördüncü ve beşinci, ve üçüncü sınıf öğrencilerin ikinci sınıflara göre düzensiz çalışma alışkanlıklarını daha sık kullanıdığı saptanmıştır. Buna ek olarak, dördüncü ve beşinci sınıftakilerin ikinci ve üçüncü sınıftaki öğrencilere göre her iki beceri türü açısından daha başarılı olduğu belirlenmiştir. Üniversite birinci sınıf öğrenciler ileri düzey becerilerde ikinci sınıf öğrencilerden daha iyi bir performans göstermmiştir. Ankara'daki öğrencilerin Kuzey Kıbrıs'takilere göre her iki beceride de daha başarılı olduğu gözlemlenmiştir. Bu çıkarım tüm test sonucunda için de geçerlidir. Ayrıca, her iki beceri için de 'bölge, sınıf' ikili etkileşim farkı bulunmuştur. Tüm test sonucunda, 'bölge, cinsiyet', 'bölge, sınıf', 'cinsiyet, sınıf' ve 'bölge, cinsiyet ve sınıf' etkileşimlerinin de anlamlı olduğu saptanmıştır.

Anahtar kelimler: Akıl Yürütme ve Matematiksel Düşünme, Çok Değişkenli Varyans Analizi (MANOVA), Demografik, Duyuşsal, Yapısal Eşitlik Modeli (YEM)

To my mother Öcen Başaran; always devoted, loving and caring,

&

To my father Eren Başaran; exceptional, guiding scholar and father

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LIST OF ABBREVIATIONS

MEANORT:	Meaning Orientation
MSEFFIC:	Mathematics Self-Efficacy
SURAPP:	Surface Approach
MOT:	Motivation (Intrinsic, Extrinsic and Achievement)
DISORSD:	Disorganized Study Methods
EXPEXTCMP:	Express, Extract, Compute (basic/fundamental skills)
EXPLOGINF:	Express and infer logically (higher order/elaborate skills)
EFA:	Exploratory Factor Analysis
CFA:	Confirmatory Factor Analysis
SEM:	Structural Equation Modeling
MANOVA:	Multivariate Analysis of Variance
ANOVA:	Univariate Analysis of Variance
SURVEY:	Adopted survey on approaches to studying, self-efficacy, problem solving strategies and demographic profile
TEST:	Mathematical Thinking and Reasoning Competency Test
SURVEY-TEST:	Structural Equation Model for the factors of the survey and the test
SURVEY-TESTt:	Structural Model for the factors of the survey and the summed version observed variables for factors of the test
SURVEYi-TEST:	Structural Model for the index scores of the factors of the survey and the factors of the test
MTRC:	Mathematical Thinking and Reasoning Competency

CHAPTER 1

INTRODUCTION

Mathematical thinking and reasoning are essential elements for doing and learning mathematics and henceforth they are among the important indicators of success in mathematics as well. Understanding of both is required for everyone. Students as well as individuals often use reasoning along with mathematical thinking to synthesize or decide on the validity of claims in everyday life. Reasoning and mathematical thinking consist of all the connections between experiences and knowledge that a person uses to explain what they see, think and conclude. They trigger the discovery of new ideas and serve as a tool to explain why and how a method works (National Council of Teachers of Mathematics [NCTM], 1991, 2000; Turkish Ministry of National Education [MNE], 2005).

Particularly, reasoning and learn to think mathematically are not only essential for solving mathematical problems but also important for successfully adapting the knowledge acquired to real life situations as well (Schoenfeld, 1992). Nationwide and international mathematics curricula coherently state that these two intertwined attributes should be the integral elements of teaching and learning of mathematics (MNE, 2005; NCTM, 2000).

Albeit the recent reforms in the mathematics curricula at both national and international stands, much of the mathematics instruction still focuses on the procedural and algorithmic applications even at the undergraduate level. The instances requiring students' engagement with problems that trigger their mathematical thinking and reasoning are still sparse. Consequently they tend to demonstrate poor mathematical thinking and reasoning abilities. This may be due to the fact that, endorsing mathematical thinking and reasoning that is persistently suggested by educational policy makers and is also a prerequisite for learning and doing mathematics, typically is not in the agenda of higher mathematics education and hence depriving students of the situations to understand why and how a method works when tackling with problems. It is yet apparent that mathematical thinking and reasoning are still neglected at mathematics classrooms for variety of reasons as; difficulty of creating real life situated assessment items to evaluate these concepts, time constraint for lectures and taking tests including such concepts and the time used in classrooms to prepare these concepts oriented instruction.

Although mathematical thinking and reasoning are central to teaching and learning of mathematics, the field of mathematics education has yet not accomplished to portray a broad view to promote mathematical thinking and reasoning in coherent with the learning and studying experiences of students along with affective and demographic constructs at all grade levels particularly at the undergraduate level. Aside from contributing factors like mathematical thinking and reasoning to achievement in mathematics, student characteristics and their way of learning are additional components of promoting mathematics achievement.

There exist numerous affective factors influencing mathematics achievement, one of which is; self-efficacy beliefs that is considered to be one of the strongest predictor of mathematics performance of students (Organization for Economic Cooperation and Development [OECD], 2006; Pajares, 1996). The self-efficacy beliefs indicating a person's perceived ability or capability to successfully perform a given task or behavior is defined as the conviction in one's ability to successfully organize and execute courses of action to meet desired outcomes (Bandura A. , 1986). Another description of self-efficacy belief is; one's perceived ability to plan and execute to achieve specific tasks (Bandura A. , 1997). It has been widely investigated in studies that have explored its relationship particularly with problem solving behaviors in the academic settings (Bouffard-Bouchard, 1989; Larson, Piersel, Imao, & Allen, 1990 as cited in Pajares, 1996).

In addition, learning process variables such as approaches to studying and learning are important factors in determining student's learning progress and are influential for academic achievement in tertiary education (Murray-Harvey, 1993). Marton and Säljö (1976) identified two distinct approaches to studying, namely; deep and surface approach. The deep approach refers to a deeper level of understanding where the learner understands the content, the argument and the meaning of the materials and could apply a critical point of view when interacting with the learning materials. The surface approach involves a superficial mastery of the learning materials where the learner typically memorizes the facts. Moreover, there exist motivation and strategic components that enact with deep, surface and achieving approaches to studying (Biggs J. B., 1979). The surface approach generally produces a surface grasp of the subject matter and a low level of conceptual understanding whereas the deep approach evokes understanding and integrating of principles and concepts (Murray-Harvey, 1993). Meaning orientation involves the use of deep approach, relating ideas, evidence, and intrinsic motivation whereas reproducing orientation includes the use of surface approach, syllabus boundness, fear of failure, extrinsic motivation, improvidence, disorganized study methods and achievement motivation (Ramsden & Entwistle, 1981).

It is argued that all these factors do not operate in isolation but form a complex system that brings about changes in mathematics achievement (Leung, 2001). Individual characteristics such as self-efficacy, problem solving strategies and studying approaches are known to be the important factors influencing academic achievement at undergraduate level (Bos&Kuiper, 1999; Hei, 1999; Minnaert & Janssen, 1992; Watkins, 1986; Schreiber, 2002; Yayan&Berberoğlu, 2004). While these variables are believed to influence achievement, little is known about their interrelationships and their interactive effect on mathematics achievement more specifically on mathematical thinking and reasoning. So far, these variables have been studied in relative isolation and their influence on learning has been assessed as independent effects. Up to date, few studies examined the relationships of these variables all together and their causal effects on each other (Keeves, 1986; Murray-Harvey, 1993; Watkins, 1989).

The abundance of research investigating affective factors contributing to mathematics achievement and given the scarcity of studies on the inspection of affective factors in particular to mathematical thinking and reasoning constitute the foundation of this study. For this purpose, this study primarily aimed to identify the factors and their relationships perceived by undergraduate students regarding their approaches to studying, self-efficacy and problem solving strategies, mathematical thinking and reasoning competency and the linkage among these factors are commonly investigated by using structural modeling techniques.

Moreover, structural equation modeling is also a prevalently used practice for testing the factorial invariance that is; the identification of differences and similarities of the factorial models across different groups. Testing factorial invariance has been broadly employed in cross-cultural studies. However, no study has been located in the literature that has examined the invariance of the factor structure with the aforementioned factors particularly for samples from Ankara and Northern Cyprus regions. The rationale behind choosing particularly these two sample groups is that; some cultural differences might emerge from the comparison of students across two regions. Furthermore, researcher's individual and profession related connections to both of these two regions sets further practical ground for investigation. Secondly, this study aimed to investigate regional based similarities and differences of the factors regarding approaches to studying, self-efficacy, problem solving strategies and competency in mathematical thinking and reasoning across undergraduate students from Ankara and Northern Cyprus.

Also students' learning approaches, mathematical thinking and reasoning could be considered from demographic standpoints. Literature addresses gender and age related differences regarding these constructs that were usually inspected in isolated manner (Cole, 1997; Royer, et. al., 1999; Zeeger, 1999, 2000). There exists no research that the researcher is aware of exploring any gender, grade level and regional differences on mathematical thinking and reasoning competency of students and along together their approaches to learning and self-efficacy, problem solving strategies. Thirdly, this study soughts to explore any regional, gender and grade level based differences and their interaction effects attributed to approaches to studying, self-efficacy and problem solving strategies, competency in mathematical thinking and reasoning among undergraduate students.

Consequently, this study informs instructors and educational policy makers on affective and demographic constructs that could be effective in promoting students' mathematical thinking and reasoning. It might be helpful for instructors to pay attention to these attributes when organizing their lectures and preparing relevant assessments. Pedagogical implications of the findings could provide essential guidance for researchers in a way to take into consideration of the identified factors as a complex system and their interaction with each other. In addition researchers could focus on the rarely discussed issues in the literature based on the different cultures with same native language.

1.1 Research Questions and Hypotheses

The current research is chiefly concerned with the stated problem: Although mathematical thinking and reasoning are fundamental to teaching and learning of mathematics, the field of mathematics education has yet not accomplished to portray a broad view to promote mathematical thinking and reasoning in coherent with the learning and studying experiences of students along with other affective and demographic attributes particularly at undergraduate level. In this respect, this study aimed to address three main research questions:

(1) What are the factors and their relationships perceived by undergraduate students regarding their approaches to studying, self-efficacy and problem solving strategies, mathematical thinking and reasoning competency?

(2)What are the regional based similarities and differences of the factors regarding approaches to studying, self-efficacy, problem solving strategies and competency in mathematical thinking and reasoning of undergraduate students from Ankara and Northern Cyprus regions?

(3)What are the regional, gender and grade level based differences attributed to approaches to studying, self-efficacy and problem solving strategies, competency in mathematical thinking and reasoning of undergraduate students?

In the light of the above, the purpose of this study was four-fold: It aims to determine the factors that are influential in undergraduate students' approaches to studying, self-efficacy, problem solving strategies, competency in mathematical thinking and reasoning; to explore the interrelationship between these factors, their contribution to students' competency in mathematical thinking and reasoning; to verify the invariance of the factor structure of the model that best represents data across two regions (Ankara and Northern Cyprus); to identify any gender, grade level, and regional differences among these factors and on the overall competency in mathematical thinking and reasoning of participants.

More specifically, the present study addresses the following questions:

1. What are the factors perceived by undergraduate students in terms of approaches to studying, self-efficacy and problem solving strategies? (Statistical analysis: EFA)
2. What are the main factors related to undergraduate students' mathematical thinking and reasoning competency? (Statistical analysis: EFA)
3. What are the relationship between these factors and students' competency in mathematical thinking and reasoning?
    3.1. What linear structural model explains affective factors that are related to students' competency in mathematical thinking and reasoning?

    H_0: The linear structural model between MO, RO, SO, NAO, MSE, PSS and MTRC is not statistically significant (see Figure 1 below).

    H_a: The linear structural model between MO, RO, SO, NAO, MSE, PSS and MTRC is statistically significant (see Figure 1 below).

    (Independent variables: MO, RO, SO, NAO, MSE, PSS; dependent variables: factors related to MTRC; statistical analysis: SEM)

    3.2. What linear structural model explains the interrelationships between affective factors and competency in mathematical thinking and reasoning among students?

H_0: There will be no significant relationship between MO, RO, SO, NAO, MSE, PSS and MTRC.

H_a: There will be significant relationship between MO, RO, SO, NAO, MSE, PSS and MTRC.

(Independent variables: MO, RO, SO, NAO, MSE, PSS; dependent variables: factors related to MTRC; statistical analysis: SEM)

4. Do similar structural relationships related to approaches to studying, self-efficacy, problem solving strategies and competency in mathematical thinking and reasoning hold across students from both regions (Ankara and Northern Cyprus)?

   H_0: The linear structural model between MO, RO, SO, NAO, MSE, PSS and MTRC is not statistically significant across two regions (see Figure 1 below).

   (Independent variables: MO, RO, SO, NAO, MSE, PSS; dependent variables: factors related to MTRC; statistical analysis: SEM)

   H_a: The linear structural model between MO, RO, SO, NAO, MSE, PSS and MTRC is statistically significant across two regions (see Figure 1 below).

   (Independent variables: MO, RO, SO, NAO, MSE, PSS; dependent variables: factors related to MTRC; statistical analysis: SEM)

5. What are the differences among factors regarding approaches to studying, self-efficacy and problem solving strategies with respect to the gender, grade level?

   5.1. What are the differences among these factors with respect to undergraduate students at Ankara and at Northern Cyprus regarding gender?

   H_0: There exist no difference between the factors related to approaches to studying, self-efficacy and problem solving strategies among undergraduate students with respect to gender.

   H_a:There exists differences between the factors related to approaches to studying, self-efficacy and problem solving strategies among undergraduate students with respect to gender.

5.2. What are the differences among these factors across undergraduate students regarding grade level?

H_0: There exist no difference between the factors related to approaches to studying, self-efficacy and problem solving strategies among undergraduate students with respect to grade level.

H_a:There exist differences between the factors related to approaches to studying, self-efficacy and problem solving strategies among undergraduate and prospective teachers with respect to grade level.

5.3. Are there any significant differences among these factors across undergraduate students with respect to gender and grade level?

H_0: There is no significant interaction between gender and grade level upon the factors related to approaches to studying, self-efficacy and problem solving stratetiges among undergraduate students.

H_a:There is significant interaction between gender and grade level upon the factors related to approaches to studying, self-efficacy and problem solving strategies among undergraduate students.

(Independent variables: gender, grade level; dependent variables: MO, RO, SO, NAO, MSE, PSS; statistical analysis: two-way MANOVA)

6. What are the differences among factors attributed to competency in mathematical thinking and reasoning among undergraduate students with respect to region and grade level?

6.1. What are the differences among these factors across undergraduate students at Ankara and at Northern Cyprus?

H_0: There exist no differences of the factors related to competency in mathematical thinking and reasoning among undergraduate students with respect to region.

H_a: There exist differences of the factors related to competency in mathematical thinking and reasoning among undergraduate students with respect to region.

6.2. What are the differences among these factors across undergraduate students regarding grade level?

H_0: There exist no differences of the factors related to competency in mathematical thinking and reasoning among undergraduate students with respect to grade level.

H_a: There exist differences of the factors related to competency in mathematical thinking and reasoning among undergraduate students with respect to grade level.

6.3. Are there any significant differences among these factors across undergraduate studentswith respect to region and grade level?

H_0: There is no significant interaction between region and grade level upon the factors related to competency in mathematical thinking and reasoning among undergraduate students.

H_a: There is significant interaction between region and grade level upon the factors related to competency in mathematical thinking and reasoning among undergraduate students.

(Independent variables: region, grade level; dependent variables: factors related to MTRC statistical analysis: two-way MANOVA)

7. What are the differences on the total test of competency in mathematical thinking and reasoning among undergraduate students with respect to region, gender and grade level?

7.1. What are the differences on the total test in competency in mathematical thinking and reasoning across undergraduate students at Ankara and at Northern Cyprus?

H_0: There exist no difference on the total test of mathematical thinking and reasoning competency among undergraduate students with respect to region.

H_a: There exist differences on the total test of competency in mathematical thinking and reasoning among undergraduate students with respect to region.

7.2. What are the differences across undergraduate students regarding gender?

H_0: There exist no difference on the total test of competency in mathematical thinking and reasoning among undergraduate students with respect to gender.

H_a: There exist differences on the total test of competency in mathematical thinking and reasoning among undergraduate students with respect to gender.

7.3. What are the differences across undergraduate students on the total test regarding grade level?

H_0: There exist no difference on the total test of competency in mathematical thinking and reasoning among undergraduate students with respect to grade level.

H_a: There exist differences on the total test of competency in mathematical thinking and reasoning among undergraduate students with respect to grade level.

7.4. Are there any significant differences on the total test of competency in mathematical thinking and reasoning of undergraduate students with respect to region, gender and grade level?

H_0: There is no significant interaction between region, gender and grade level on the total test of competency in mathematical thinking and reasoning among undergraduate students.

H_a: There is significant interaction between region, gender and grade level on the total test of competency in mathematical thinking and reasoning among undergraduate students.

(Independent variables: region, gender, grade level; dependent variables: total test score in MTRC; statistical analysis: three-way ANOVA)

It is hypothesized that determined factors – *meaning orientation (MO)* (deep approach, relating ideas, use of evidence, intrinsic motivation), *reproducing orientation (RO)* (surface approach, syllabus-boundness, fear of failure) *strategic orientation (SO)* (extrinsic and achievement motivation), *non-academic orientation (NAO)* (disorganized study methods), *mathematics self-efficacy(MSE)* and *problem solving strategies (PSS)* directly influence students' competency in mathematical thinking and reasoning *(MTRC).* The latent variables of the structural model were determined by exploratory and confirmatory factor analyses of the observed variables. The priori model is depicted in Figure 1:

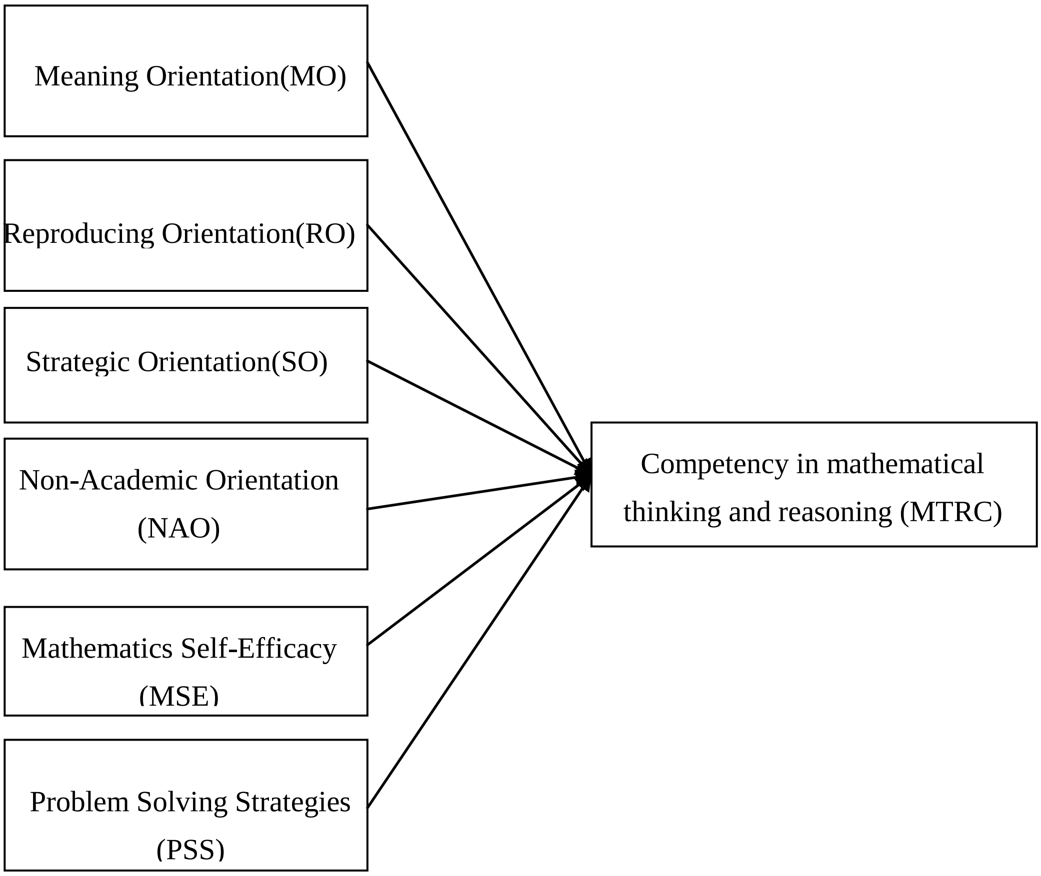


Figure 1 Initial Hypothesized Structural Model

1.2 Definition of Important Terms

The definitions of the terms are given below in order to provide essential information of the latent variables used in the structural equation models (SEM) and in MANOVA and ANOVA analyses in terms of clarity.

Meaning Orientation: This term consists of *deep approach* - looking for underlying meaning and interacting it actively by linking it with real life; *use of evidence* – critical inspection of evidence and *relating ideas* - relating new knowledge with the former ones; *intrinsic motivation* - learning for own's sake (Ramsden,1997, p. 211). It is measured through adopted version of Approaches to Studying Inventory that was developed by Entwistle and Ramsden (1983).

Reproducing Orientation: It includes; *surface approach*- relying on rote learning; being conscious of exam demands; *syllabus-boundness* - prefering to restrict learning to defined syllabus and specified tasks; *fear of failure*: being anxious about assessment demands; lacking in self-confidence; *improvidence* being not prepared to look for relationships between ideas; fact-bound (Ramsden, 1997, p. 211). It is measured through adopted version of Approaches to Studying Inventory that was developed by Ramsden and Entwistle (1981).

Strategic Orientation: It includes; *strategic approach* - trying to find out about assessment demands; seeks to impress staff; *extrinsic motivation*- qualifications as main source of motivation for learning; *achievement motivation*- competitive and self-confident; motivated by hope for success (Ramsden, 1997, p. 212). It is measured through adopted version of Approaches to Studying Inventory that was developed by Ramsden and Entwistle (1981).

Disorganized Study Methods: It refers to organizing time ineffectively, not prompt in submitting work (Ramsden, 1997). It is within the sub dimension of non-academic orientation. It is measured through adopted version of Approaches to Studying Inventory that was developed by Ramsden and Entwistle (1981).

MathematicsSelf-Efficacy: Self-efficacy, the conviction in one's ability to successfully organize and execute courses of action to meet desired outcomes

(Bandura, 1986). Specifically, it is defined as one's confidence in having the necessary resources to succeed in mathematics (Pajares & Miller, 1997).

Problem Solving Strategies: Problem situation requires the use of reasoning and mathematical thinking abilities that has no obvious way that yields directly to the solution.The way that students solve a problem, the information considered in the solving it, choice of strategy and his/her representation and contribution is more important than the answer of a problem (NME, 2005, pp.14-15). It indicates one's approach to a problem situation on why, what and how has been done.

Mathematical Thinking: This term refers to the connections to construct some sort of mathematical understanding where it is applied to given situation. It also means developing mathematical capabilities using the tools necessary in the mathematics classroom. It is defined as being able to express concrete factual relations in abstract terms and deriving into generalizations. In this respect, mathematical truth is not factual but in logical manner (NME, 2005, p.5).It involves discovery, logically relating ideas and expressing ideas, predicting intuitively the relationships among facts and procedures and employing this to problem solving. It includes recognizing, establishing, expressing, classifying, generalizing and linking it to real life situations and hence inferring to conclusions linking between mathematical procedures, concepts and conceptual structures (NME, 2005, p. 14).

Problem solving requires thinking mathematically as one needs basic knowledge of mathematics to solve problems (NCTM, 1991; NME, 2005, p. 14). It involves "the development of a mathematical point of view valuing the process of mathematization and abstraction and having the predilection to apply them; and the development of competence with the tools of the trade, and using those tools in the service of the goal of understanding structure" (Schoenfeld, 1992, p. 335).

Reasoning: Student's ability to conclude from assumed facts leading from hypothesis to conclusion. The process may include analysis, arguments, and verification (Lee, 1999). It involves being able to infer logically, using mathematical models, rules and relations when expressing own's thoughts,defending the solution methods and the conclusions regarding a problem,when analyzing mathematical situations being able to use relations,self believing that mathematics is logical and meaningful subject, being able to predict (NME,2005, p.17). It involves the ability to observe and make conjectures, making logical deductions based on specific assumptions and rules, and justifying results (TIMSS, 2003).

Analytic reasoning: learners must apply principles of formal logic in determining necessary& sufficient conditions or in determining if implication of causality occurs among the constraints and conditions provided in the problem (OECD, 2003).

Quantitative reasoning: learner must apply properties and procedures related to number operations form mathematics to solve problem (OECD, 2003).

Logico-deductive reasoning: conclusions (new knowledge) follow from premises (old knowledge) through the application of arguments (syllogisms, rules of inference) (OECD, 2003).

1.3 Significance of the Study

This research work was initially inspired by evidence from classroom instructions that was observed by the researcher in various occasions. Although mathematical thinking and reasoning are considered at the center of learning and doing mathematics and persistent emphasis was addressed in both national and international mathematics curricula, the instances that require students' engagement with real life situated problems triggering their mathematical thinking and reasoning are still rare and thus they still tend to demonstrate poor mathematical thinking and reasoning abilities.

Besides, the path of learning to think mathematically inevitably passes through developing accurate problem solving strategies and hence reasoning abilities in the first place (Schoenfeld, 1992). Thus, problem solving strategies could shed light on the nature of mathematical thinking. For the successful engagement with problems students should be able to apply their mathematical thinking and reasoning skills to non-routine, real life situated problems.

A significant body of research indicates that mathematical thinking and reasoning are essential contributors of achievement in mathematics. However, little investigation has been done to determine whether or not undergraduate students particularly prospective teachers are properly equipped with these necessary skills in a manner to understand the conceptual link between students' learning approaches, problem solving strategies and mathematical thinking and reasoning abilities they posses. Combining and investigating all these attributes in relation with each other at once, provides a more complete vision and understanding of students' competency in mathematics.

Participants of this study most likely came from almost various region of Turkeyand Northern Cyprus with different educational experiences and knowledge. Hence conducting this study at undergraduate level constitutes more diverse sample representing various regions of Turkey and Northern Cyprus. Besides, this research focused partly on students from mathematics based departments that might provide clues about the claim that exposure to study mathematics more than any other disciplines could yield to the development of mathematical thinking and reasoning abilities in general (Inglis & Simpson, 2008).

Moreover, prospective teachers subject to this study are candidates for educating tomorrows individuals' therefore potential knowledge on their abilities on the declared affective and demographic constructs could also provide clues to education policy makers and curriculum developers. It was also stated that preservice teachers tend to perfom poorly on tests requiring mathematical thinking and reasoning and they usually avoid taking mathematics courses (Leung, 2001). In this respect, this study could give clues about the condition of prospective teachers.

One focus of this study is to clarify the interrelations among aforementioned factors and students' competency on mathematical thinking and reasoning. As these factors are believed to affect mathematics achievement one by one, little is known about their connections with mathematical thinking and reasoning all together. In general, these factors were examined independently and few studies have made an attempt to investigate some of these variables simultaneously and their causal effects on each other.

These complex relationships could only be identified and inspected by using structural equation models (SEM). SEM could give a comprehensible overall picture of how all these constructs are connected to each other and their contribution to students' competency in mathematics. It could be used as a method to reveal the factors that support or lessen students' success in mathematics and could provide clues to the instructors to alter their instructional practices to best fit to the needs of their students.

In addition, structural modeling technique was also employed to test the invariance of factor structure across groups. This method of investigation is informative in a way to provide insight about the similarities and the differences across different groups. Also, this study is an attempt to explore any occurring regional based differences and similarities among students from Ankara and Northern Cyprus regions. No studies were found to grant such information in the literature. The researcher's personal and profession related connections to these two regions made it possible to investigate the regional based differences with respect to the formerly mentioned factors. These two regions might give clue about some emerging cultural differences among regions.

Furthermore, this study could supplement valuable information in the area of gender, grade level related differences in terms of affective factors and mathematical thinking and reasoning abilities of students and prospective teachers. This research not only pinpoints any possible particular grade level impact at which students' mathematical thinking and reasoning and their approaches to studying/learning may differ, but also has attempts to identify differences with respect to gender whether to see if there exists any gap between male and female students regarding the constructs of this study.

CHAPTER 2

LITERATURE REVIEW

This chapter is an overview of the relevant literature in the following areas: (1) mathematical thinking and reasoning (MTR) as contributors of mathematics achievement and its relation to problem solving strategies (PSS); (2) studies on affective (self-efficacy and approaches to learning/studying), demographic (gender, region and grade level) factors and mathematics achievement.

2.1 MTR in Math. Achievement and in Problem Solving Strategies

Research on students' achievement in mathematics has received considerable attention for many decades. Some studies try to clarify reasons behind the poor mathematics performance of students in international assessments like Programme for International Student Assessment [PISA], Third International Mathematics and Science Study [TIMSS] and National Assessment of Educational Progress at United States of America [NAEP] (Harel&Sowder,2007, pp.24-25; Güzel,2003; Güzel&Berberoğlu,2005; Papanastasiou, 2000a, 200b; Patterson et.al., 2003). While, other studies focussed on exploring key components of learning and doing mathematics (Edwards et. al., 2005; Leung, 2001; Rasmussen et. al., 2005; Schoenfeld, 1992; Selden&Selden, 2005; Tall,1991). In the latter case, mathematical thinking and reasoning skills serve as an essential component, in the construction of new mathematical knowledge and hence fostering successful engagement with mathematics learning.

Yet, researchers have agreed neither on the meaning of mathematical thinking nor in the underlying components that it involves. One framework pertaining to this study is, to define mathematical thinking in terms of its defining features which is known as prototypical framework (Rosch, 1973, 1978 as cited in Strenberg, 1996, p. 304). According to Sternberg (1996, pp. 305-333) this framework includes, psychometric, computational, cultural, pedagogical, and mathematical approaches.

The key components stated in the secondary mathematics education curricula of Turkish National Ministry of Education, involve; discovery, logically relating ideas and expressing ideas, predicting intutivley the relationships among facts and procedures and employing this to problem solving. It includes recognizing, establishing, expressing, classifiying, generalizing and linking it to real life situations and hence inferring to conclusions linking between mathematical procedures, concepts and conceptual structures (NME, 2005, p. 14). In addition, reasoning involves being able to infer logically, using mathematical models, rules and relations when expressing own's thoughts, defending the solution methods and the conclusions regarding a problem, when analyzing mathematical situations being able to use relations, self believing that mathematics is logical and meaningful subject, being able to predict (NME, 2005, p.17). It is the ability to observe and make conjectures, making logical deductions based on specific assumptions and rules, and justifying results (TIMSS, 2003).

In order to develop high level of mathematical thinking and reasoning students should be exposed to opportunities in the classrooms and genuine problem situations should be put forward to tackle with such situations by applying necessary problem solving strategies (Fennema et al., 1996; Henningsen&Stein, 1997). Tall(1991) also contented in a similar manner that moving from fundamental mathematical thinking to more advanced level involves a transition, where at first students approach concepts intuitively based on their experiences and later on they learn to use formal definitions and where their thinking is reconstrued through logical inferencing.

The overlapping defining characteristics of mathematical thinking and reasoning require; the ability to infer logically, being able to obtain mathematical representations, particularly in everday life situations that trigger creativity, applying adequate computational skills to the problem situations that require quantitative reasoning. Sternberg (1996, p. 313) stated that creative mathematical thinking is essential for advancement in mathematics and he commented on the prospective mathematicians that as they advance in their education they acquire better analytical reasoning while having poor creative thinking skills. Other researchers also emphasized the importance of logical inferencing (Durand-Guerrier, 2003; Epp, 2003; Inglis&Simpson, 2004).

Mathematical thinking and reasoning are deeply interconnected along with affective constructs such as approaches to learning in a way that students' approaches to learning have impact on their mathematical thinking. On the other hand, it was stated that little is known about the interaction of mathematical thinking and the affective constructs (Evans, 2000, p.4).

Students' mathematical thinking and reasoning and problem solving abilities are also intertwined with each other in a way that improving one aspect also enchances the other (Evans, 2000). Problem solving requires such way of thinking mathematically when one needs the basic knowledge of mathematics to solve problems (NCTM, 1991; NME, 2005, p. 14). It involves the development of a mathematical point of view; appreciating the process of mathematization and abstraction and having the tendency to apply them; and the development of competence with the tools of the trade, and using those tools in the service of the goal of understanding structure" (Schoenfeld, 1992, p. 335).

In order to improve mathematics achievement, problem solving approaches of students should be taken into account. When students encounter with rountine or traditional problems that require applying basic facts and procedures carrying out basic computational skills they usually accomplish it well, but when it comes applying those skills to authentic or real world mathematical problems it seems that only few of them are successful. This implies that mathematical problem solving performance of the students who posses those skills do not always comply with their performance at non- traditional mathematical problems. In that respect, being aware of the steps of the problem solving behaviors could shed light to enchancing students' engagement with problems more conscientiously so that they could be able to explain what they prefer and why they do it that constitutes the main steps of problem solving approach.

Schoenfeld (1992) developed a model for studying problem solving approaches of college students. He observed that students focus superficially on the mathematical concepts. When they are asked to reflect upon their own thoughts and self-monitor their strategies, their behavior approach to those of experienced students. He also identified instructive differences among novice and experienced student approaches when solving a mathematical problem. It was found out that, novice students usually stick to and apply the first idea that came to their mind and approach problem using this idea while experienced ones try alternate approaches and if they are not successful they change their strategy. In addition, it was noted that novice students give up easily and they are not cautious about jumping to conclusions whereas experienced students spent much time on organizing of their solutions.He remarked that when students are aware of what they are doing, why they are doing it, and how they are doing, improve their capability of solving problems efficiently. Hence, helping students to improve their mathematical thinking and reasoning passes from to recognizing the processes they exhibit when engaged in problem solving (Schoenfeld, 1992).

It was stated at NAEP report dated in 1986 that, students tend to perform higher on the basic computational skills than on higher order skills in problem solving in mathematics. Reason for that result could only be understood by clarifying how students build their approach when problem solving and how they justify their conclusions. Identfying problem solving strategies of students is curical in this respect.

2.2 Affective, Demographic Factors and Mathematics Achievement

As a recommended research trend in mathematical thinking studies Sternberg (1996, p. 304) emphasized the importance of investigating how affective constructs i.e. self-efficacy influence the abilities of students in mathematics as well. Among the affective constructs in relation to mathematics achievement, two key categories relevant to this study are; approaches to learning and self-efficacy that brought attention to the fact that the both factors are considered as extremely essential for achievement in mathematics.

These affective constructs derived from frameworks that thus far discussed under cognitivist, behavioral, constructivist and humanistic-motivational perspectives. The learning approach theory that is subject to this study comes from the motivationally oriented paradigm. Approaches to learning as a theory has been stated to integrate many factors in a comprehensive manner that could be used as an effective framework to analyze the relationship among affective along together cognitive constructs (Bessant, 1995)

Approach to learning has always been confused with style of learning where the distinction between these two lies in that; learning approach is the combination of both study/learning habits and motivational dispositions as stated by Biggs (1990) whereas learning styles are rather structural and represent form not the process (Kolb, 1984).

In terms of context, learning approach is relying on the context that is, student's approach may differ depending on the context whereas learning styles are said to be invariant regardless of the context. Besides, in the learning approach, individual characteristics are not exclusive to the process; however, student's engagement with the learning situation that determines and shapes his/her approach to learning (Entwistle & Ramsden, 1983).

The pioneer contributors of students' approaches to learning and studying are Marton and Säljö (1976), Biggs (1987, 1990), Entwistle and Ramsden (1983) and Ramsden (1987, 1988, 1997). These researchers have mainly investigated the relationship between students' learning outcome and their approaches to learning and studying.

Biggs (1987) developed presage-process-product model of student learning where presage variables could be regarded as affective constructs that constitute students' learning experiences, process variables comprise of their approaches to learning and product variable could be achievement. Later on, Biggs (1987) and other researches confined their research on the process part, that includes two key components; motives and strategies where the motive is the driving force of the student during tackling with a task and students' ways of engaging with tasks constitute strategies.

These researchers have elicited two major approaches to learning/studying namely; deep and surface approach methods at academic settings. These two distinctive approaches were observed in reading tasks by Marton and Säljö (1976), and approaches to studying was examined and was extended to lifetime practices by Biggs (1999) and they were also investigated at the undergraduate level (Entwistle and Ramsden, 1983; Prosser & Trigwell, 1999).

The deep approach is associated with comprehension of underlying meaning and surface approach is related to reproducing superficial facts and concepts mainly based on rote memorization, in the general sense, it yields to studying just for the sake of avoiding failure, instead of grasping meaning and understanding the relation to other information and how that information could be employed to other situations.

According to Ramsden (1997) deep approach is linked with three other factors; relating and distinguishing evidence (using evidence), relating former knowledge to new ones (relating knowledge) and emphasizing internally acquired eagerness in learning (intrinsic motivation) that the entire group was named as meaning orientation (Entwistle and Ramsden,1983, pp.193).

Whilst, surface approach is associated with the other three factors; preference for well-organized tasks (depending heavily on syllabus and staff), displaying anxiety at academic endeavours(fear for failure), tendency to focus on unrelated parts of a task(improvidence) that was named as reproducing orientation as a whole group of attributes (Entwistle and Ramsden,1983, pp.193; Entwistle & Tait,1994).

Apart from these two approaches, there exists a third approach known as achieving/strategic approach which is defined as the combination of three sub-factors; being aware of the demands of the staff about the task and act accordingly (strategic), acquiring qualifications are the main motive for learning (extrinsic motivation), being competent and success oriented (achievement motivation) (Biggs, 1987; Ramsden, 1997; Prosser & Trigwell, 1999).

Moreover, Ramsden (1997) gathered negative attributes about students' approach to learning under the non-academic based orientation dimension involving yet other three factors as; disorganized study habits (inefficient and irregular time organization during working), lack of interest and minimum involvement to work (negative attitudes towards studying) and concluding without evidence (globetrotting). However, later on these factors were eliminated by the researchers because of the inefficiency in their measurement.

The aforementioned learning approaches were researched through two main instruments; the Study Process Questionnaire (Biggs, 1987) and Approaches to Learning questionnaire (Entwistle et al., 1979). From these studies, the Approaches to Study Inventories began to evolve Entwistle (1981). Later on, the studies have focussed on refining scales to produce distinct and elaborate sub-dimensions. Mainly, meaning, reproducing, and achieving orientations were included, to investigate undergraduate students' approaches to learning (Entwistle & Ramsden, 1983).

Some researchers conducted interdisciplinary and cross-cultural studies by using the Approaches to Studying Inventory (ASI). Among these studies, Berberoğlu and Hei (2003) employed adopted Turkish and Chinese translated versions of ASI to a convenience sampling of university students in Turkey (*N=464*) and in Taiwan (*N=546*) from various departments; social and natural sciences, engineering, literature and arts. Results indicated that Turkish students have reported higher scores than Taiwanese students in the sub scales regardless of the approach used. There was no significant difference among the two cultures in terms of meaning and reproducing orientation subcomponents however, Turkish students seem to favor meaning orientation subcomponents more often than Taiwanese students. Besides, Turkish students tend to use surface approach methods, syllabus-boundness and fear of failure more frequently as compared to their counterparts. In addition, when the gender is considered there exist no interactions of gender groups across two cultures in reproducing and strategic orientation. In the strategic orientation dimension, Turkish students prefer extrinsic and achievement motivation more often than Taiwanese peers. Males were found to be more strategic-oriented than females. Moreoever, Taiwanese female students were less meaning oriented than Taiwanese males. On the other hand, no difference was detected for the Turkish students.

Hei (1999) in her dissertation investigated the factors related to approaches to learning and their similarities and differences among 465 Turkish and 549 Taiwanese university students across different disciplines. Results indicated that Taiwanese female students were more syllabi bounded and less achievement oriented than Taiwanese male students. Both Turkish and Taiwanese females have fear of failure than males. Taiwanese students prefer memorization strategies prior to deep approach but have reported that they have more tight schedules than Turkish students.

In terms of learning outcomes, meaning orientation involving deep approach method is said to be linked with higher quality of learning outcomes hence requiring engagement with higher cognitive skills whereas reproducing orientation including surface approach method is related to employing low level cognitive processes (Biggs, 1987, Entwistle, 1982; Marton and Säljö, 1997; Ramsden, 1992). Moreover, there exist positive relationships among students' approaches to learning ad achievement in exams (Entwistle&Tait, 1994, Trigwell and Prosser, 1991). However, in Hei (1999)'s study no significant relationship was observed between the university entrance scores and the approaches to studying of students across Taiwan and Turkey. Yet, Turkish students who obtained high scores at the exam do not necessarily use deep approach methods and seem to use memorization strategy less than other students.

These learning approaches as was mentioned previously are not attributes of individual learners. A learner may adopt any of these approaches at different occasions. The deep and surface approaches are distinct whereas from time to time achieving approach could be associated by one or the other. This may be due to their close connection with types of motivation. For instance, the deep approach is correlated with intrinsic motivation and the surface approach with extrinsic motivation while the achievement motivation is linked to strategic approach. Nevertheless, either approach can be adopted by a student with either type of motivation. However, it was observed that high achieving students tend to exhibit combination of achievement and deep approach methods together (Biggs, 1987). Also students who develop a strategy in effective use of academic resources to obtain good marks may display a combination of achievement and surface approach methods together.

Self-efficacy is defined by Bandura (1986) as the conviction in one's ability to successfully organize and execute courses of action to meet desired outcomes and it is regarded as one of the strong predictors of mathematics achievement (Pajares, 1996). It stands for a student's sense of ability to plan and execute actions to achieve an academic goal and also represents students' confidence in their cognitive and learning skills in performing a task and (Bandura A. , 1997).
Four defining elements of self-efficacy are; one's performance in prior similar tasks, one's learning explicit by others, one's receiving praise from others, and one's emotional reaction to tasks (Bandura A. , 1997).

Studies reported that senior prospective mathematics teacher students have higher self-efficacy scores as compared to junior elementary mathematics pre sevice teachers (Işıksal & Çakıroğlu, 2006). They argued that senior students are more experienced than freshmen students that could explain this difference. This finding is also in line with Umay (2001)'s work with 127 elementary pre service mathematics teacher students.

It was pointed out that there was a positive relationship among self-efficacy and academic achievement that is; the higher self-efficacy beliefs of students the better they perform at academic settings (Schunk & Zimmerman, 1994).

Third International Mathematics and Science Study (TIMSS) findings also in coherent with the literature, indicating self- efficacy's strong positive impact on mathematics achievement along with other student, teacher, and school related constructs as well (Papanastasiou C. , 2000).

Students with high self-efficacy beliefs were reported not give up easily when encountered with challenging problems (Bandura & Schunk, 1981).

Although its relation to academic achievement, it worths mentioning due to it relevance to affective variables involved in the study and hence their influence on academic achievement, a structural modeling study was carried out by Drew and Watkins (1998) who investigated the interrelationships of affective variables (locus of control, academic self-concept), learning approaches and academic achievement outcomes with 162 first year university students in Hong Kong. Findings pertaining to this study revealed that, surface approach has a negative direct moderate effect on academic achievement whereas deep approaches to studying showed positive moderate direct effect on academic achievement.

Leung and Man (2005) investigated with structural modeling the relationship of 410 preservice teachers' affective traits (mathematics teaching self-efficacy; mathematics self-concept; teaching attitudes towards mathematics, mathematics beliefs) and their impacts on mathematics achievement at Hong Kong. Their model based on the three stage model of Biggs (1987). The results show that mathematics teaching self-efficacy acts as the mediator of affective characteristics, learning approaches and mathematics achievement. The findings indicate that mathematics teaching self-efficacy directly influences achievement, as there is also a direct path of strength 0.33 linking mathematics teaching self-efficacy and mathematics achievement. However, mathematics teaching self-efficacy indirectly influences achievement through deep approach and surface approach to learning because mathematics teaching self-efficacy put forward a positive strong impact(0.60) on deep approach and positive moderate(0.26) impact on surface approach to learning. It could be concluded that pre-service teachers' mathematics teaching self-efficacy influences their both approach to learning and the higher the efficacy they held, they are more likely to prefer deep approach method.

Gonske (2002) in her phenomenographical dissertation examined the relationships among five components of mathematics anxiety, six beliefs about the nature and the learning of mathematics, and three learning approaches of 129 non-traditional (age 25 and over) students that were enrolled to elementary algebra, intermediate algebra, college algebra, trigonometry, and introductory statistics courses at three community colleges. Adopting surface approach methods was found to be a significant contributor to mathematics anxiety and hence impedes mathematics achievement. Also it was noted that memorizing was found to be defining feature for surface approach and deep approach is characterized by understanding. Apparently, participant students use memorization as a strategy to attain deeper understanding.

Baker (2004) investigated the mathematical skills in the contex of problem solving and its relationship to math anxiety, and approach to learning (surface, deep, strategic) 27 undergraduate preservice teacher education students that were enrolled to elementary mathematics methods class. The common approach that preservice students use was the strategic approach, at pre and post course. In the end, deep-associative approach replaces the surface-disintegrated approach for second place. This implies a growth in these preservice teacher education students as mathematicians and problem solvers since the surface approach to learning has negative association and the deep approach is a much more positive and deeply intrinsic approach to learning. Positive correlations were found between both among the strategic study and deep-associative study approaches and problem solving. There exist no relation between surface-disintegrated study approach and problem solving.

Some researchers have attempts to develop structural models to explain the mathematics achievement of students along with affective factors as self-efficacy. In this respect, Mousoulides and Philippou (2005) examine the relationships between motivational beliefs such as self-efficacy, self regulation strategies use, and mathematics achievement in 194 Cypriot pre-service teachers. The study revealed that self-efficacy being a strong positive effect on mathematics achievement while self-regulation strategies use having negative moderate effect on achievement.

Another modeling study, Pimta et. al. (2009) investigated factors (concentration, attitude towards mathematics, achievement motive, self-esteem and teacher’s behaviors, self-efficacy) influencing mathematical problem-solving ability of 1028, sixth grade students in Thailand. It was found out that self-efficacy took positive indirect effect on the mathematical problem solving of students by through achievement motive, attitude and concentration.

Few studies from the literature have showed the the impact of grade level of students on their study/learning approaches.These studies indicate that as students get older they tend to use deep and achieving approaches and appear to use surface approach methods less often (Zeegers, 1999, 2001). Zeegers (1999) indicated that students who adopt surface approach method in their earlier grade levels may still preserve the same approach to learning.

Besides, gender differences do exist in mathematics performance usually favoring males where these differences are mrore apparent at high school and university levels. Royer et al. (1999) found that male students outperformed females on standardized mathematics achievement tests in which he claimed that male students might be more prone to grasping mathematical facts and procedures easily on the other hand females are more competent in verbal processing tasks.

Cole (1997) reported on a longitudinal study on elementary and high school females' success on basic computational mathematical items in standardized tests whereas males prevailing competency on mathematical conceptual questions that require higher order thinking skills. One contradictory result came from Pajares (1996) that examined the self-efficacy of gifted students and its relation to mathematical performance particularly to problem solving. The study revealed that females outscored males in problem solving while no difference in self-efficacy of both male and female students.

In another study, Işıksal and Aşkar (2003) investigated gender differences in mathematics and computer self-efficacy 123 seventh and eigth grade elementary students. They found out no significant mean difference among males and females with respect to their mathematics self-efficacy.

Gender differences also exist concerning the approaches to learning. The deep approaches to learning was more frequently preferred by males whereas females showed more often a surface or reproducing approach to learning (Severiens & Ten Dam,1994 as cited in Berberoğlu& Hei,2003).

Some studies examined the similarities of the factor structure mainly across different cultures (Berberoğlu& Hei, 2003; Güzel& Berberoğlu, 2005) and across different groups such as gender, school types and years (Arıkan, 2010). Güzel and Berberoğlu (2005) using PISA 2000 data have developed and tested a model for Brazilian, Japanese and Norwegian students with the factors attitudes towards reading, student-teacher relations, classroom climate, communication with parents, use of technology, attitudes towards mathematics, and reading literacy whereas Berberoğlu and Hei (2003) explored the similarities and differences across Turkish and Taiwanese university students with respect to approaches to learning dimensions. In addition, Arıkan (2010) have inspected and proposed three-factor model for mathematics subtest for national student selection test regarding mathematical thinking skills on the invariance of the factors across gender, school types and years. In that respect, identifying regional based similarities and differences across different groups could provide a unique opportunity for comparing and contrasting results and gaining insight about different groups at once.

2.3 Summary of the Literature Review

Mathematics achievement in particular, how to improve mathematics performance has at all times been the central attraction for researchers, educators and policy makers. However, any kind of improvement could be possible by gaining deeper understanding of the subcomponents that are crucial in the enhancement of mathematics achievement.

Among many of the attributes, one key component is to learn how to think and reason mathematically. However, the process of learning on how to think and reason mathematically is still considered as a great debate in which many researchers have up to date contributions on this crucial matter (Sternberg, 1996; Tall, 1991). The international and nationwide mathematics curricula and assesments persistently emphasize the importance of fostering mathematical thinking and reasoning skills. Despite the debate that what constitutes mathematical thinking, the overlapping defining components such in which the researchers have consensus are subject to this study. It was indicated that students' approach to a problem is also a determining feature and key to success in solving problems (Lee, 1999; Schoenfeld, 1992).

Yet, it is not sufficient to discuss and investigate this issue as a stand-alone practice due to the existence of considerable amount of other contributing factors to mathematics achievement. Among these, one of which could be considered as approaches to learning though that were usually inspected in isolated manner. Some studies have mainly focused on deep and surface approach methods that are distinct from each other (Baker, 2004; Drew&Watkins, 1998; Gonske, 2002; Leung, 2001, Leung&Man, 2005). There exist also studies including a third approach along with the former two which is called strategic or achieving approach (Ramsden, 1997). Findings of these studies have generally agreed upon positive influence of deep approach on achievement in both academic settings specifically in mathematics and negative impact of surface approach on achievement. It was observed additionally that even high achieving students could from time to time display the combination of surface and achieving approaches together although the meaning oriented learning approaches including deep approach is often associated with higher learning outcomes and high achievement. Yet, these learning approaches are context dependent and could be to some extent stable with respect to age (Zeegers, 2001).

In addition, approaches to learning also includes non academic oriented dimension as well and it is quite commonly observed in the Turkish culture to use habitually disorganized study methods that may result due to heavy course-work load, inefficient use of time and the teaching merely based on rote memorization approaches that might be influential in true attainment of mathematical thinking and reasoning.

Apart from all these attributes, significant amount of studies have found out that self-efficacy plays an important role in the prediction of success in mathematics and it is important in the enhancement of mathematics achievement (Bandura, 1986; Pajares, 1996, 1997). As the strong predictor of success self-efficacy in mathematics it was remarked that it should be investigated in particular relation to mathematical abilities of students (Sternberg, 1996). Studies with pre-service mathematics teachers revealed that as students get older they gain more experienced and as result they become more confident in their own abilities (Umay, 2001; Pajares, 1996)

However, yet to date no study was encountered in the literature that tried to clarify the relationships among these factors and their possible contribution to the mathematical thinking and reasoning competency of undergraduate students.

Moreover, in the literature there exist studies on gender related differences in mathematics success (Berberoğlu& Hei, 2009; Cole, 1997; Royer et. al., 1999; Schunk& Pajares, 2001) and grade level related differences (Zeegers, 1999, 2001) and cross-cultural studies was found to investigate these aforementioned differences based on culture(Berberoğlu& Hei, 2009). This study also makes a valuable contribution to the existing literature on the exploration of regional, gender and grade lvel related differences on the previously mentioned affective factors and mathematical thinking and reasoning competency.

CHAPTER 3

METHODOLOGY

This part presents the design of the study, population, sample, development and validation of the scales, the validity and reliability issues, procedures for collecting data and analysis of data, handling missing data and outliers.

3.1 Research Design

There are three major aims of this study: (1) to explore the factors and their relationships perceived by undergraduate students regarding their approaches to studying, self-efficacy and problem solving strategies, mathematical thinking and reasoning competency; (2) to reveal potential regional based similarities and differences of the factors regarding approaches to studying, self-efficacy, problem solving strategies and competency in mathematical thinking and reasoning of undergraduate students from Ankara and Northern Cyprus regions; (3) to investigate any regional, gender and grade level based differences attributed to approaches to studying, self-efficacy and problem solving strategies, competency in mathematical thinking and reasoning of undergraduate students.

The correlational and causal comparative research designs as mentioned in Fraenkel and Wallen (2003) fulfill all three purposes of this study. The data was collected in a cross-sectional manner that is; the scales used in this study were administered to the participants at once. The quantitative data obtained were analyzed through SEM, two-way MANOVA and three-way ANOVA statistical techniques.

3.2 Population and Sample

The target population of the study was undergraduate students from elementary, secondary mathematics education, early childhood and classroom teacher education, mathematics departments that were enrolled to 2010 spring and summer semesters in Ankara and in Northern Cyprus. The accessible population was 431 undergraduate students from these departments that were enrolled to 2010 spring and summer semesters in Ankara and in Northern Cyprus regions. As declared by the former director of Atatürk Teacher Training Academy at Northern Cyprus, the total number of enrolled students was 310 at the time of administration of this study. In addition, the Table 1 below shows the annual number of students accepted to the departments subject to this study that was retrieved from the website of the Central Placement Center of Turkey.

Table 1 Annual Capacities of Participating Departments

Institution	Department	Capacity
METU	Mathematics	75
Gazi University	Mathematics	60
Gazi University	SecondaryMathEduc.	60
Hacettepe University	SecondaryMathEduc.	95
Hacettepe University	Mathematics	95
Near East University	Mathematics	60
Eastern Mediterranean Uni.	Elementary Math. Educ.	102

The rationale for conducting this study with undergraduate students is that; participants most likely come from almost every region of Ankara and Northern Cyprus with various educational experiences and knowledge. Hence conducting this study at undergraduate level constitutes more diverse sample representing various regions of Turkey and Northern Cyprus. Besides, this research focused partly on students from mathematics based departments that might provide clues about the claim that exposure to study mathematics more than any other disciplines could yield to the development of mathematical thinking and reasoning abilities in general (Inglis & Simpson, 2008). Moreover, prospective teachers subject to this study are candidates for educating tomorrows individuals' therefore potential knowledge on their abilities on the declared affective and demographic constructs could also provide clues to education policy makers and curriculum developers.

This study was administered to undergraduate mathematics, early childhood and classroom teacher education, elementary and secondary mathematics education students at all grade levels in Ankara and in Northern Cyprus regions during the spring and summer semesters of 2010. The analysis in the present study was based on data collected from 431 students. The major characteristics of the sample were documented in the Table 2:

Table 2 Major Characteristics of Participant Students

University	Frequency	Percentage (%)
Gazi University	66	15.3
Hacettepe University	106	24.6
Eastern Mediterranean University	56	13.0
Atatürk Teacher Training Academy	139	32.3
Middle East Technical University	59	13.7
Near East University	5	1.2
Total	431	100.0
Department		
Mathematics	180	41.8
Elementary Mathematics Education	56	13.0
Secondary Mathematics Education	57	13.2
Classroom Teacher Education	76	17.6
Early Childhood Education	62	14.4
Total	431	100.0
Grade Level		
1	86	20.0
2	115	26.7
3	109	25.3
4	111	25.8
5	8	1.9
Total	429	99.5
Missing	2	0.5
Total	431	100.0

Table 2 (continued)

Gender	Frequency	Percentage (%)
Male	148	34.3
Female	281	65.2
Total	429	99.5
Missing	2	0.5
Total	431	100.0
CGPA(out of 4.00)		
0.70-1.37	14	3.2
1.38-2.02	93	21.6
2.03-2.68	132	35.3
2.69-3.33	115	26.7
3.34-4.00	57	13.2
Total	421	97.7
Missing	20	4.6
Total	431	100.0

3.3 Instruments

Two main scales were used for data collection; the adopted version of the survey on students' approaches to studying/learning which was developed by and Ramsden and Entwistle (1981) with additional items on demographic profile, with self-efficacy in mathematics and problem solving strategies and the test on mathematical thinking and reasoning competency that was developed by the researcher. The medium of instruction at participant universities and at Atatürk teacher training academy is in Turkish and in English. Both scales were administered in Turkish.

3.2.1 The Survey

The original version of the adopted Approaches to Studying Inventory subject to this study was designed particularly for undergraduate students (Ramsden & Entwistle, 1981). The Turkish version of this inventory was already available and was used by Hei (1999) in researcher's dissertation. The initial inventory consisted of 64 items on five-point Likert scales. Only the items related to deep (Q1-Q4) and surface (Q17-Q22) approaches, relating ideas (Q5-Q8), use of evidence (Q9-Q12), intrinsic motivation (Q13-Q16), syllabus-boundness (Q23-Q25), fear of failure (Q26-Q28), extrinsic motivation (Q29-Q32), disorganized study methods (Q33-Q36), achievement motivation (Q37-Q39) were adapted from the Approaches to Studying Inventory (ASI).

Furthermore, additional information about students' background characteristics was also gathered by supplementary items. Also, mathematics self-efficacy items (Q40-Q43) were adapted from Umay (2001) and problem solving strategies items (Q44-Q51) was adopted from Lee (1999). The original Approaches to Studying Inventory consisted of 16 subscales and 64 items however, only 10 subscales and 41 items were adopted and were translated into Turkish by the researcher and was later on checked by her supervisor for suitability in terms of format, content and language. The final version of the survey included 65 items in total; 14 of which are related to the demographic profile and 51 items are based on Likert type, 5 point scale ranging from *strongly disagree* (1) to *strongly agree* (5). The adopted survey was given in the Appendix B and the table of specifications was given at the Appendix E.

For convenience, the survey was primarily pilot tested by 162 volunteered students who were enrolled to Introduction to Information Technologies and its Applications (IS100) course at Middle East Technical University [METU] at 2010 spring semester. The Cronbach's alpha reliability of the piloted survey for the total of 162 students is 0.851. The stem of the demographic item related to home possessions were modified after the pilot testing.

3.3.1 The MTRC Test

The second scale was designed to measure students' competency in mathematical thinking and reasoning in Turkish. The scale is an ability test that was designed to measure the competency of undergraduate students in a set of thinking processes that were situated in real life problems. The steps for designing such a test were explained in detail in the subsequent paragraphs.

The items were developed by taking into acount the overlapping and defining features that are considered to be essential elements of mathematical thinking and reasoning in the existing literature. The nature of the items should require to be situated in real life context to trigger mathematical thinking and reasoning skills and were emphasized by the mathematics literacy and mathematics cognitive domain frameworks of PISA 2003, TIMSS 2003, NAEP, 2009 and by Epp (2003). Also, some studies addressed the significance of representations, expressing and extracting given situation mathematically (Selden&Selden, 2005, p. 2). In addition, the importance of logical inferencing that is evaluating conditional statements within the given context was addressed in various studies (Durand-Guerrier, 2003; Epp, 2003; Evans, 2000, p.10; Inglis&Simpson, 2004, 2008). Moreover, employing analytical, quantitative and logico-deductive reasoning skills are persistently addressed in the frameworks of these international mathematics assessments.

The scope of the mathematical thinking and reasoning test was delimited to aforesaid specifications. In the developmental phase of the items various textbooks and corresponding sources from the literature were consulted. Items that were developed by the researcher are; 1, 4, 5, 8, 14, 21 and 23(see Appendix A). The complete set of items in the question 9 were taken from Durand-Guerrier (2003), the item 10 is known as Wason selection task (Wason, 1968), the item 20 was adapted from PISA 2006 Mathematics example 21 and the rest of the items were adapted from the book on mathematical thinking (D'Angelo & West, 2000). A pool of 36 questions in the multiple choice format was designed with respect to the framework. The multiple choice format was preferred due to the time constraint in administering the test and the survey together.

The table of specifications of the test was provided in the Appendix C. Participants were asked to choose the correct response from the available options and answers were scored as 1 for correct and 0 for incorrect responses.

The draft of the final version of the test with the table of specifications and the checklist for face and content validity were given (see Appendices A, C, F) to a fellow research assistant at Secondary Science and Mathematics

Education department and was asked to match the items with the given cognitive processes. In the same manner, the test was also shown to a Mathematics Professor from the department of Mathematics, METU and ambiguous items and or thinking processes were modified accordingly. For the content validity, items were designed so that no specific mathematical knowledge is required. All participants could understand and work on these items without having any particular expertise on the subject matter. The final version of the test was given in the Appendix A.

The final version of the test included 26 multiple choice items which 20 items have 5 options and 6 set of items have only 3 options where only one option is correct for each item.

For convenience, the test was pilot tested to a group of students of METU who were registered to the Introduction to Information Technologies and its Applications (IS100) for the 2010 spring term. Students were mainly first year undergraduate students from various departments. The pilot version of the test was administered to total of 56 students. The two parallel versions of the mathematical thinking and reasoning tests were administered at the piloting stage. The Cronbach's Alpha reliability for the test of the pilot 1 of 23 students is 0.878 and for the pilot 2 the reliability for 23 students is 0.668. Items 12, 17, 20 and 21 were revised in terms of options and stem. Items 22 and 23 were only included pilot testing phase of the test and were excluded from the final version of the test (see Appendix D).

3.4.1 The Content-Construct Related Validity and Reliability

After the necessary modifications were made, according to the results of the pilot testing, the final versions of the survey and the test were administered to 431 undergraduate students. The data of the test were coded as 1 for correct and 0 for incorrect responses and the survey data were coded from 1 to 5 depending on the response of the students.

By using listwise deletion method, the reliability of the test for total of 26 items before the missing values were imputed by 0 is 0.775 and after imputing the missing values with 0 for 26 items, the Cronbach's alpha reliability is 0.762.

Replacing missing data with zero indicates the absence of the correct response and is a common imputation method that is used in educational achievement tests.

After outlier and factor analyses only 18 items were retained. The detail analyses were given in the subsequent chapter. The Cronbach's alpha reliability for 18 items is 0.765. The reliability for the survey of 51 questions before substituting missing values with mean is 0.874 and after replacement is 0.864. After outlier and factor analysis only 33 items were included in the tested structural models for the survey. Therefore Cronbach's alpha reliability of 33items is 0.871.

In general, a Cronbach's alpha in the range of .70 to .79 is considered as adequate, a value in the range of .80 to .89 is considered good (Cohen, 1988). Therefore, the test and the survey yielded satisfactory internal consistencies to carry out further analyses.

The content related evidence was maintained by translating the adopted survey in Turkish into English and any differences between the original inventory in English and the translated version were noted in terms of wording by an expert who has been doing professional, technical translations as profession. In addition, the test's content and coverage were examined by a fellow PhD student and a professor of Mathematics in terms of face and content validity. Suggestions were noted and required revisions were made.

The construct related validity evidences of both test and the survey were maintained by the exploratory factor analyses. The results of the factor analyses were presented in the Chapter 4.

3.4 Procedures

In the first phase of this study, a comprehensive review of the literature such as journal articles, relevant theses and dissertations, books on the subject were investigated and gathered by the researcher by using the keywords mentioned in the Appendix G at fall 2009 semester.

Various mathematics and problem solving frameworks were inspected for the development of the mathematical thinking and reasoning competency test such as TIMMS, PISA and NAEP assessments. Overlapping and defining features were also noted from the mathematics curricula of MNE and NCTM and relevant studies. Test specification was derived from the integration and combination of these frameworks. 36 test items were developed and only 26 of them were included in the final version of the test with respect to the test specification and pilot study outcomes.

Relevant factors that are related to students' competency were taken into consideration for the test. In addition, relevant subscales from the Approaches to Studying Inventory were adopted. Additionally, items referring to students' demographic profile, mathematics self-efficacy and problem solving strategies were also adopted and included in the survey. The developmental phase of the test and the survey lasted from December 2009 of the fall semester till the spring semester March 2010.

After necessary consent permissions granted, instruments were then pilot tested to volunteered undergraduate students of IS100 course of the spring 2010 semester at Middle East Technical University. The survey and questionnaire were administered together to students during class hours. 14 items of demographic profile and 51 Likert type items, a total of 64 items were included in the survey and, 27 items in total were included in the pilot 1 test.

After and revising the test and survey items according to the results of the pilot study and obtaining required permissions from the faculties, the study was conducted to undergraduate students stated universities in Northern Cyprus and at Atatürk Teacher Training Academy in May, spring semester 2010 and to the stated universities of Ankara region in the summer semester 2010. Instructors and assistants were advised to administer the survey and the test during the class hour. The survey and test booklets were numbered in pairs so that even they were given one at each class session, the scales could be recognized and paired by the researcher to make sure that they were filled in by the same student. The 30-45 minutes were sufficient to complete the scales.

After the data were collected numerous exploratory factor analyses were conducted to identify the dimensions of the survey and the test. Depending on the literature and the outcomes of the analyses factors for further analysis were determined. Accordingly, observed variables with high factor loadings are selected as the latent variables. Subsequently, separate confirmatory factor analyses were conducted for each instrument. When the factors were decided with the substantial support from the theoretical framework, three models were proposed and were tested by using structural equation modeling techniques. After revising the modifications, the model that best fits to the data, was used for the purpose of investigating the invariance of the factor structure across two regions. In this respect, the data was splitted into two parts with respect to regions and the model yielding the best fit was tested across these two samples. In addition, region, gender and grade level related differences concerning the dimensions of the survey and the test and the total test score were obtained by using two two-way MANOVA and three-way ANOVA analyses. The results and findings of the analyses were examined. And explanations and recommendations were presented in the final chapter.

3.5 Data Collection

The related data was collected through Turkish versions of; (1) the adopted version of Approaches to Studying Inventory (2) the competency test on mathematical thinking and reasoning. The testing was administered by the instructors and assistants of the selected universities and teacher training academy. The instructors and assistants were informed beforehand about the instructions for the administration of the scales and the directions and descriptions for students were included in the scales.

3.6 Analysis of Data

The data gathered from survey and the test on mathematical thinking and reasoning was analyzed by SPSS 17.0 program and LISREL 8.71. Firstly, the data was coded into a SPSS file. Half of the main data obtained was coded by a trained fellow PhD student and the rest of the data including the pilot study was coded by the researcher. Later on, data was scanned for potential improper data entries. For this purpose, descriptive statistics and frequency tables of the items were documented and checked out for unusual values. Randomly selected data were also examined for improper entries. Secondly, reverse recoding was applied to the survey items that have negative meaning. These items were; Q17-Q22, Q25-Q28, Q33-Q36, Q43-Q45, Q47 and Q51. The test was coded dichotomously that is; 1 and 0 for correct and incorrect responses respectively. Missing values analysis was conducted and only the missing values of the Likert type survey items were replaced by the mean of each item and the missing values of the test were imputed by zero accordingly.

The data was analyzed through several exploratory factor analyses in order to identify the factor structure of the survey and the test. After determining the factors outlier and influential data points were investigated and necessary changes were made by removing problematic items from further analyses. Separate confirmatory factor analyses were carried out for valdating non-directly observable factors that were determined as result of exploratory factor analyses. Suggested modifications were done to improve the fit of the models. Structural equation modeling techniques were next employed to test the hypotheses of the study. Maximum likelihood method was used to estimate the model parameters. The following fit indexes were considered to evaluate the extent to which the data fit the models tested. In particular, scaled chi-square, Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA) were examined to inquire about the fit of the model for CFA and SEM. Three proposed models were tested accordingly. The fit indices and the direction, magnitude of the relationships among variables were stated. The model with best fit indices was selected to test for the invariance factor structure across two splitted groups namely; Northern Cyprus (N=231) and Ankara (N=200). Fit indices and the significant relationships among latent variables were considered.

Two-way MANOVA was employed to inspect gender, grade level differences across the dimensions of the survey at SPSS v17 program. Gender and grade level are independent variables whereas the dimensions of the survey as index scores were included in the analysis as dependent variables at the significance alpha (α) level of 0.05. Bonferroni adjustment was used in the subsequent univariate tests.

Another two-way MANOVA procedure was carried out for the region and grade level differences across the subdimensions of the test where region and grade level are independent variables and the two subdimensions of the test are dependent variables.

Finally, three-way ANOVA technique was used to explore region, gender and grade level related differences on the total test score.

3.7 Missing Data Analysis

Since the statistical analyses might be impacted by the missing entries, missing value analysis was carried out to identify the percentage of missing values for every item and case.

The cases that haven't completed one of the scales completely were excluded from the statistical analyses. The missing values of the items ranges from 0% to 4.9% and for the cases it ranges from 0% to 7.4% within the acceptable range that the missing data should be less than or equal to 10% (Pallant, 2007). Therefore, missing entries of the survey items were replaced by the mean of that item and the missing values for the mathematical thinking and problem solving test were substituted by zero indicating wrong answer which is a common replacement practice for achievement tests (McKnight et. al., 2007). Missing data of the student's demographic profile section such as father and mother education level, siblings were not substituted and were not included in either of the analyses

3.8 Effect Sizes

An effect size measure shows the degree of the relationship among variables. In other words, it is an indicator of the association between two or more variables (Stevens, 2002).

For correlational studies, the squared multiple correlation coefficients (R^2) are used for indicating effect sizes. The classification for effect sizes which were measured in terms of R^2 as; R^2 = 0.01 is small, R^2 = 0.09 is medium, and R^2 = 0.25 is large effect size which was suggested by (Cohen, 1988). The classification for standardized path coefficients(R) for interpreting the effect sizes of the relationships where absolute values of the path coefficients that are less than 0.10 are considered small, 0.30 as medium and greater than 0.50 as large effect sizes.

Furthermore, for evaluating the questions regarding group comparisons eta-square is taken into account: the effect size classification for eta-square *($\eta 2$)* values less than 0.01 may indicate small, whereas values around 0.06 show medium and values 0.14 and above indicate large effect size. In the present study, standardized path coefficients(R), squared multiple correlation (R^2) and eta-square *($\eta 2$)* coefficients were taken into consideration as effect sizes (Cohen, 1988, p.2; Pallant, 2007, p. 208).

3.9 Handling Outliers, Influential Points, non-Normality

Outliers and any influential points were also identified and if essential should be eliminated completely from the study due to their biased impact on the interpretation of the results. After employing exploratory factor analyses to the survey and the test separately, outlier analyses were conducted on the predictor and outcome variables. Taking into consideration the standardized residuals on the outcome variable which is total test scores of students, outliers beyond the range of ±3 were excluded from the study to the utmost. In addition, for the normality, regarding skewness and kurtosis should be in the ranges ±2 for acceptable normality (George & Mallery, 2001). Outliers on the predictor variables was identified by using Leverage values that are beyond the range of $3p/n$ where $p = number\ of\ predictor\ variables + 1\ and\ n = sample\ size.$ On the other hand, Cook's distance is used to detect influential data pointswhere values greater than 1 are regarded as influential points (Stevens, 2002).

For detecting univariate outliers for interval and ordinal level variables of the survey that were treated as metric and the test, the items with standard scores beyond the range ±3 were investigated. In this respect, items from the test: R5, R6, R8, R9i, R9ii, R15, R20 and the items of the survey: Q3, Q5, Q8, Q9, Q10, Q11, Q15, Q23, Q24, Q46, Q50, SiblingR, StudyTime were detected as univariate outliers. For detecting multivariate outliers, Mahalanobis D^2 were calculated. The probability of Mahalanobis distance (1- CDF.CHISQ) less than 0.001 is considered to be multivariate outlier. The influential data points were detected by the values of the Cook's distance that are greater than 1. As it could be seen from the table there are no influential points detected. Outliers on the set of predictor variables is inspected by the Leverage value i.e. the values greater than 0.042 are considered as outlier. As it could be seen from the Table 3, although there exist few cases that could be considered as multivariate outliers since they are not influential cases they were included in the analyses.

Table 3 Residual Statistics

	Minimum	Maximum	Mean	Std. Deviation
Std. Residual	-2.401	2.503	0.000	0.994
Cook's Distance	0.000	0.045	0.002	0.004
Centered Leverage Value	0.000	0.090	0.012	0.011
Prob. Mahalanobis Distance	0.000	0.9991	0.5448	0.3173

For the detecting non-normality, some items that were beyond skewness and kurtosis ranges ±2 were detected (PC, Internet, StudyRoom, StudyDesk, Aidbooks, Q3, Q11, Q24, Q50, R5, R6, R8, R9i, R9ii, R15, R20).

To sum up, the retained items for the test are; R1, R2, R3, R4, R7, R9iii, R9iv, R9v, R9vi, R11, R12, R13, R14, R16, R17, R18, R19, R21 and for the survey;Q3, Q8, Q5, Q6, Q4, Q7, Q11, Q9, Q10, Q2, Q12, Q1, Q43, Q40, Q44, Q45, Q42, Q41, Q51, Q14, Q13, Q16, Q29, Q38, Q34, Q33, Q36, Q35, Q20, Q19, Q18, Q21, Q22 and all demographic related items were excluded from SEM analyses and gender, region and grade level variables were only included in the two- way MANOVA and three-way ANOVA analyses as independent variables. Exploratory factor analyses were carried out by 33 items for the survey (Cronbach's alpha (α) reliability= 0.871) and 18 items in total for the test (Cronbach's alpha (α) reliability= 0.765). The results were presented in the subsequent Chapter 4.

CHAPTER 4

RESULTS

This chapter comprises of preliminary analyses, the testing of structural equation models, two two-way MANOVA and a three-way ANOVA parts. Preliminary analyses include descriptive statistics of the scales used in the study and results of the exploratory factor and confirmatory analyses for each scale. The structural equation modeling part includes testing of three proposed models and the outcomes of these models for inspecting the relationship between aforementioned factors and mathematical thinking and reasoning competency. Afterwards the model that accounted the data best was chosen and tested across two regions. Last part is devoted to inspecting gender, grade level and region related differences across the dimensions of the survey and the test and on the total test score.

4.1 Preliminary Analyses

Exploratory factor analyses were conducted to group observed variables and to determine the factor structures of the survey and the test separately. After determining the theoretical constructs (latent variables) from the results of the exploratory factor analyses, confirmatory factor analyses were carried out for the survey and the test to confirm the latent structure and to apply necessary modifications for improving the models. From the results of the confirmatory factor analyses final set of latent variables from observed variables were chosen to include in the structural equation modeling.

4.2 Results of the Exploratory Factor Analysis of the Survey

Principal Component Analyses with Varimax rotation method were carried out by using SPSS 17.0 for Windows in order to group and reduce the number of observed variables with respect to the common shared variance. The survey initially consisted of 65 items where 14 items related to demographic profile and 51 items are of five point scale Likert type questions. After missing outlier and influential point analyses, some items mentioned in the preliminary analyses part were excluded from further analyses since they might cause inconsistent factor loadings.

After removing observed variables with ambiguous factor loadings, the final Principal Component Analysis (PCA) with only 33 observed variables yielded better results in terms of factor structure. The listwise deletion method was used to handle missing values.

Since the sample size was 431, the criterion for the sample size to be 5-10 times the number of variables was satisfied in the final version of PCA (Crocker & Algina, 1982). The Kaiser-Meyer-Olkin measure of the adequacy of the distribution values for conducting factor analysis was obtained as 0.866 is in the range between 0.80 and 0.89 which was defined as meritorious (Kaiser, 1974). In addition, Bartlett’s test of Sphericity value (0.000) is significant ($p<0.05$) which shows that the distribution is multivariate normal and the correlation matrix is not an identity matrix (George & Mallery, 2001). The KMO and Bartlett’s Test of Sphericity values were depicted in the Table 4:

Table 4 KMO and Barlett’s Test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.866
Bartlett's Test of Sphericity	Approx. Chi-Square	4720.825
	df	528
	Sig.	0.000

The factor analysis was conducted with the restriction of the number of factors to 5. To determine the number of factors to extract in the final solution is Cattell's scree plot of eigenvalues was consulted. The scree plot indicated 5 factors to retain. The total variance explained by 5 factors with 33 observed variables is 48.516%. The rotated factor loadings of the observed variables for the survey are presented in Table 5 where factor loadings that are less than 0.20

were omitted. The items of factor loadings greater than 0.30 in absolute value were considered. The scree plot of the factors is given in the Figure 2 below:

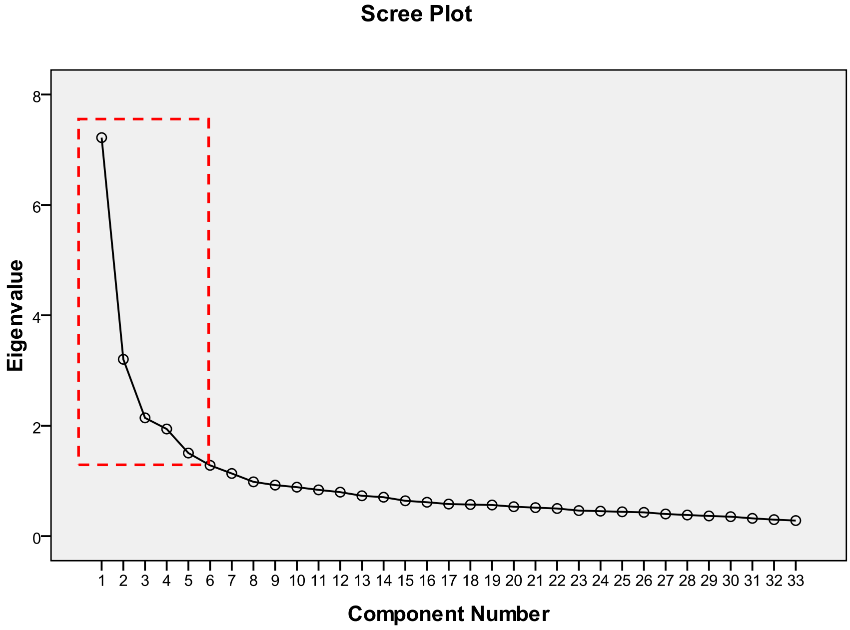


Figure 2 Scree Plot of the Factors of the Survey

Table 5 Factor Structure of the Survey

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
DAp3Q3	**0.725**				
RIdea4Q8	**0.708**				
RIdea1Q5	**0.705**				
RIdea2Q6	**0.685**				
DAp4Q4	**0.663**				
RIdea3Q7	**0.591**				
Evid3Q11	**0.582**				
Evid1Q9	**0.576**				
Evid2Q10	**0.576**				
DAp2Q2	**0.551**				
Evid4Q12	**0.520**		0.293		
DAp1Q1	**0.487**				
SEff4Q43		**0.669**			
SEff1Q40		**0.637**	0.305		
PSSt1Q44		**0.623**			
PSSt2Q45		**0.599**		0.341	
SEff3Q42		**0.577**	0.310		
SEff2Q41		**0.572**	0.487		
PSSt8Q51	0.255	**0.518**		0.270	
IMot2Q14	0.260		**0.728**		
IMot1Q13			**0.677**		
IMot4Q16	0.293		**0.650**		
EMot1Q29			**0.550**		
AMot2Q38	0.286		**0.514**		
DOSt2Q34				**0.722**	
DOSt1Q33				**0.707**	
DOSt4Q36				**0.702**	
DOSt3Q35				**0.683**	
SAp4Q20					**0.748**
SAp3Q19					**0.713**
SAp2Q18					**0.687**
SAp5Q21	0.267			0.263	**0.609**
SAp6Q22				0.385	**0.449**

The 5 factors were named based on the literature and the content of the items. The factors were named as; meaning orientation, mathematics self-efficacy, motivation (intrinsic, extrinsic, achievement), disorganized study methods and surface approach respectively.

The findings comply with the table of specifications of the survey (see

Appendix E) which also provides evidence for construct validity. The eigenvalues, the percentage, and the cumulative percentages and Cronbach's alpha reliabilities of these five factors were given in Table 6.

Table 6 Rotation Sums of Squared Loadings

	Total	% of Variance	Cumulative %	Cronbach's alpha
Meaning Orientation (MEANORT)	5.199	15.756	15.756	0.869
Mathematics self- efficacy (MSEFFIC)	2.868	8.691	24.447	0.762
Motivation (MOT)	2.821	8.550	32.996	0.745
Disorganized study methods (DISORSTD)	2.703	8.190	41.186	0.737
Surface approach(SURAPP)	2.419	7.330	48.516	0.721

4.3 Results of the Exploratory Factor Analysis of the Test

Principal Component Analyses with Varimax rotation method was conducted with restriction to 4 factors in order to identify the factor structure and to reduce the number of observed variables. The test initially included 26 items. Items that didn't meet with the criteria from the preliminary analyses were excluded from further analyses due to their ambiguous factor loadings. The final PCA with 18 observed variables yielded better factor structure. The Kaiser-Meyer-Olkin measure for the adequacy for conducting factor analysis and the Bartlett's Test of Sphericity values are given in the Table 7.

Table 7 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.795
Bartlett's Test of Sphericity	Approx. Chi-Square	1037.891
	df	153
	Sig.	0.000

The Kaiser-Meyer-Olkin measure of the adequacy of the distribution values for conducting factor analysis was obtained as 0.795 is in the range between 0.70 and 0.79 which was defined as middling (Kaiser, 1974) and is sufficient to conduct analysis. Besides, Bartlett's test of Sphericity value (0.000) is significant (p<0.05) which shows that the distribution is multivariate normal and the correlation matrix is not an identity matrix (George & Mallery, 2001). The scree plot which was depicted in the Figure 3 indicated 2 factors to retain. The total variance explained by 4 factors with 18 observed variables is 41.898%. The rotated factor loadings of the observed variables for the test are presented in Table 8 where factor loadings that are less than 0.25 were omitted. The items of factor loadings greater than 0.30 in absolute value were considered

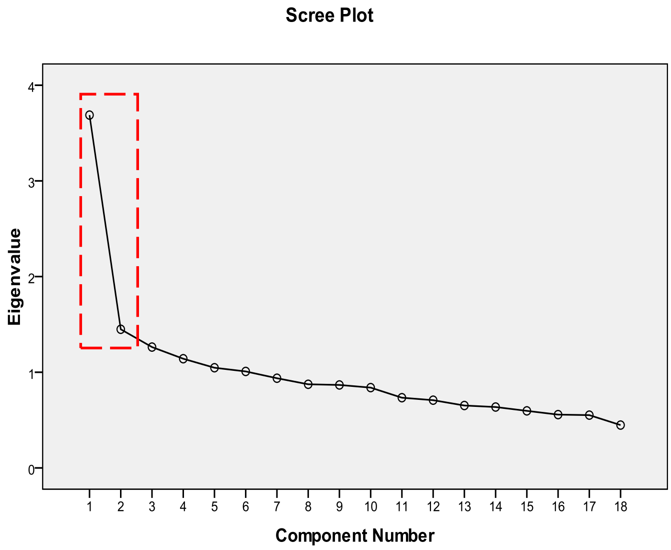


Figure 3 Scree Plot of the Factors of the Test

Table 8 Factor Structure of the Test

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
ExTb2R14	**0.656**			
ECp4R16	**0.575**			0.299
CpSkl1R7	**0.537**			
ECp2R12	**0.498**			
ECp6R18	**0.478**		0.267	
ECp7R19	**0.467**			
ExTb3R21	**0.448**			
ECp1R11	**0.310**	0.261	0.280	
LInf2R2		**0.749**		
LInf1R1		**0.705**		
MEx1R4	0.385	**0.515**		
ECp3R13		**0.435**		
LInf3R3		0.428	**0.409**	
EC6R9vi			**0.772**	
EC3R9iii			**0.661**	
EC5R9v				**0.784**
EC4R9iv				**0.737**
ECp5R17		0.333	0.324	**0.369**

After factors were determined, they were named based on the literature and the content of the items. The four factors were named as; ‘Express, extract and compute’, ‘representing statements’, ‘evaluating conditions’ and ‘decision making’ respectively. The eigenvalues, percentages, cumulative percentages and Cronbach’s alpha reliabilities of four factors were shown in Table 9.

Table 9 Rotation Sums of Squared Loadings

	Total	% of Variance	Cumulative %	Cronbach’s alpha
‘Express,extract&compute’ (EXPEXTCMP)	2.382	13.232	13.232	0.657
Representingstatements(REPSTAT)	2.000	11.112	24.343	0.579
Evaluating conditions(EVALCOND)	1.659	9.217	33.560	0.485
Decision making(DECMAK)	1.501	8.338	41.898	0.415

The Cronbach’s alpha reliabilities of the last three components were less than 0.60 that did not meet with the general criterion of accepting a factor as reliable as was stated in Cohen (1988). In addition, the examination of the scree plot indicated that the curve starts to level off after 2 factors. Furthermore, it was observed that there exist high correlations among the factors REPSTAT and EVALCOND and between the factors REPSTAT and DECMAK as 0.736, 0.772 correspondingly. In this respect, the last three factors were combined to form a unique factor that was named as 'Express, infer logically' (EXINFLOG) based on the nature of the items included. The final, respecified factor structure of the test is shown in the Table 10 below:

Table 10 Respecified Factors of the Test

Factors	Items	Cronbach's alpha
'Express. extract & compute'(EXPEXTCMP)	ExTb2R14	0.657
	ECp4R16	
	CpSkl1R7	
	ECp2R12	
	ECp6R18	
	ECp7R19	
	ExTb3R21	
	ECp1R11	
'Express, infer logically' (EXINFLOG)	LInf2R2	0.651
	LInf1R1	
	MExp1R4	
	ECmp3R13	
	LInf3R3	
	ECon6R9vi	
	ECon3R9iii	
	ECon5R9v	
	ECon4R9iv	
	ECp5R17	

4.4 Results of the Confirmatory Factor Analysis of the Test

Confirmatory factor analyses were conducted to identify latent variables of the test. 18 observed variables from the results of the exploratory factor analyses were taken into consideration and the model was tested by using structural equation modeling (SEM). By using SIMPLIX syntax of LISREL, after inspecting modification indices with higher values, error covariances of the suggested observed variables were noted and revision was done by permitting errors of four pairs of observed variables to correlate. In order to improve the fit of the model, four error covariances were set free since as default the error terms are assumed to be uncorrelated by LISREL 8 (Jöreskog & Sörbom, 1993). The final SIMPLIS syntax for the confirmatory factor analysis of the test was included in the Appendix Q. The standardized solution of the parameter estimates and the t values of the structural model for the test are shown in the Figures 4 and 5 respectively.

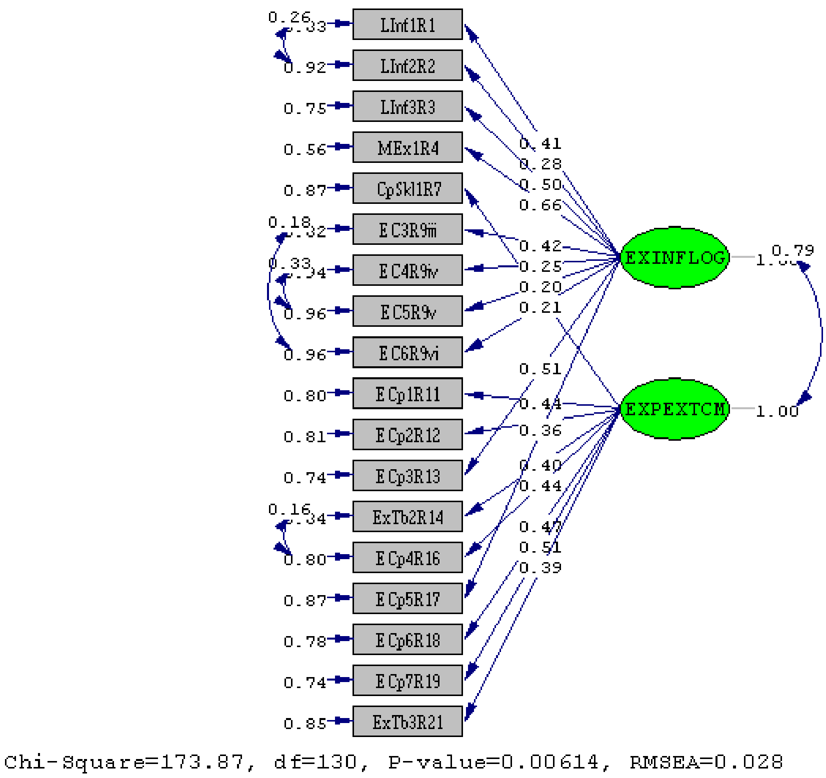


Figure 4 Parameter estimates of the Test Model with Standardized Values

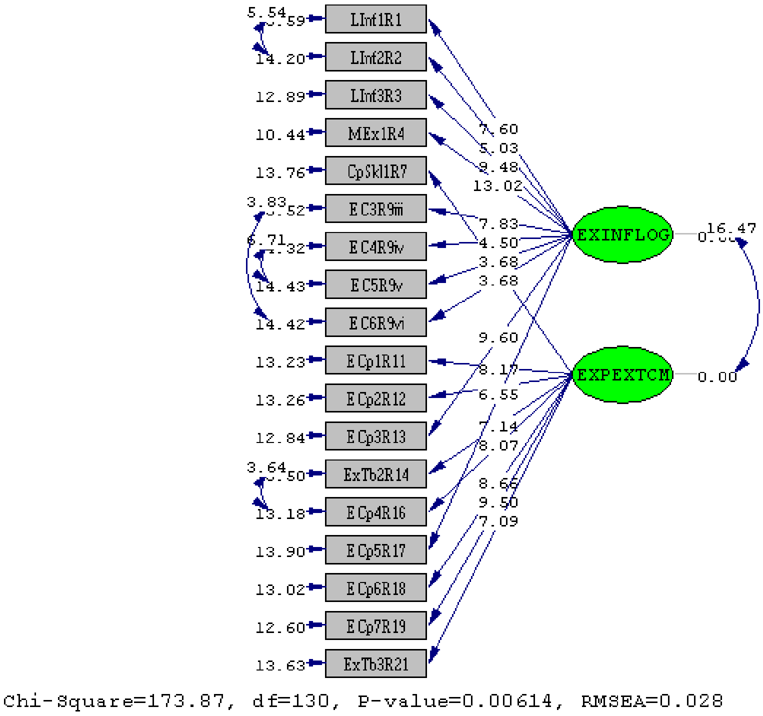


Figure 5 Parameter estimates of the Test Model with T Values

The model of the test was confirmed for 2 latent variables that were measured by 18 observed variables. The squared multiple correlations R^2 for specified observed variables of the latent variables were given in the Table 11.

Table 11 Squared Multiple Correlations for the Test

Latent Variables	Observed Variables	Squared Multiple Correlation (R^2)
EXINFLOG	LInf1R1	0.17
	LInf2R2	0.08
	MEx1R4	0.44
	ECp3R13	0.26
	LInf3R3	0.25
	EC3R9iii	0.18
	EC6R9vi	0.04
	EC4R9iv	0.06
	EC5R9v	0.04
	ECp5R17	0.13

Table 11 (continued)

Latent Variables	Observed Variables	Squared Multiple Correlation (R^2)
EXPEXTCMP	ECp7R19	0.26
	ECp4R16	0.20
	ExTb2R14	0.16
	CpSkl1R7	0.14
	ECp2R12	0.19
	ECp6R18	0.22
	ExTb3R21	0.15
	ECp1R11	0.20

The measurement coefficients (λ_x) and their error variances (ε) in the λ_Y variables were listed in the Table 12 below:

Table 12 Measurement and Error Coefficients of the Test Model

Latent Variables	Observed Variables	λ_Y	ε
EXINFLOG	LInf1R1	0.41	0.83
	LInf2R2	0.28	0.92
	MEx1R4	0.66	0.56
	ECp3R13	0.51	0.74
	LInf3R3	0.50	0.75
	EC3R9iii	0.42	0.82
	EC6R9vi	0.21	0.96
	EC4R9iv	0.25	0.94
	EC5R9v	0.20	0.96
	ECp5R17	0.36	0.87
EXPEXTCMP	ECp7R19	0.51	0.74
	ECp4R16	0.44	0.80
	ExTb2R14	0.40	0.84
	CpSkl1R7	0.37	0.86
	ECp2R12	0.44	0.81
	ECp6R18	0.47	0.78
	ExTb3R21	0.39	0.85
	ECp1R11	0.44	0.80

The summary statistics for the CFA model of the test were given in the Appendix X. The steam-leaf and Q-plots of both fitted and standardized residuals indicate that the model fits the data well. In addition, fitted residuals within the range of 0.13 in absolute value and are considered as small in magnitude

(Schumacker & Lomax, 2004). The fit indices of the test model after suggested modification indices made are: [(□χ^2(177.451 N = 431) =173.874 p<.0000. RMSEA= 0.0280. S-RMR = 0.0418. GFI =0.957. AGFI = 0.943. CFI =0.973. NNFI= 0.968]. Thus, the values obtained as goodness of fit indices show that the model of the test fits the data very well. The the acceptable range for the fit indices and their values for assessing the fit of the model for the test were given below in the Table 13 (see Appendix O for range of fit indices in detail).

Table 13 Fit Indices and Values for the model of the Test

Fit Index	Criterion	Value
Chi-Square (χ^2)	Ratio of χ^2 to *df* <5	177.451 1.37<5
Degrees of Freedom(*df*)		130
Root Mean Square Error of Approximation (RMSEA)	< 0.05 smaller the better	0.0280
Root Mean Square Residual (RMR)		0.0418
Standardized Root Mean Square Residual (S-RMR)		0.0418
Parsimony Goodness of Fit Index (PGFI)	higher the better	0.728
Parsimony Normed Fit Index (PNFI)		0.770
Normed Fit Index (NFI)	> 0.90	0.907
Non-Normed Fit Index (NNFI)		0.968
Comparative Fit Index (CFI)		0.973
Incremental Fit Index (IFI)		0.973
Relative Fit Index (RFI)		0.890
Goodness of Fit Index (GFI)		0.957
Adjusted Goodness of Fit Index (AGFI)		0.943

4.5 Results of the Confirmatory Factor Analysis of the Survey

CFA was also conducted for the survey. Observed variables from EFA were considered as latent variables. Thirty five error covariances were set free. In addition, the paths from observed variable SEff3Q42 to the latent variable MEANORT and from the variables SEff2Q41 and SEff1Q40 to MOT were added with respect to the modification index suggestions. For SIMPLIS syntax and the summary statistics please see Appendices R and X. The Figures 6 and 7 show the parameter estimates in standardized and in t-values respectively.

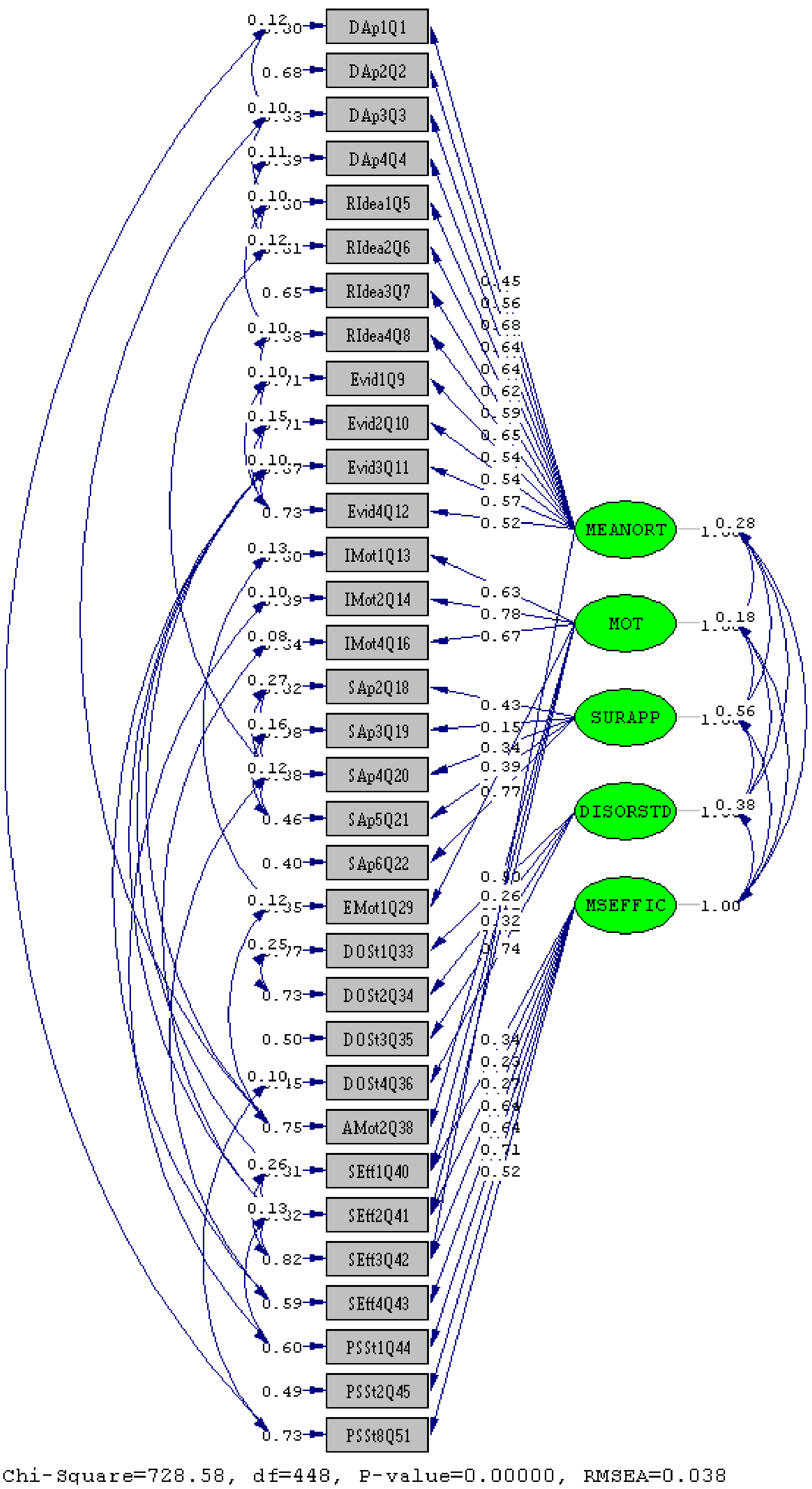


Figure 6 Standardized Parameter Estimates of the Survey Model

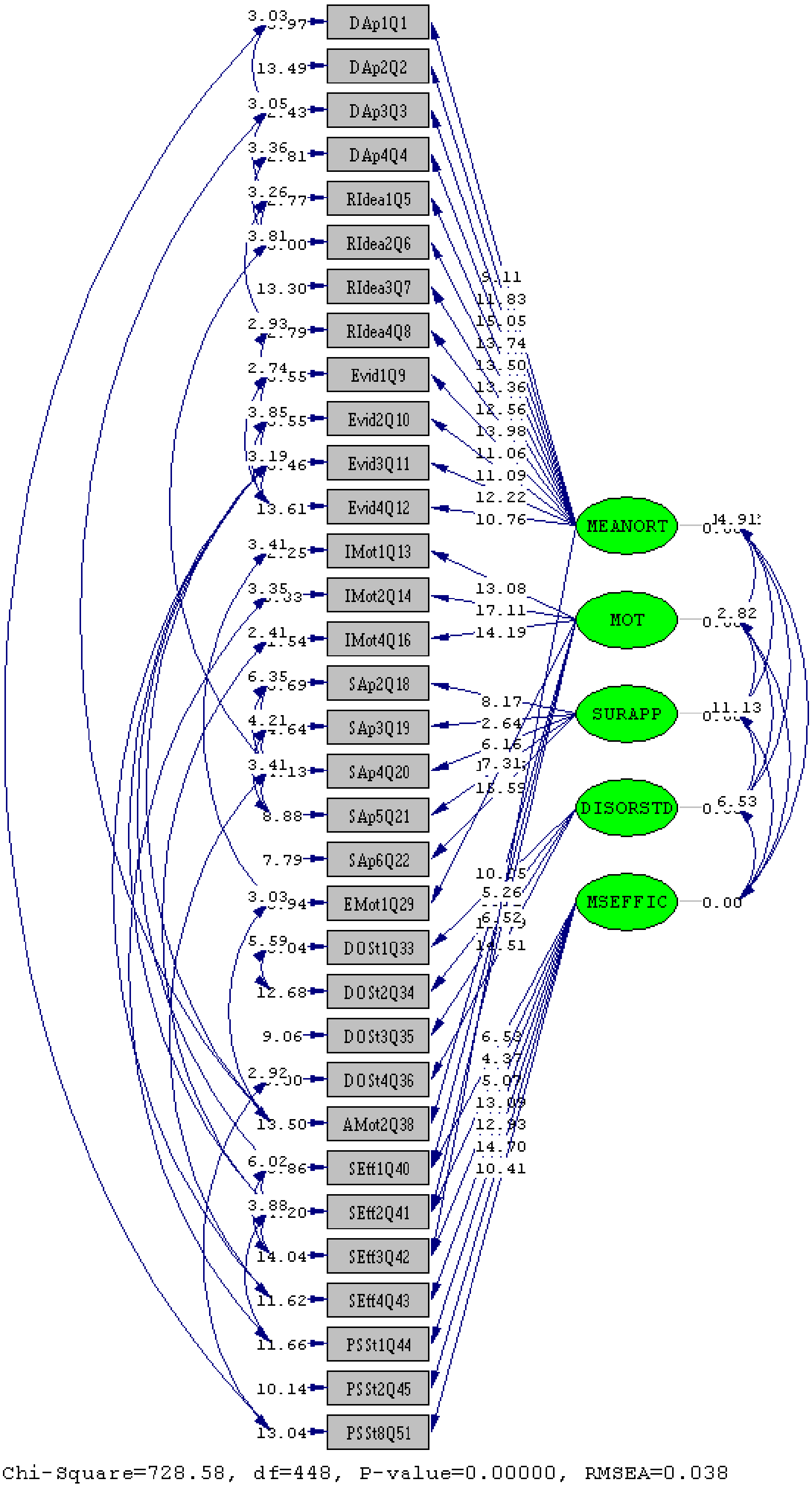


Figure 7 Parameter Estimates of the Survey in T-values

The final model of the survey comprise of five latent variables that were measured by 33 observed variables. The multiple squared correlation R^2 values for each observed variable for each latent variable is shown at the Table 14.

Table 14 Squared Multiple Correlations for the Survey Model

Latent Variables	Observed Variables	Squared Multiple Correlation(R^2)
MEANORT	DAp3Q3	0.47
	RIdea4Q8	0.42
	RIdea1Q5	0.40
	RIdea2Q6	0.39
	DAp4Q4	0.41
	RIdea3Q7	0.35
	Evid3Q11	0.33
	Evid1Q9	0.29
	Evid2Q10	0.29
	DAp2Q2	0.32
	Evid4Q12	0.27
	DAp1Q1	0.20
	SEff3Q42	0.18
MSEFFIC	SEff4Q43	0.41
	SEff1Q40	0.19
	PSSt1Q44	0.40
	PSSt2Q45	0.51
	SEff3Q42	0.18
	SEff2Q41	0.18
	PSSt8Q51	0.27
MOT	IMot2Q14	0.61
	IMot1Q13	0.40
	IMot4Q16	0.45
	EMot1Q29	0.15
	AMot2Q38	0.25
	SEff2Q41	0.18
	SEff1Q40	0.19
DISORSTD	DOSt4Q36	0.55
	DOSt2Q34	0.27
	DOSt3Q35	0.50
	DOSt1Q33	0.23
SURAPP	SAp4Q20	0.12
	SAp3Q19	0.02
	SAp2Q18	0.18
	SAp5Q21	0.54
	SAp6Q22	0.60

In addition, the measurement (λ_x) and error (δ) coefficients are given in the Table 15.

Table 15 Measurement and Error Coefficients of the Survey Model

Latent Variables	Observed Variables	λ_x	δ
MEANORT	DAp3Q3	0.68	0.53
	RIdea4Q8	0.65	0.58
	RIdea1Q5	0.63	0.60
	RIdea2Q6	0.62	0.62
	DAp4Q4	0.64	0.59
	RIdea3Q7	0.59	0.65
	Evid3Q11	0.57	0.66
	Evid1Q9	0.54	0.71
	Evid2Q10	0.54	0.71
	DAp2Q2	0.56	0.68
	Evid4Q12	0.52	0.72
	DAp1Q1	0.44	0.78
	SEff3Q42	0.26	0.81
MSEFFIC	SEff4Q43	0.64	0.60
	SEff1Q40	0.22	0.80
	PSSt1Q44	0.64	0.60
	PSSt2Q45	0.71	0.49
	SEff3Q42	0.26	0.81
	SEff2Q41	0.23	0.80
	PSSt8Q51	0.52	0.72
MOT	IMot2Q14	0.78	0.39
	IMot1Q13	0.63	0.60
	IMot4Q16	0.67	0.54
	EMot1Q29	0.39	0.85
	AMot2Q38	0.50	0.75
	SEff2Q41	0.32	0.80
	SEff1Q40	0.22	0.80
DISORSTD	DOSt4Q36	0.74	0.44
	DOSt2Q34	0.52	0.73
	DOSt3Q35	0.71	0.49
	DOSt1Q33	0.48	0.77
SURAPP	SAp4Q20	0.34	0.90
	SAp3Q19	0.15	0.98
	SAp2Q18	0.75	0.43
	SAp5Q21	0.73	0.46
	SAp6Q22	0.77	0.40

The summary statistics of the fitted residuals, stem-leaf and q-plots that were given in the Appendix R show that fitted residuals range are within the acceptable values for a good fit (Kelloway, 1998). The goodness of fit indices after the revision according to the modification indices are: [(χ^2(731.822 N = 431) = 728.852 p<.0000. RMSEA= 0.0382. S-RMR = 0.0550. GFI = 0.907. AGFI = 0.883. CFI = 0.973. NNFI= 0.969]. The goodness of fit indices is given in the Table 16 below:

Table 16 Goodness of Fit Indices for CFA of the Survey Model

Fit Index	Criterion	Value	
Chi-Square (χ^2)	(Ratio of χ^2 to *df*) <5	731.822	1.63<5
Degrees of Freedom(*df*)		448	
Root Mean Square Error of Approximation (RMSEA)	< 0.05 smaller the better	0.0382	
Root Mean Square Residual (RMR)		0.0549	
Standardized Root Mean Square Residual (S-RMR)		0.0550	
Parsimony Goodness of Fit Index (PGFI)	higher the better	0.724	
Parsimony Normed Fit Index (PNFI)		0.793	
Normed Fit Index (NFI)	> 0.90	0.935	
Non-Normed Fit Index (NNFI)		0.969	
Comparative Fit Index (CFI)		0.973	
Incremental Fit Index (IFI)		0.974	
Relative Fit Index (RFI)		0.923	
Goodness of Fit Index (GFI)		0.907	
Adjusted Goodness of Fit Index (AGFI)		0.883	

From the values of the Table 16, regarding the number of indicators and the complexity of the model, it could be concluded that there exists a adaquate fit of the survey model to the data.

4.6 Summary of the Results of EFA and CFA

The Principal Component Analyses were carried out with Varimax rotation method in order to identify the underlying factor structures of the survey and the test. The four latent variables that are measured by 18 observed variables were identified and named based on the literature and their coverage for the test by using SPSS 17.0 software package. However, regarding the low internal consistencies (below 0.60) and high correlations among the last three factors, later on these three factors were combined to form a unique factor called EXINFLOG(Express and infer logically). Therefore the test model which included 2 latent variables that were measured by 18 observed variables. Furthermore, five latent variables that were measured by 33 observed variables were identified and were named for the survey after conducting exploratory factor analyses.

Afterwards, confirmatory factor analyses were performed to test the model fit for the survey and the test. Results showed that the survey model comprised of 5 latent variables that were measured by 33 observed variables indicated satisfactory fit. Additionally, 2-factor model with 18 observed variables for the test revealed the best fit with respect to the goodness of fit statistics. The items (observed variables) with respect to the latent variables were illustrated in the Appendix H.

4.7 Structural Equation Modeling

The initial model was depicted in Figure 1 of the Chapter 1. However, the model was re- specified by taking into account the results of the exploratory and confirmatory factor analyses, empirical results and the literature. Path analysis using LISREL 8.71 program in the SIMPLIS syntax language were employed to study the interrelationships between aforementioned factors of the survey and the test. Maximum likelihood method of estimation and listwise deletion method were used and the alpha level of significance was set to 0.05. The covariance matrices used in the analysis were generated by PRELIS 2.71, a sub-program of LISREL 8.71.

The initial model including five independent latent variables of the survey 'meaning orientation', 'mathematics self-efficacy', 'motivation [intrinsic-achievement-extrinsic]','disorganized study methods','surface approach' and two dependent latent variables of the test; 'Express, extract and compute'(EXPEXTCM) and 'Express, infer logically' (EXINFLOG) were tested by using the structural equation modeling (SEM). In total, three main models were tested and presented in the subsequent paragraphs.

4.8 First Structural Model of the Survey and the Test (Survey-Test)

Thirty seven error covariances of the observed variables were set free by taking into account the results of confirmatory factor analyses and suggested modification indices. In addition, a path from the observed variable DOSt1Q33 to the latent variable SURAPP was added with respect to the content and the suggestions by the program. A path from EXPEXTCM to EXINFLOG was added based on the correlations, relevant theory and modification suggestions of the program.The path diagrams of the model in the Figures 8 and 9 represent the parameter coefficients in standardized and in t-values respectively. The basic structural model in standardized and in t-value estimates can be found in the Appendix I respectively. The final model includes five independent ; 'meaning orientation' (MEANORT), 'mathematics self-efficacy(MSEFFIC)', 'motivation (MOT)', 'disorganized study methods(DISORSTD)', 'surface approach(SURAPP)' and two dependent latent variables 'Express, extract and compute(EXPEXTCM)', 'Express, infer logically' (EXINFLOG) that were measured by total of 51 observed variables.

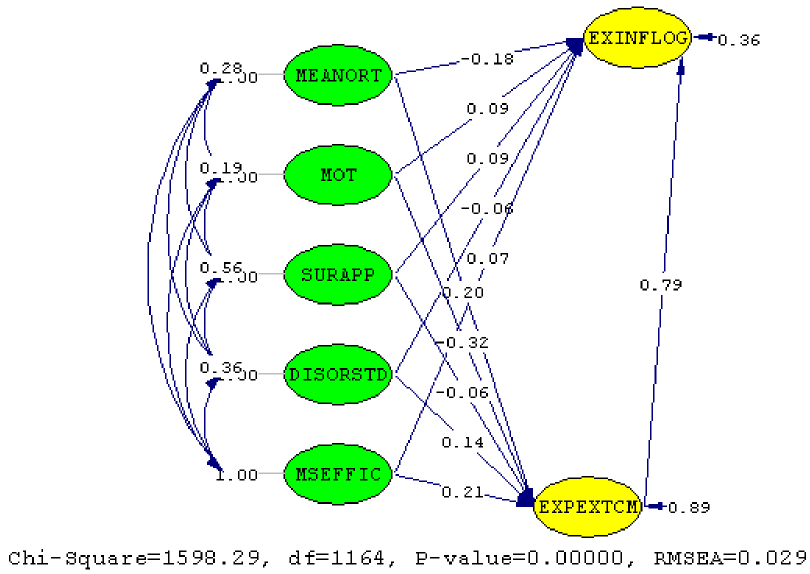


Figure 8 Parameter Estimates of the Model in Standardized Values

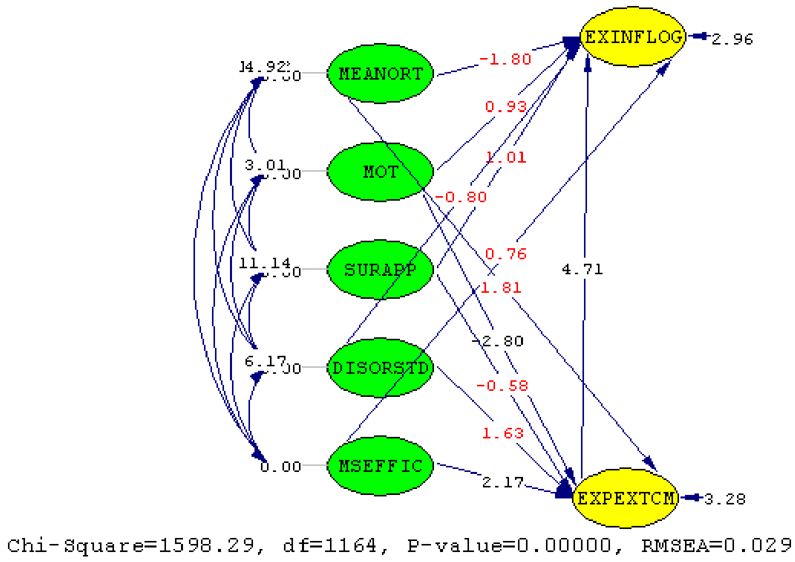


Figure 9 Parameter Estimates of the Model in t-values

The measurement and path coefficients (λ) of the model with errors of the independent (δ) and dependent variables (ε) were depicted in the Table 17:

Table 17 Measurement and Error Coefficients of the Model

Independent Variables	Observed Variables	λ_x	δ
MEANORT	DAp3Q3	0.55	0.33
	RIdea4Q8	0.57	0.47
	RIdea1Q5	0.52	0.42
	RIdea2Q6	0.62	0.63
	DAp4Q4	0.60	0.53
	RIdea3Q7	0.54	0.55
	Evid3Q11	0.48	0.48
	Evid1Q9	0.47	0.56
	Evid2Q10	0.48	0.55
	DAp2Q2	0.53	0.61
	Evid4Q12	0.50	0.67
	DAp1Q1	0.44	0.69
	SEff3Q42	0.23	0.65
MSEFFIC	SEff4Q43	0.65	0.58
	SEff1Q40	0.34	0.80
	PSSt1Q44	0.67	0.69
	PSSt2Q45	0.65	0.42
	SEff3Q42	0.24	0.65
	SEff2Q41	0.24	0.86
	PSSt8Q51	0.53	0.74

Table 17 (continued)

Independent Variables	Observed Variables	λ_x	δ
MOT	IMot2Q14	0.87	0.55
	IMot1Q13	0.79	0.85
	IMot4Q16	0.70	0.62
	EMot1Q29	0.54	0.79
	AMot2Q38	0.52	0.75
	SEff2Q41	0.32	0.86
	SEff1Q40	0.22	0.80
DISORSTD	DOSt4Q36	0.87	0.60
	DOSt2Q34	0.64	0.73
	DOSt3Q35	0.87	0.71
	DOSt1Q33	0.43	0.94
SURAPP	SAp4Q20	0.36	0.95
	SAp3Q19	0.17	0.98
	SAp2Q18	0.48	0.82
	SAp5Q21	0.73	0.45
	SAp6Q22	0.83	0.46
	DOSt1Q33	0.22	0.94
Dependent Variables	Observed Variables	λ_Y	ε
EXINFLOG	LInf1R1	0.15	0.12
	LInf2R2	0.10	0.12
	MEx1R4	0.32	0.13
	ECp3R13	0.25	0.17
	LInf3R3	0.21	0.13
	EC3R9iii	0.21	0.20
	EC6R9vi	0.10	0.23
	EC4R9iv	0.09	0.12
	EC5R9v	0.07	0.12
	ECp5R17	0.17	0.21
	ECp7R19	0.24	0.16
EXPEXTCM	ECp4R16	0.17	0.13
	ExTb2R14	0.19	0.18
	CpSkl1R7	0.14	0.13
	ECp2R12	0.21	0.19
	ECp6R18	0.22	0.16
	ExTb3R21	0.18	0.17
	ECp1R11	0.21	0.20

The magnitude and the direction of the paths from independent to dependent latent variables gamma (γ) are given in the Table 18.

Table 18 Gamma Path Coefficients of the Model

Dependent Variables(η)	Independent Variables(ξ)	γ
EXINFLOG	MEANORT	-0.02
	MSEFFIC	0.23
	MOT	-0.16
	DISORSTD	0.05
	SURAPP	0.05
EXPEXTCM	MEANORT	0.22
	MSEFFIC	0.03
	MOT	-0.19
	DISORSTD	0.10
	SURAPP	-0.09

Path coefficients among dependent variables beta (β) are shown in the Table 19 and the squared multiple correlations (R^2) of 51 observed variables that were included in the model are given in the Table 20 below:

Table 19 β path coefficients among dependent variables

Dependent Variables(η)		β
EXINFLOG	EXINFLOG	-
	EXPEXTCMP	-
EXPEXTCMP	EXINFLOG	0.79
	EXPEXTCMP	-

Table 20 Squared Multiple Correlations of Observed Variables of the Model

Observed Variables	R^2
DAp3Q3	0.48
RIdea4Q8	0.41
RIdea1Q5	0.40
RIdea2Q6	0.38
DAp4Q4	0.40
RIdea3Q7	0.35
Evid3Q11	0.33
Evid1Q9	0.28
Evid2Q10	0.29
DAp2Q2	0.32
Evid4Q12	0.27

Table 20 (cont'd)

DAp1Q1	0.22
SEff4Q43	0.42
SEff1Q40	0.19
PSSt1Q44	0.40
PSSt2Q45	0.50
SEff3Q42	0.18
SEff2Q41	0.18
PSSt8Q51	0.28
IMot2Q14	0.58
IMot1Q13	0.42
IMot4Q16	0.44
EMot1Q29	0.21
AMot2Q38	0.26
DOSt4Q36	0.56
DOSt2Q34	0.27
DOSt3Q35	0.52
DOSt1Q33	0.24
SAp4Q20	0.12
SAp3Q19	0.02
SAp2Q18	0.18
SAp5Q21	0.54
SAp6Q22	0.60
LInf1R1	0.16
LInf2R2	0.07
MEx1R4	0.44
ECp3R13	0.26
LInf3R3	0.25
EC3R9iii	0.18
EC6R9vi	0.44
EC4R9iv	0.06
EC5R9v	0.04
ECp5R17	0.12
ECp7R19	0.26
ECp4R16	0.19
ExTb2R14	0.17
CpSkl1R7	0.13
ECp2R12	0.20
ECp6R18	0.22
ExTb3R21	0.15
ECp1R11	0.19

The account of variance explained by the latent dependent (endogenous) variables in terms of squared multiple correlations which are also known as effect sizes are given by the Table 20 and 21 respectively.

Table 21 Squared Multiple Correlations of Dependent Latent Variables

Endogenous Variables(η)	R^2
EXPEXTCMP	0.11
EXINFLOG	0.64

The endogenous variable EXPEXTCM (express, extract and compute) has small effect size whereas EXINFLOG (express, infer logically) has large effect size.

In addition, the summary statistics were given in the Appendix X shows that fitted residuals range are within the acceptable values for a good fit that is ±1 (Kelloway, 1998). The goodness of fit indices after the revision according to the modification indices are: [(χ^2(1643.963. N = 431) = 1598.295 p<.0000. RMSEA= 0.0357. S-RMR = 0.0588. GFI = 0.860. AGFI = 0.839. CFI = 0.939. NNFI= 0.932]. The goodness of fit indices is given in the Table 22 below:

Table 22 Goodness of Fit Indices of the Survey-Test Model

Fit Index	Criterion	Value	
Chi-Square (χ^2)	(Ratio of χ^2 to df) <5	1643.963	1.41<5
Degrees of Freedom(df)		1164	
Root Mean Square Error of Approximation (RMSEA)	< 0.05 smaller the better	0.0295	
Root Mean Square Residual (RMR)		0.0400	
Standardized Root Mean Square Residual (S-RMR)		0.0520	
Parsimony Goodness of Fit Index (PGFI)	higher the better	0.766	
Parsimony Normed Fit Index (PNFI)		0.806	
Normed Fit Index (NFI)	> 0.90	0.883	
Non-Normed Fit Index (NNFI)		0.959	
Comparative Fit Index (CFI)		0.963	
Incremental Fit Index (IFI)		0.963	
Relative Fit Index (RFI)		0.872	
Goodness of Fit Index (GFI)		0.873	
Adjusted Goodness of Fit Index (AGFI)		0.855	

Even though some values of fit indices moderately meet with the required cut-off criteria, considering the amount of indicator variables, the complexity of the model and the sensitivity of the indices as GFI, AGFI to the sample size it could be concluded that the model fits the data fairly. In addition, the normal shape steam-leaf and q-plots of the fitted residuals and their range that are within 1 in absolute value and the similarity of the shape of the steam-leaf plots of fitted residuals to the standardized residuals could also refer to an overall fit of the data to the model.

The direct, indirect and total effects of exogenous variables to endogenous variables are shown in the Table 23. In addition, the structural regression equations of the survey-test model are shown in the Appendix N.

Table 23 Direct, Indirect and Total Effects Survey-Test Model

Variable	EXINFLOG			EXPEXTCMP		
	Direct	Indirect	Total	Direct	Indirect	Total
MEANORT	-0.18	0.16	-0.0221	0.20	-	0.20
MSEFFIC	0.06	0.17	**0.234**	**0.21**	-	**0.21**
MOT	0.091	-0.25	-0.159	**-0.32**	-	**-0.32**
DISORSTD	-0.062	0.11	0.0510	0.14	-	0.14
SURAPP	0.0933	-0.05	0.0458	-0.06	-	-0.06

*: Values in bold faces indicate significant direct and total effects.

4.9 Second Model for the Survey and the Test (Survey-Testt)

In this model, observed variables for each factor of the test were added together to reduce the number of observed variables that were included in the analysis. The test's latent variable's error variance was set to 1- Cronbach's alpha reliability of the corresponding factor at the SIMPLIX syntax (see Appendix T). The survey's independent latent variables and error covariances that were set as free were included from the confirmatory factor analysis of the survey. In addition paths from EXPETCM to EXINLOG and from observed variable DOSt1Q33 to the latent variable SURAPP were added and with respect to the modification suggestions.The basic models in standard and in t-values are at the Appendix J and below. The model includes; 'meaning orientation' (MEANORT), 'mathematics self-efficacy(MSEFFIC)', 'motivation (MOT)', ‘disorganized study methods (DISORSD)’, ‘surface approach (SURAPP)’ and two dependent latent variables ‘Express, extract and compute (EXPEXTCM)’, ‘Express, infer logically’ (EXINFLOG) measured by 35 observed variables.

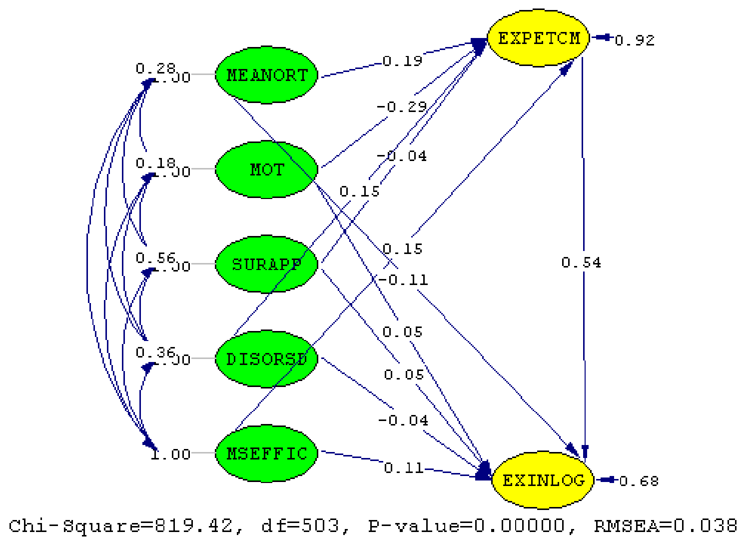


Figure 10 Parameter Estimates of the Model in Standardized Values

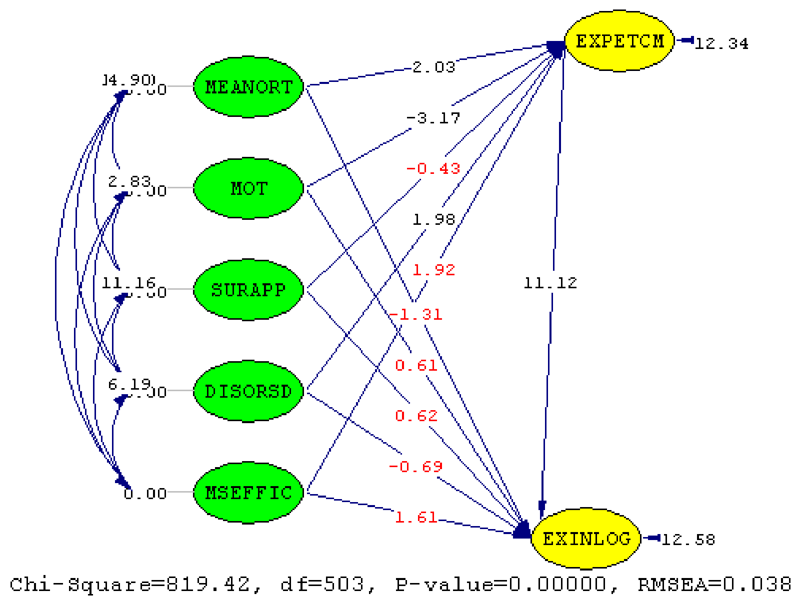


Figure 11 Paramater Estimates of the Model in t-values

The measurement and path coefficients (λ) of the model with errors of the independent (δ) and dependent variables (ε) were depicted in the Table 24.

Table 24 Measurement and Error Coefficients of the Model

Independent Variables	Observed Variables	λ_x	δ
MEANORT	DAp3Q3	0.54	0.34
	RIdea4Q8	0.58	0.46
	RIdea1Q5	0.53	0.42
	RIdea2Q6	0.62	0.62
	DAp4Q4	0.60	0.53
	RIdea3Q7	0.54	0.55
	Evid3Q11	0.48	0.48
	Evid1Q9	0.47	0.56
	Evid2Q10	0.48	0.55
	DAp2Q2	0.53	0.62
	Evid4Q12	0.50	0.66
	DAp1Q1	0.42	0.71
	SEff3Q42	0.23	0.65
MSEFFIC	SEff4Q43	0.65	0.58
	SEff1Q40	0.34	0.81
	PSSt1Q44	0.67	0.69
	PSSt2Q45	0.65	0.42
	SEff3Q42	0.24	0.65
	SEff2Q41	0.24	0.86
	PSSt8Q51	0.53	0.74
MOT	IMot2Q14	0.89	0.52
	IMot1Q13	0.77	0.89
	IMot4Q16	0.71	0.60
	EMot1Q29	0.47	0.84
	AMot2Q38	0.50	0.76
	SEff2Q41	0.33	0.86
	SEff1Q40	0.22	0.81
DISORSTD	DOSt4Q36	0.87	0.60
	DOSt2Q34	0.64	0.73
	DOSt3Q35	0.87	0.72
	DOSt1Q33	0.43	0.94
SURAPP	SAp4Q20	0.36	0.95
	SAp3Q19	0.18	0.98
	SAp2Q18	0.48	0.82
	SAp5Q21	0.73	0.45
	SAp6Q22	0.83	0.46
Dependent Variables	Observed Variables	λ_Y	ε
EXINFLOG	EXINFLOGt	2.29	0.34
EXPEXTCM	EXPEXTCMt	1.64	0.35

The magnitude and the direction of the paths from independent to dependent latent variables (γ) are given in the Table 25.

Table 25 Gamma Path Coefficients of the Model

Dependent Variables(η)	Independent Variables(ξ)	γ
EXPETCM	MEANORT	0.19
	MSEFFIC	0.15
	MOT	-0.28
	DISORSD	0.14
	SURAPP	-0.03
EXINLOG	MEANORT	-0.11
	MSEFFIC	0.11
	MOT	0.05
	DISORSD	-0.04
	SURAPP	0.05

Path coefficients among dependent variables beta (β) are shown in the Table 26 and the squared multiple correlations (R^2) of 35 observed variables that were included in the model are given in the Table 27 below:

Table 26 β path coefficients among dependent variables

Dependent Variables(η)		β
EXINFLOG	EXINFLOG	-
	EXPEXTCMP	0.54
EXPEXTCMP	EXINFLOG	-
	EXPEXTCMP	-

Table 27 Squared Multiple Correlations of Observed Variables of the Model

Observed Variables	R^2
DAp3Q3	0.46
RIdea4Q8	0.42
RIdea1Q5	0.40
RIdea2Q6	0.39
DAp4Q4	0.41
RIdea3Q7	0.35
Evid3Q11	0.33
Evid1Q9	0.29
Evid2Q10	0.29
DAp2Q2	0.32
Evid4Q12	0.28

Table 27(cont'd)

Observed Variables	R^2
DAp1Q1	0.20
SEff4Q43	0.42
SEff1Q40	0.19
PSSt1Q44	0.39
PSSt2Q45	0.50
SEff3Q42	0.18
SEff2Q41	0.18
PSSt8Q51	0.28
IMot2Q14	0.61
IMot1Q13	0.40
IMot4Q16	0.46
EMot1Q29	0.16
AMot2Q38	0.25
DOSt4Q36	0.56
DOSt2Q34	0.27
DOSt3Q35	0.51
DOSt1Q33	0.24
SAp4Q20	0.12
SAp3Q19	0.02
SAp2Q18	0.18
SAp5Q21	0.54
SAp6Q22	0.60
EXPETCMt	0.89
EXINLOGt	0.94

The account of variance explained by the latent dependent (endogenous) variables in terms of squared multiple correlations which are also known as effect sizes are given by the Table 28.

Table 28 Squared Multiple Correlations of Dependent Latent Variables

Endogenous Variables(η)	R^2
EXPETCM	0.08
EXINLOG	0.32

The endogenous variable EXPETCM (express, extract and compute) has small effect size whereas EXINLOG (express, infer logically) has large effect size.In addition, the summary statistics of the model were given in the Appendix X shows that fitted residuals range are within the acceptable values for a good fit that is ±1 (Kelloway, 1998). The goodness of fit indices after the revision according to the modification indices are: [(χ^2(818.445 N = 431) = 819.419 p<.0000. RMSEA= 0.0382. S-RMR = 0.0540. GFI = 0.902. AGFI = 0.877. CFI = 0.971. NNFI= 0.966]. The goodness of fit indices is given in the Table 29 below:

Table 29 Goodness of Fit Indices of the Survey-Testt Model

Fit Index	Criterion	Value	
Chi-Square (χ^2)	(Ratio of χ^2 to *df*) <5	818.445	1.63<5
Degrees of Freedom(*df*)		503	
Root Mean Square Error of Approximation (RMSEA)	< 0.05 smaller the better	0.0382	
Root Mean Square Residual (RMR)		0.0674	
Standardized Root Mean Square Residual (S-RMR)		0.0540	
Parsimony Goodness of Fit Index (PGFI)	higher the better	0.720	
Parsimony Normed Fit Index (PNFI)		0.785	
Normed Fit Index (NFI)	> 0.90	0.929	
Non-Normed Fit Index (NNFI)		0.966	
Comparative Fit Index (CFI)		0.971	
Incremental Fit Index (IFI)		0.971	
Relative Fit Index (RFI)		0.916	
Goodness of Fit Index (GFI)		0.902	
Adjusted Goodness of Fit Index (AGFI)		0.877	

The fit indices reveal that the model fits the data well. The normal shape steam-leaf and q-plots of the fitted residuals and their range that is within 1 in absolute value indicating overall fit of the data to the model. The direct, indirect and total effects of exogenous variables to endogenous variables are shown in the Table 30. Regression equations of the SEM model are shown in the Appendix J.

Table 30 Direct, Indirect and Total Effects for Survey-test model

Variable	EXINLOG			EXPETCM		
	Direct	Indirect	Total	Direct	Indirect	Total
MEANORT	-0.11	**0.104**	-0.002	**0.19**	-	**0.19**
MSEFFIC	0.11	0.084	**0.20**	0.15	-	0.15
MOT	0.05	**-0.155**	-0.11	**-0.28**	-	**-0.28**
DISORSD	-0.04	0.079	0.03	**0.14**	-	**0.14**
SURAPP	0.05	-0.021	0.03	-0.04	-	-0.04

*: Values in bold faces indicate significant direct and total effects.

4.10 Third Model for the Survey and the Test (Surveyi-Test)

Up to now, the fit indices of the two models (survey-test and survey-testt models) that were tested could be improved up to some degree. These models were presented in the preceding paragraphs. At present, the factor scores as index scores that were calculated for five (5) factors of the survey at the exploratory factor analysis phase by using SPSS program were used in the current model. In other words, the thirth model included the index scores of these five latent variables from the survey. Each latent variable's error variance was set to 1-Cronbach's alpha reliability of the corresponding factor at the SIMPLIX syntax (see Appendix U). No other covariance errors of observed variables were set free except for the four pairs from the CFA of the test.

The path diagrams of the model in the Figures 12 and 13, represent the coefficients in standardized and in t-values respectively. The basic structural model in standardized and in t-value estimates can be found in the Appendix K. The model includes five independent observed variables; 'meaning orientation' (MEANORTi), 'mathematics self-efficacy(MSEFFICi)', 'motivation (MOTi)', 'disorganized study methods(DISORSTDi)', 'surface approach(SURAPPi)' and two dependent latent variables 'Express, extract and compute(EXPEXTCM)', 'Express, infer logically' (EXINFLOG) that were measured by 18 observed variables and 5 index scores as independent observed variables. In addition, a path from EXPEXTCM to EXINFLOG was added based on the suggested modification indices and high correlations among these latent variables.

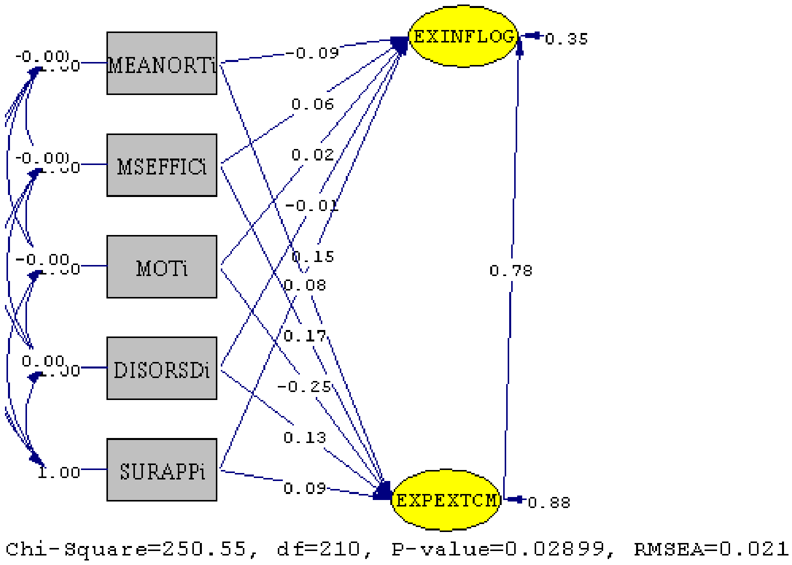


Figure 12 Parameter Estimates of the Model in Standardized Values

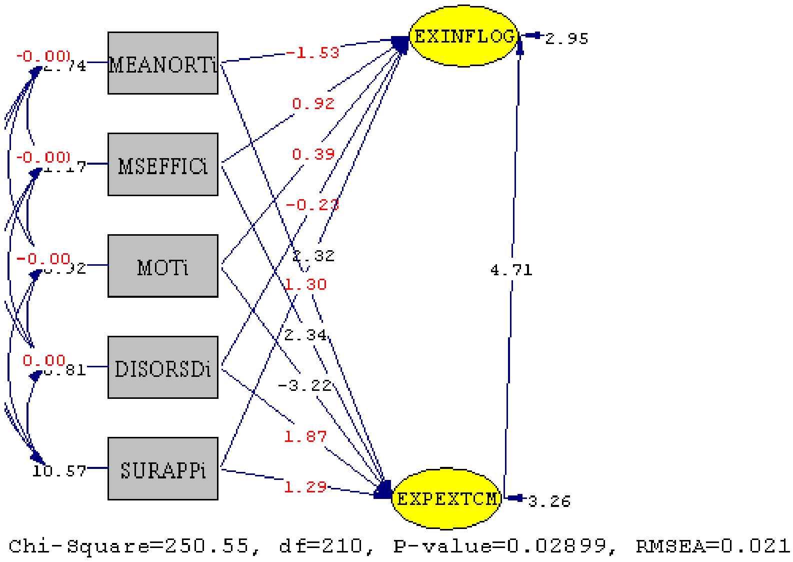


Figure 13 Paramater Estimates of the Model in t-values

The measurement and path coefficients (λ) of the model with errors of the independent (δ) and dependent variables (ε) were depicted in the Table 31:

Table 31 Measurement and Error Coefficients of the Model

Dependent Variables	Observed Variables	λ_Y	ε
EXINFLOG	LInf1R1	0.15	0.12
	LInf2R2	0.10	0.12
	MEx1R4	0.32	0.13
	ECp3R13	0.25	0.17
	LInf3R3	0.21	0.13
	EC3R9iii	0.21	0.20
	EC6R9vi	0.10	0.23
	EC4R9iv	0.09	0.12
	EC5R9v	0.07	0.12
	ECp5R17	0.17	0.21
EXPEXTCM	ECp7R19	0.24	0.16
	ECp4R16	0.17	0.13
	ExTb2R14	0.19	0.18
	CpSkl1R7	0.14	0.13
	ECp2R12	0.21	0.19
	ECp6R18	0.22	0.16
	ExTb3R21	0.18	0.17
	ECp1R11	0.21	0.20

The magnitude and the direction of the paths from independent to dependent latent variables (γ) are given in the Table 32.

Table 32 Gamma Path Coefficients of the Model

Dependent Variables(η)	Independent Variables(ξ)	γ
EXINFLOG	MEANORTi	-0.08
	MSEFFICi	0.06
	MOTi	0.03
	DISORSDi	-0.01
	SURAPPi	0.15
EXPEXTCM	MEANORTi	0.08
	MSEFFICi	0.17
	MOTi	-0.25
	DISORSDi	0.13
	SURAPPi	0.09

Path coefficients among dependent variables (β) are shown in the Table 33 below and the squared multiple correlations (R^2) of 18 observed variables that were included in the model are given in the Table 34 below:

Table 33 β path coefficients among dependent variables

Dependent Variables(η)		β
EXINFLOG	EXINFLOG	-
	EXPEXTCMP	0.78
EXPEXTCMP	EXINFLOG	-
	EXPEXTCMP	-

Table 34 Squared Multiple Correlations of Observed Variables of the Model

Observed Variables	R^2
LInf1R1	0.16
LInf2R2	0.08
MEx1R4	0.43
ECp3R13	0.26
LInf3R3	0.25
EC3R9iii	0.18
EC6R9vi	0.04
EC4R9iv	0.06
EC5R9v	0.04
ECp5R17	0.12
ECp7R19	0.26
ECp4R16	0.19
ExTb2R14	0.17
CpSkl1R7	0.13
ECp2R12	0.20
ECp6R18	0.23
ExTb3R21	0.16
ECp1R11	0.19

The account of variance explained by the latent dependent (endogenous) variables in terms of R^2 known as effect sizes are given by the Table 35 below:

Table 35 Squared Multiple Correlations of Dependent Latent Variables

Endogenous Variables(η)	R^2
EXPEXTCMP	0.12
EXINFLOG	0.65

The endogenous variable EXPEXTCM (express, extract and compute) has medium effect size whereas EXINFLOG (express, infer logically) has large effect size.In addition, the summary statistics of the fitted residuals, stem-leaf and q-plots that were given in the Appendix X shows that fitted residuals range are within the acceptable values for a good fit that is ±1 (Kelloway, 1998). The goodness of fit indices after the revision according to the modification indices are: [(χ^2(254.573 N = 431) = 250.546 p<.0000. RMSEA= 0.0212. S-RMR = 0.0407. GFI = 0.952. AGFI = 0.937. CFI = 0.976. NNFI= 0.971]. The goodness of fit indices is given in the Table 36 below:

Table 36 Goodness of Fit Indices of the Surveyi-Test Model

Fit Index	Criterion	Value	
Chi-Square (χ^2)	(Ratio of χ^2 to *df*) <5	254.573	1.21<5
Degrees of Freedom(*df*)		210	
Root Mean Square Error of Approximation (RMSEA)	< 0.05 smaller the better	0.0212	
Root Mean Square Residual (RMR)		0.0122	
Standardized Root Mean Square Residual (S-RMR)		0.0407	
Parsimony Goodness of Fit Index (PGFI)	higher the better	0.724	
Parsimony Normed Fit Index (PNFI)		0.729	
Normed Fit Index (NFI)	> 0.90	0.878	
Non-Normed Fit Index (NNFI)		0.971	
Comparative Fit Index (CFI)		0.976	
Incremental Fit Index (IFI)		0.976	
Relative Fit Index (RFI)		0.853	
Goodness of Fit Index (GFI)		0.952	
Adjusted Goodness of Fit Index (AGFI)		0.937	

It can be concluded that the model fits the data very well. The fitted residuals display are within 1 in absolute value and the similarity of the shape of the steam-leaf plots of fitted residuals to the standardized residuals could also refer to an overall fit of the data to the model. The direct, indirect and total effects of exogenous variables to endogenous variables are shown in the Table 37. In addition, the structural regression equations of the surveyi-test model at Appendix U.

Table 37 Direct, Indirect and Total Effects of Latent variables at SEM Model*

Variable	EXINFLOG			EXPEXTCMP		
	Direct	Indirect	Total	Direct	Indirect	Total
MEANORTi	-0.09	0.06	-0.02	0.08	-	0.08
MSEFFICi	0.06	**0.13**	**0.19**	**0.17**	-	**0.17**
MOTi	0.02	**-0.19**	**-0.17**	**-0.25**	-	**-0.25**
DISORSDi	-0.01	0.10	0.09	0.13	-	0.13
SURAPPi	**0.14**	0.07	**0.22**	0.09	-	0.09

*: Values in bold faces indicate significant direct and total effects.

4.11 Factor Structure Equalities across Two Regions

In order to answer the research question 4, among three structural models tested in the preceding sections, the third structural model (surveyi-test) that yielded best fit indices were considered as satisfactory for validating this model across two regions (Ankara and Northern Cyprus). The model comprise of five independent variables as index scores of the subdimensions of the survey (‘meaning orientation’ (MEANORTi), ‘mathematics self-efficacy(MSEFFICi)’, ‘motivation (MOTi)’, ‘disorganized study methods(DISORSTDi)’, ‘surface approach(SURAPPi)’) and two dependent latent variables as ‘Express, extract and compute(EXPEXTCM)’, ‘Express, infer logically’ (EXINFLOG) of the test on competency in mathematical thinking and reasoning. This model was tested by LISREL program.

The results for Ankara region are presented below. The path diagrams of the model at the Figures 14 and 15 represent the coefficients in standardized and in t-values respectively. The basic structural model in standardized and in t-value estimates can be found in the Appendix L.

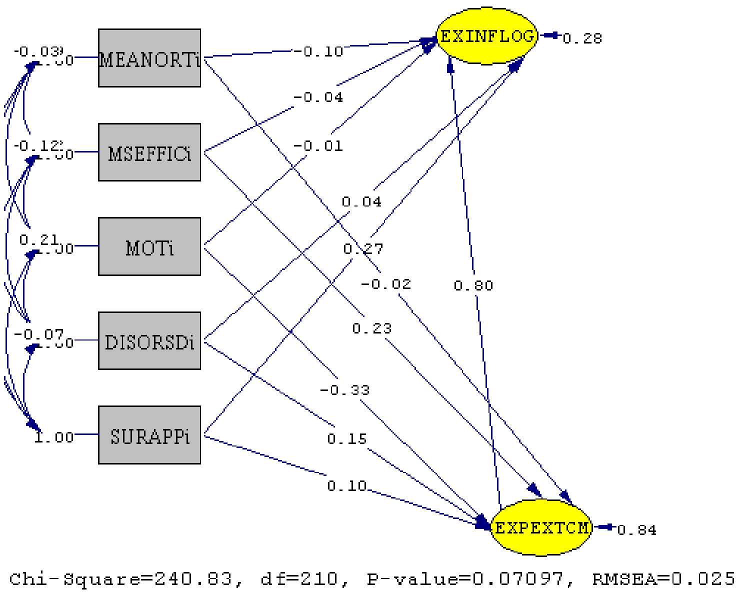


Figure 14 Standardized Parameter Estimates of the Model for Ankara Region

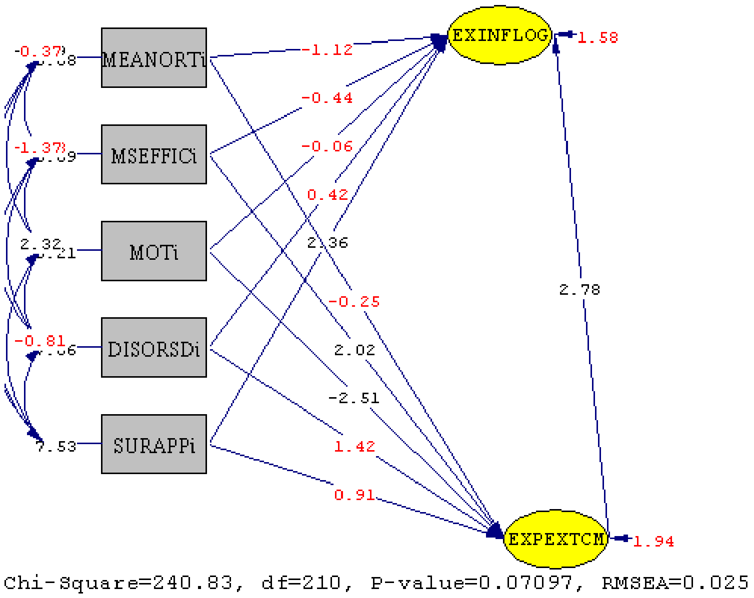


Figure 15 T-value Estimates of the Model for Ankara Region

The measurement and path coefficients (λ) of the model with errors of the independent (δ) and dependent variables (ε) were depicted in the Table 38:

Table 38 Measurement and Error Coefficients of the Model

Dependent Variables	Observed Variables	λ_Y	ε
EXINFLOG	LInf1R1	0.15	0.18
	LInf2R2	0.08	0.19
	MEx1R4	0.30	0.17
	ECp3R13	0.28	0.17
	LInf3R3	0.23	0.17
	EC3R9iii	0.12	0.19
	EC6R9vi	0.05	0.25
	EC4R9iv	0.03	0.09
	EC5R9v	0.05	0.11
	ECp5R17	0.12	0.24
EXPEXTCM	ECp7R19	0.20	0.12
	ECp4R16	0.15	0.08
	ExTb2R14	0.16	0.15
	CpSkl1R7	0.09	0.08
	ECp2R12	0.17	0.15
	ECp6R18	0.10	0.11
	ExTb3R21	0.15	0.15
	ECp1R11	0.16	0.18

The gamma (γ) path coefficients from independent to dependent latent variables are given in the Table 39.

Table 39 Gamma Path Coefficients of the Model

Dependent Variables(η)	Independent Variables(ξ)	γ
EXINFLOG	MEANORTi	-0.102
	MSEFFICi	-0.042
	MOTi	-0.006
	DISORSDi	0.039
	SURAPPi	0.269
EXPEXTCM	MEANORTi	-0.024
	MSEFFICi	0.227
	MOTi	-0.327
	DISORSDi	0.150
	SURAPPi	0.099

Path coefficients among dependent variables beta (β) are shown in the Table 40 and the squared multiple correlations (R^2) of 18 observed variables that were included in the model are given in the Table 41 below:

Table 40 β path coefficients among dependent variables

Dependent Variables(η)		β
EXINFLOG	EXINFLOG	-
	EXPEXTCM	0.80
EXPEXTCM	EXINFLOG	-
	EXPEXTCMP	-

Table 41 Squared Multiple Correlations of Observed Variables of the Model

Observed Variables	R^2
LInf1R1	0.11
LInf2R2	0.03
MEx1R4	0.37
ECp3R13	0.32
LInf3R3	0.24
EC3R9iii	0.07
EC6R9vi	0.01
EC4R9iv	0.01
EC5R9v	0.02
ECp5R17	0.06
ECp7R19	0.25
ECp4R16	0.23
ExTb2R14	0.14
CpSkl1R7	0.09
ECp2R12	0.15
ECp6R18	0.08
ExTb3R21	0.13
ECp1R11	0.12

The account of variance explained by the latent dependent (endogenous) variables in terms of squared multiple correlations which are also known as effect sizes are given by the Table 42.

Table 42 Squared Multiple Correlations of Dependent Latent Variables

Endogenous Variables(η)	R^2
EXPEXTCMP	0.16
EXINFLOG	0.72

The endogenous variable EXPEXTCM (express, extract and compute) has medium effect size whereas EXINFLOG (express, infer logically) has large effect size. In addition, the summary statistics of the fitted residuals, stem-leaf and q-plots that were given in the Appendix X shows that fitted residuals range are within the acceptable values for a good fit that is ±1 (Kelloway, 1998). The goodness of fit indices after the revision according to the modification indices are: [(χ^2(255.830 N = 231) = 240.829 p=0.0710. RMSEA= 0.025. S-RMR = 0.0561. GFI = 0.917. AGFI = 0.890. CFI = 0.922. NNFI= 0.906]. The goodness of fit indices is given in the Table 43 below:

Table 43 Goodness of Fit Indices of the Model for Ankara Region

Fit Index	Criterion	Value	
Chi-Square (χ^2)	(Ratio of χ^2 to df) <5	255.830	1.22<5
Degrees of Freedom(df)		210	
Root Mean Square Error of Approximation (RMSEA)	< 0.05 smaller the better	0.0253	
Root Mean Square Residual (RMR)		0.0147	
Standardized Root Mean Square Residual (S-RMR)		0.0561	
Parsimony Goodness of Fit Index (PGFI)	higher the better	0.697	
Parsimony Normed Fit Index (PNFI)		0.577	
Normed Fit Index (NFI)	> 0.90	0.695	
Non-Normed Fit Index (NNFI)		0.906	
Comparative Fit Index (CFI)		0.922	
Incremental Fit Index (IFI)		0.927	
Relative Fit Index (RFI)		0.633	
Goodness of Fit Index (GFI)		0.917	
Adjusted Goodness of Fit Index (AGFI)		0.890	

It can be concluded that the model fits the data very well. The fitted residuals display are within 1 in absolute value and the similarity of the shape of the steam-leaf plots of fitted residuals to the standardized residuals could also refer to an overall fit of the data to the model. The direct, indirect and total effects of exogenous variables to endogenous variables are shown in the Table 44. In addition, the structural regression equations of the SEM model are shown at Appendix N.

Table 44 Direct, Indirect and Total Effects for Ankara Region

Variable	EXINFLOG			EXPEXTCMP		
	Direct	Indirect	Total	Direct	Indirect	Total
MEANORTi	-0.10	-0.02	-0.12	-0.02	-	-0.02
MSEFFICi	-0.04	0.18	0.14	**0.23**	-	**0.23**
MOTi	-0.01	**-0.26**	-0.27	**-0.33**	-	**-0.33**
DISORSDi	0.04	0.12	0.16	0.15	-	0.15
SURAPPi	**0.27**	0.08	**0.35**	0.10	-	0.10

*: Values in bold faces indicate significant direct and total effects.

In addition, the results for Northern Cyprus region are presented below. The path diagrams of the model at the Figures 16 and 17 represent the coefficients in standardized and in t-values respectively. The basic structural model in standardized and in t-value estimates can be found in the Appendix M

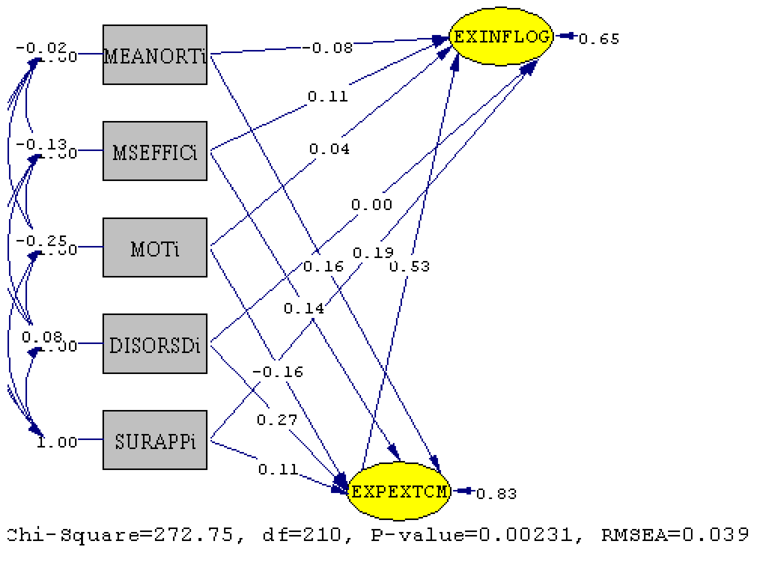


Figure 16 Standard Parameter Estimates of the Model for Northern Cyprus Region

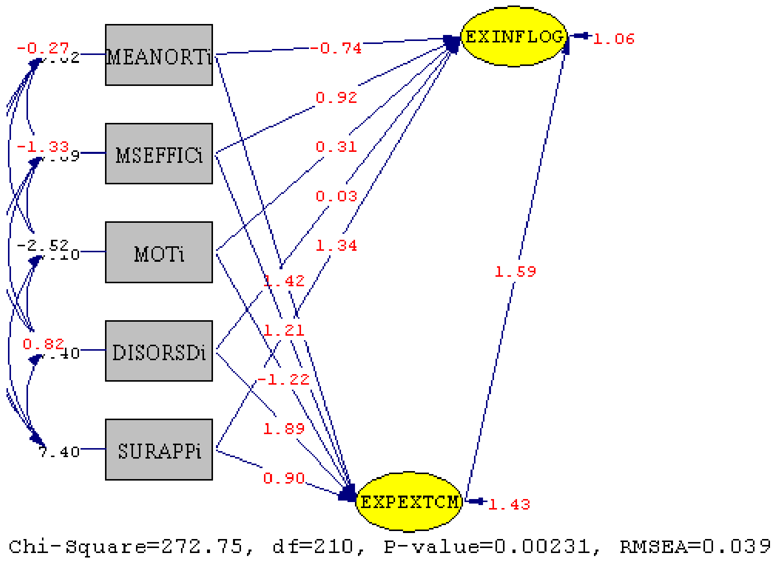


Figure 17 T-value Estimates of the Model for Northern Cyprus Region

The measurement and path coefficients (λ) of the model with errors of the independent (δ) and dependent variables (ε) were depicted in the Table 45:

Table 45 Measurement and Error Coefficients of the Model

Dependent Variables	Observed Variables	λ_Y	ε
EXINFLOG	LInf1R1	0.04	0.05
	LInf2R2	-0.01	0.02
	MEx1R4	0.20	0.11
	ECp3R13	0.14	0.18
	LInf3R3	0.12	0.08
	EC3R9iii	0.21	0.20
	EC6R9vi	0.21	0.19
	EC4R9iv	0.13	0.15
	EC5R9v	0.12	0.13
	ECp5R17	0.23	0.17
EXPEXTCM	ECp7R19	0.25	0.18
	ECp4R16	0.16	0.18
	ExTb2R14	0.20	0.20
	CpSkl1R7	0.12	0.19
	ECp2R12	0.14	0.23
	ECp6R18	0.19	0.21
	ExTb3R21	0.20	0.19
	ECp1R11	0.13	0.23

The magnitude and the direction of the paths from independent to dependent latent variables (γ) are given in the Table 46.

Table 46 Gamma Path Coefficients of the Model

Dependent Variables(η)	Independent Variables(ξ)	γ
EXINFLOG	MEANORTi	-0.08
	MSEFFICi	0.108
	MOTi	0.037
	DISORSDi	0.004
	SURAPPi	0.189
EXPEXTCM	MEANORTi	0.162
	MSEFFICi	0.144
	MOTi	-0.161
	DISORSDi	0.266
	SURAPPi	0.109

Path coefficients among dependent variables beta (β) are shown in the Table 47 and the squared multiple correlations (R^2) of 18 observed variables that were included in the model are given in the Table 48 below:

Table 47 β path coefficients among dependent variables

Dependent Variables(η)		β
EXINFLOG	EXINFLOG	-
	EXPEXTCM	0.52
EXPEXTCM	EXINFLOG	-
	EXPEXTCMP	-

Table 48 Squared Multiple Correlations of Observed Variables of the Model

Observed Variables	R^2
LInf1R1	0.04
LInf2R2	0.01
MEx1R4	0.26
ECp3R13	0.10
LInf3R3	0.14
EC3R9iii	0.18
EC6R9vi	0.18
EC4R9iv	0.10
EC5R9v	0.09
ECp5R17	0.23

Table 48 (Cont'd)

Observed Variables	R^2
ECp7R19	0.25
ECp4R16	0.12
ExTb2R14	0.16
CpSkl1R7	0.07
ECp2R12	0.07
ECp6R18	0.15
ExTb3R21	0.16
ECp1R11	0.07

The account of variance explained by the latent dependent (endogenous) variables in terms of squared multiple correlations which are also known as effect sizes are given by the Table 49.

Table 49 Squared Multiple Correlations of Dependent Latent Variables

Endogenous Variables(η)	R^2
EXPEXTCMP	0.35
EXINFLOG	0.17

The endogenous variable EXPEXTCM (express, extract and compute) has large effect size whereas EXINFLOG (express, infer logically) has medium effect size. In addition, the summary statistics of the fitted residuals, stem-leaf and q-plots that were given in the Appendix X shows that fitted residuals range are within the acceptable values for a good fit that is ±1 (Kelloway, 1998). The goodness of fit indices after the revision according to the modification indices are: [(χ^2(273.187 N = 200) = 272.748 p=0.0231. RMSEA= 0.0387. S-RMR = 0.0635. GFI = 0.894. AGFI = 0.860. CFI = 0.861. NNFI= 0.833]. The goodness of fit indices is given in the Table 50.

Table 50 Goodness of Fit Indices of the Model for Northern Cyprus Region

Fit Index	Criterion	Value	
Chi-Square (χ^2)	(Ratio of χ^2 to *df*) <5	273.187	1.30<5
Degrees of Freedom(*df*)		210	
Root Mean Square Error of Approximation (RMSEA)	< 0.05 smaller the better	0.0387	
Root Mean Square Residual (RMR)		0.0189	
Standardized Root Mean Square Residual (S-RMR)		0.0635	
Parsimony Goodness of Fit Index (PGFI)	higher the better	0.680	
Parsimony Normed Fit Index (PNFI)		0.510	
Normed Fit Index (NFI)	> 0.90	0.614	
Non-Normed Fit Index (NNFI)		0.833	
Comparative Fit Index (CFI)		0.861	
Incremental Fit Index (IFI)		0.873	
Relative Fit Index (RFI)		0.535	
Goodness of Fit Index (GFI)		0.894	
Adjusted Goodness of Fit Index (AGFI)		0.860	

It can be concluded that the model fits the data reasonably. The fitted residuals display are within 1 in absolute value and the similarity of the shape of the steam-leaf plots of fitted residuals to the standardized residuals could also refer to an overall fit of the data to the model. The direct, indirect and total effects of exogenous variables to endogenous variables are shown in the Table 51. In addition, the structural regression equations of the SEM model are shown at Appendix N.

Table 51 Direct, Indirect and Total Effects for Northern Cyprus Region

Variable	EXINFLOG			EXPEXTCMP		
	Direct	Indirect	Total	Direct	Indirect	Total
MEANORTi	-0.078	0.08	0.01	0.16	-	0.16
MSEFFICi	0.108	0.08	0.18	0.14	-	0.14
MOTi	0.037	-0.08	-0.05	-0.16	-	-0.16
DISORSDi	0.004	0.14	0.14	0.27	-	0.27
SURAPPi	0.19	0.06	0.25	0.11	-	0.11

The comparison of the overall and region based fit indices, Cronbach's alpha coefficients of the factors and the ranges of the standardized path coefficients are given in the Tables 52, 52, and 54.

Table 52 Goodness of Fit Indices for surveyi-test model

Fit Index	Overall	Ankara	Northern Cyprus
Chi-Square (χ^2) / Degrees of Freedom(*df*)	1.21	1.22	1.30
Root Mean Square Error of Approximation (RMSEA)	0.0212	0.0253	0.0387
Standardized Root Mean Square Residual (S-RMR)	0.0407	0.0561	0.0635
Goodness of Fit Index (GFI)	0.952	0.917	0.894
Adjusted Goodness of Fit Index (AGFI)	0.937	0.890	0.860
Comparative Fit Index (CFI)	0.976	0.922	0.861

Table 53 Alpha Reliability Coefficients for All Latent Variables across Regions

Latent Variables	Overall(N=431)	Ankara(N=200)	Northern Cyprus(N=231)
MEANORT	0.869	0.795	0.911
MSEFFIC	0.762	0.774	0.756
MOT	0.745	0.747	0.752
DISORSTD	0.737	0.736	0.744
SURAPP	0.721	0.700	0.743
EXPEXTCM	0.657	0.575	0.562
EXINFLOG	0.651	0.525	0.606

Table 54 Overall Range of the Standardized Path coefficients across Regions

Path Coefficients Range	Min.	Max.
Overall	-0.25	0.22
Ankara	-0.33	0.35
Northern Cyprus	-0.16	0.27

From the Table 52 above, all the fit indices are deemed to be acceptable for moving on the interpretation of the significant relationships among the latent variables of the model across the two regions.

With the aim of further investigating of the region based differences in the subdimensions of the survey and the test, the aforementioned surveyi-test model was taken into account for this purpose. In order to validate whether surveyi-test model holds across two regions, covariance matrices obtained for Ankara (*N=231*) and Northern Cyprus (*N=200*) samples separately and the model was tested for each region respectively. The model yielded adequate fit to the data for both regions. For Northern Cyprus sample, however no statistically significant relationship was observed in the path coefficients of the model. On the other hand, at Ankara sample, MSEFFICi (positively affects EXPEXTCM whereas MOTi negatively affects EXPEXTCM and SURAPPi positively affects EXINFLOG. In addition, there is a positive effect of EXPEXTCM on EXINFLOG. This outcome is in line with the overall model.

For both regions, there are positive direct and total effects of SURAPPi on EXINFLOG. In addition, there exist positive indirect and total effects of MSEFFICi on EXINFLOG and negative indirect and total effects of MOTi on EXINFLOG. There exist also direct positive and total effects of MSEFFICi on EXPEXTCM and negative direct and total effects MOTi on EXPEXTCM.

For Ankara region, there are direct positive effects of EXPEXTCM and SURAPPi on EXINFLOG. There is positive direct effect of MSEFFICi and there is negative effect of MOTi on EXPEXTCM. In addition, there exists negative indirect effect of MOTi and positive total effect of SURAPPi on EXINFLOG. There exist positive total effect of MSEFFIC, and negative total effect of MOTi on EXPEXTCM.

4.12 Gender and Grade Level Differences among Factors of Survey

Addressing research questions 5.1 through 5.3, corresponding hypotheses were tested by two-way Multivariate Analysis of Variance (MANOVA). The independent variables are gender and grade level, the dependent variables are the index scores of the factors of the survey; 'meaning orientation' (MEANORTi), 'mathematics self-efficacy (MSEFFICi)', 'motivation (MOTi)', 'disorganized study methods (DISORSDi)', 'surface approach (SURAPPi)'. The descriptive statistics of minimum, maximum, mean, standandard deviation, skewness and kurtosis of the dependent variables with respect to the levels of independent variables were shown below at the Tables 55 and 56.

Table 55 Descriptive Statistics with respect to Gender

	N	Min.	Max.	M	STD	SK	KR
Female							
MEANORTi	281	-4.79	2.18	0.10	0.93	-1.29	4.80
MSEFFICi	281	-3.45	3.06	-0.03	1.01	0.01	0.15
MOTi	281	-3.21	2.71	0.08	0.96	-0.46	0.54
DISORSDi	281	-2.53	2.63	-0.01	1.00	0.22	-0.17
SURAPPi	281	-3.09	2.76	0.01	0.96	-0.16	0.06
Male							
MEANORTi	148	-4.43	2.01	-0.18	1.08	-1.24	2.88
MSEFFICi	148	-2.47	2.74	0.06	0.98	0.00	-0.21
MOTi	148	-3.57	2.18	-0.15	1.06	-0.50	0.71
DISORSDi	148	-2.15	2.54	0.01	1.00	0.12	-0.51
SURAPPi	148	-2.88	2.71	-0.03	1.08	-0.22	0.17
All							
MEANORTi	431	-4.79	2.18	0.00	1.00	-1.30	3.84
MSEFFICi	431	-3.45	3.06	0.00	1.00	0.00	0.04
MOTi	431	-3.57	2.71	0.00	1.00	-0.50	0.67
DISORSDi	431	-2.53	2.63	0.00	1.00	0.18	-0.30
SURAPPi	431	-3.09	2.76	0.00	1.00	-0.20	0.15

Table 56 Descriptive Statistics with respect to Grade Level

	N	Min.	Max.	M	STD	SK	KR
Grade Level 1							
MEANORTi	86	-2.04	1.94	0.13	0.76	0.04	0.46
MSEFFICi	86	-2.79	2.09	-0.01	0.99	0.04	-0.32
MOTi	86	-2.27	1.83	0.21	0.80	-0.24	0.35
DISORSDi	86	-2.11	2.63	-0.02	0.94	0.36	0.36
SURAPPi	86	-1.87	1.83	-0.07	0.85	0.04	-0.44
Grade Level 2							
MEANORTi	115	-4.13	2.18	-0.07	0.98	-1.35	4.20
MSEFFICi	115	-2.00	3.06	0.01	0.96	0.33	0.11
MOTi	115	-2.94	2.71	-0.06	1.11	-0.21	-0.11
DISORSDi	115	-2.53	2.54	-0.34	0.97	0.47	0.09
SURAPPi	115	-3.09	2.41	-0.17	1.14	-0.32	-0.11
Grade Level 3							
MEANORTi	109	-2.83	1.75	-0.01	1.01	-0.80	0.66
MSEFFICi	109	-3.45	2.74	-0.01	1.13	-0.09	-0.05
MOTi	109	-3.57	2.16	0.00	0.91	-0.95	3.03
DISORSDi	109	-2.15	2.10	0.17	0.97	-0.02	-0.59
SURAPPi	109	-2.64	2.71	0.05	0.94	-0.02	0.23

Table 56 (continued)

Grade Level 4 and 5 (4&5)							
MEANORTi	119	-4.79	1.96	-0.02	1.15	-1.74	4.98
MSEFFICi	119	-2.47	2.60	0.00	0.95	-0.18	0.22
MOTi	119	-3.21	2.18	-0.11	1.07	-0.43	0.05
DISORSDi	119	-2.16	2.35	0.18	1.03	0.03	-0.25
SURAPPi	119	-2.88	2.76	0.15	0.99	-0.12	0.13
All Grade Levels							
MEANORTi	431	-4.79	2.18	0.00	1.00	-1.30	3.84
MSEFFICi	431	-3.45	3.06	0.00	1.00	0.00	0.04
MOTi	431	-3.57	2.71	0.00	1.00	-0.50	0.67
DISORSDi	431	-2.53	2.63	0.00	1.00	0.18	-0.30
SURAPPi	431	-3.09	2.76	0.00	1.00	-0.20	0.15

From the Tables 55 and 56, except for the few kurtosis values, the skewness and kurtosis values are within the acceptable range of ±2. In addition, histograms with normal curves were given in the Figures 18 and 19 below:

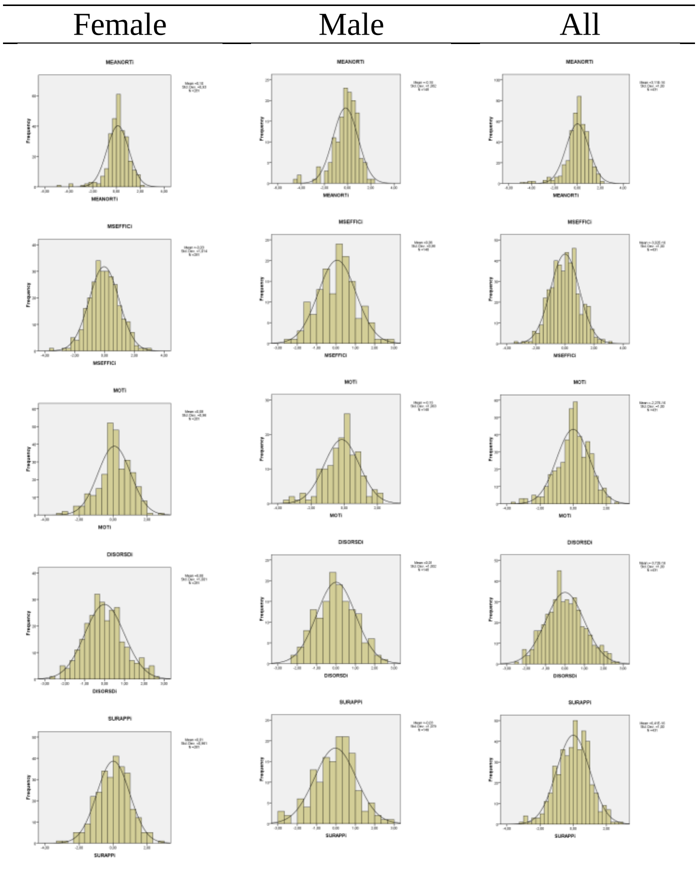


Figure 18 Histograms of the Dependent Variables with respect to Gender

Grade Level				
1	2	3	4&5	All

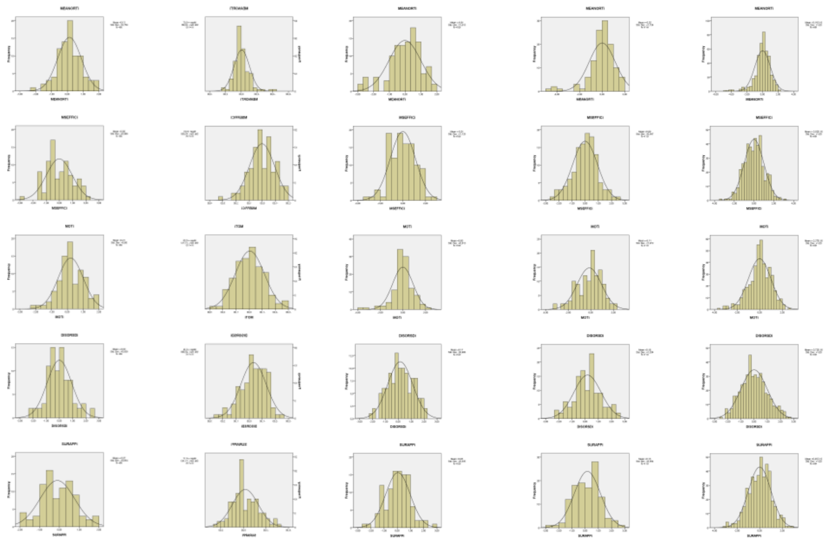


Figure 19 Histograms of the Dependent Variables with respect to Grade Level

Multivariate analysis of variance (MANOVA) has three assumptions; independence of observations, normality of the population variances that indicates multivariate normality i.e. observations on the dependent variables are multivariately normally distributed for each group of independent variables and that univariate normality could be inspected by histograms, skewness and kurtosis and multivariate normality can be detected by Mahalanobis distance calculated for dependent variables, and the equality of the population variance-covariance matrices for the dependent variables could be checked by Box test of equality of covariance matrices and Levene’s test of equality of error variances.

It was assumed that the there exist no correlated observations between subjects. For the univariate normality assumption, histograms with normal curve and skewness and kurtosis were inspected. Although there are few violations regarding kurtosis but since there are more than 30 subjects for each cell the MANOVA analysis is still robust (Pallant, 2007, p. 286).

For the multivariate normality Mahalanobis Distance was calculated. Although there are few outliers that are not influential points and since MANOVA can tolerate few outliers they are included in the analysis (Pallant, 2007, p. 279). From the Box's M Test of Equality of the Covariance matrices it could be seen that covariance matrices for 5 dependent variables were not equal. Since the ratio of largest group size to the smallest 3.24 > 1.5 this assumption is not met. However, it was stated that Box's M Test could be too strict for the large sample size (Tabachnick & Fidell, 2001).

Table 57 Box's Test of Equality of Covariance Matrices

Box's M	174.536
F	1.589
df1	105
df2	117546.749
Sig.	0.000

For the equality of the error variances, Levene's test revealed that except the dependent variable MOTi other variables satistfy this assumption.

Table 58 Levene's Equality of Error Variances

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
MEANORTi	1.509	7	419	0.162
MSEFFICi	1.952	7	419	0.060
MOTi	4.288	7	419	0.000
DISORSDi	0.373	7	419	0.918
SURAPPi	1.698	7	419	0.108

After the verification of the assumptions, two-way MANOVA was conducted to test the null hypothesis regarding research question 5.1 through 5.3 at significance level of 0.05. Wilk's Lambda (Λ) was considered for testing multivariate null hypotheses. The result was shown in the Table 59.

Table 59 Multivariate Tests

Effect	Wilks'Λ Value	F	Hypo.df	Err. df	Sig.	Partial Eta Squared	Observed Power
Gender	0.969	2.618[a]	5	415	**0.024***	0.031	0.803
GradeLevel	0.932	1.962	15	1146.034	**0.015***	0.023	0.940
Gender*GradeLevel	0.968	0.904	15	1146.034	0.560	0.011	0.567

***** $p<0.05$

Significant differences were found among the dependent variables with respect to gender and grade level separately at the alpha (α) level of significance 0.05. However, there exists no significant interaction between gender and grade level on the composite set of related factors. From multivariate test results, for gender, Wilk’s $\Lambda = 0.969$ $F(5,415) = 2.618$, $p = 0.024$, $\eta^2 = 0.031$, for grade level Wilk’s $\Lambda = 0.932$ $F(15, 1146.034) = 1.962$, $p < 0.05$, $\eta^2 = 0.023$). The eta-squared η^2 has small effect that is only 3.1% and 2.3% of the variance are explained by 5 dependent variables regarding gender and grade level respectively. The follow-up test results are shown in the Table 60 below:

Table 60 Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[b] Source
Gender	MEANORTi	7.550	1	7.550	7.704	**.006***	0.018	0.791
	MSEFFICi	0.651	1	0.651	0.637	0.425	0.002	0.125
	MOTi	4.213	1	4.213	4.271	0.039	0.010	0.541
	DISORSDi	0.129	1	0.129	0.135	0.714	0.000	0.066
	SURAPPi	0.097	1	0.097	0.097	0.756	0.000	0.061
GradeLev.	MEANORTi	2.205	3	0.735	0.750	0.523	0.005	0.211
	MSEFFICi	0.049	3	0.016	0.016	0.997	0.000	0.053
	MOTi	7.056	3	2.352	2.384	0.069	0.017	0.595
	DISORSDi	13.075	3	4.358	4.561	**.004***	0.032	0.885
	SURAPPi	6.067	3	2.022	2.024	0.110	0.014	0.519

** p<0.01*

The tests between-subject effect results were tested at the alpha level 0.01 which was calculated by dividing the selected alpha level (0.05) into the number of dependent variables (5). Results showed that there exist statistically significant mean differences among MEANORTi (meaning orientation of students) with respect to gender ($F(1,419) = 7.704$, $p = 0.006$, $\eta^2 = 0.02$)) and DISORSDi (disorganized study methods) with respect to grade level (F (3,419)

=4.561, p=0.04, η^2=0.032)). The partial eta-squared has small effect sizes on the specified factors. In order to detect significantly different groups, post hoc analysis was considered for the grade level since it has more than 3 categories and estimated marginal means were taken into consideration for the independent variable gender. The inspection of mean scores revealed that females (*M=0.10, SD= 0.93*) reported remarkably higher scores in the MEANORTi (meaning orientation) dimension than males (*M= -0.18, SD= 1.08*). The multiple comparisons across grade level were presented at the Table 61:

Table 61 Multiple Comparisons across Grade Level

Dependent Variable		(I) Grade Level	(J) Grade Level	Mean Difference (I-J)	Std. Error	Sig.
DISORSDi	Scheffe	1	2	0.3169	0.13936	0.161
			3	-0.1842	0.14157	0.639
			4 ve 5	-0.2086	0.13835	0.519
		2	1	-0.3169	0.13936	0.161
			3	**-0.5011***	0.13130	**0.002***
			4 ve 5	**-0.5255***	0.12783	**0.001***
		3	1	0.1842	0.14157	0.639
			2	**0.5011***	0.13130	0.002
			4 ve 5	-0.0243	0.13023	0.998
		4 ve 5	1	0.2086	0.13835	0.519
			2	**0.5255***	0.12783	0.001
			3	0.0243	0.13023	0.998
	Bonferroni	1	2	0.3169	0.13936	0.141
			3	-0.1842	0.14157	1.000
			4 ve 5	-0.2086	0.13835	0.795
		2	1	-0.3169	0.13936	0.141
			3	**-0.5011***	0.13130	**0.001***
			4 ve 5	**-0.5255***	0.12783	**0.000***
		3	1	0.1842	0.14157	1.000
			2	**0.5011***	0.13130	**0.001**
			4 ve 5	-0.0243	0.13023	1.000
		4 ve 5	1	0.2086	0.13835	0.795
			2	**0.5255***	0.12783	**0.000**
			3	0.0243	0.13023	1.000

* *p<0.01*

From the Table 61, there exist significant differences between grade levels 2 and 3; and between grade levels 2, and 4&5 across the dependent variable DISORSDi (disorganized study methods). In other words, third year students (*M=0.17, SD=0.97*) have acquired more disorganized study methods than second year students (*M= -0.34 SD=0.97*). Besides, fourth and fifth year students (*M=0.18, SD=1.03*) use more disorganized study methods than second year students (*M= -0.34, SD=0.97*). However, the effect sizes are again small for these particular comparsions.

4.13 Region and Grade Level Differences among Factors of the Test

Two-way Multivariate Analysis of Variance (MANOVA) was employed in order to investigate research questions 6.1 through 6.3 and corresponding hypotheses.The independent variables are region and grade level, and the dependent variables as EXPEXTCMt (express, extract and compute) and EXINFLOGt (express, infer logically) where observed variables comprising each factor were added together to create a total score for each dimension. The descriptive statistics of minimum, maximum, mean, standandard deviation, skewness and kurtosis of the dependent variables with respect to the levels of independent variables were shown below at the Tables 62 and 63:

Table 62 Descriptive Statistics with respect to Region

Students at Ankara Region							
	N	Min.	Max.	M	STD	SK	KR
EXPEXTCMt	231	1	8	6.46	1.57	-1.40	2.02
EXINFLOGt	231	1	10	5.39	1.96	0.16	-0.52
Students at Northern Cyprus Region							
EXPEXTCMt	200	0	8	4.66	1.92	-0.35	-0.52
EXINFLOGt	200	0	8	3.38	1.84	0.31	-0.40
All Students							
EXPEXTCMt	431	0	8	5.62	1.96	-0.77	-0.12
EXINFLOGt	431	0	10	4.46	2.15	0.21	-0.46

Table 63 Descriptive Statistics with respect to Grade Level

	N	Min.	Max.	M	STD	SK	KR
Grade Level 1							
EXPEXTCMt	86	1.00	8.00	5.86	2.00	-0.93	0.19
EXINFLOGt	86	1.00	9.00	4.90	1.83	0.37	-0.36
Grade Level 2							
EXPEXTCMt	115	1.00	8.00	5.25	1.91	-0.38	-0.64
EXINFLOGt	115	0.00	10.00	3.77	2.36	0.40	-0.41
Grade Level 3							
EXPEXTCMt	109	0.00	8.00	5.33	2.17	-0.66	-0.40
EXINFLOGt	109	0.00	9.00	4.18	1.92	0.47	-0.05
Grade Level 4&5							
EXPEXTCMt	119	1.00	8.00	6.08	1.67	-1.14	1.03
EXINFLOGt	119	0.00	10.00	5.08	2.14	0.05	-0.69
All Grade Levels							
EXPEXTCMt	431	0.00	8.00	5.62	1.96	-0.77	-0.12
EXINFLOGt	431	0.00	10.00	4.46	2.15	0.21	-0.46

Tables 62 and 63 imply that skewness and kurtosis values are within the acceptable ranges (±2). Histograms with normal curves were shown in the Figures 20 and 21.

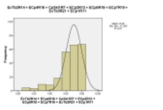
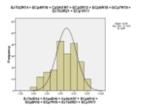
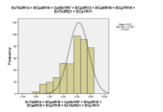
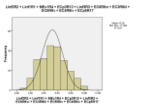
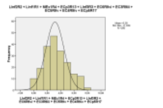
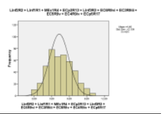
	Ankara	Northern Cyprus	All
EXPEXTCMt			
EXINFLOGt			

Figure 20 Histograms of the Dependent Variables with respect to Region

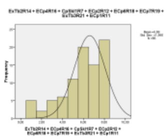
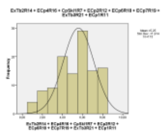
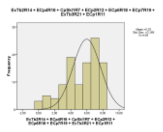
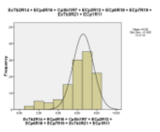
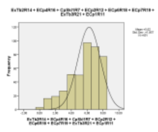
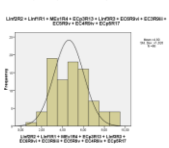
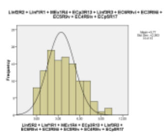
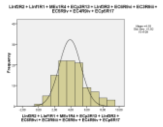
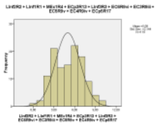
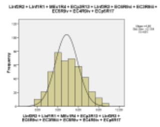
	Grade Levels 1	2	3	4&5	All
EXPEXTCMt					
EXINFLO Gt					

Figure 21 Histograms of the Dependent Variables with respect to Grade Level

It was assumed that there exist no correlated observations between subjects. For the univariate normality assumption, histograms with normal curve and skewness and kurtosis were inspected. Since there are more than 30 subjects for each cell the MANOVA analysis is robust (Pallant, 2007, p. 286).

For the multivariate normality Mahalanobis Distance was calculated. Although there are few outliers that are not influential points and since MANOVA can tolerate few outliers they are included in the analysis (Pallant, 2007, p. 279). From the Box's M Test of Equality of the Covariance matrices it could be seen that covariance matrices for 2 dependent variables were not equal. Since the ratio of largest group size to the smallest 2.69 > 1.5 this assumption is not met. It was stated that Box's M Test could be too strict for the large sample size (Tabachnick & Fidell, 2001).

Table 64 Box's Test of Equality of Covariance Matrices

Box's M	67.319
F	3.144
df1	21
df2	102420.058
Sig.	0.000

For the equality of the error variances, Levene's test revealed that the dependent variable EXPEXTCMt doesn't meet with the assumption.

Table 65 Levene's Equality of Error Variances

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
EXPEXTCMt	3.711	7	421	.001
EXINFLOGt	.927	7	421	.485

After the verification of the assumptions, two-way MANOVA was conducted to test the null hypothesis regarding research question 6.1 through 6.3 at both significance of level of 0.05. Wilk's Lambda (Λ) was considered for testing multivariate null hypotheses. The result was shown in the Table 66:

Table 66 Multivariate Tests

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power[b]
Grade Level	0.939	4.477[a]	6	840	**.000***	.031	.986
Region	0.737	75.013[a]	2	420	**.000***	.263	1.000
Region * Grade Level	0.950	3.617[a]	6	840	**.002***	.025	.957

***** *p<0.05*

Significant differences were found among dependent variables with respect to region and grade level separately at the alpha (α) level of significance 0.05. Furthermore, the interaction between region and grade level were also found to be significant on these composite set of factors. From multivariate test results, Wilk's Λ = 0.939 F (2,420) =75.013, p=0.000, η^2=0.263 for region, Wilk's Λ = 0.939 F (6, 840) =4.477, p=0.000, η^2=0.031) for grade level and for the interaction Wilk's Λ = 0.950 F (6, 840) =3.617, p=0.02, η^2=0.025). The partial eta-squared η^2 has small effect size for grade level and for the region by grade level interaction that are 3.1% and 2.5% of the variances are explained by 2 dependent variables respectively. On the other hand, the partial eta-squared η^2 has large effect size for region. That is 26.3% of the variance is explained by the 2 dependent variables regarding Cohen's (1988) classification of η^2 effect size where 0.01 is small, 0.06 is medium, and 0.14 or greater is considered as large. The follow-up test results are shown in the Table 67:

Table 67 Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[b]
GradeLev	EXPEXTCMt	34.888	3	11.629	4.034	**.008***	.028	.840
	EXINFLOGt	74.755	3	24.918	7.331	**.000***	.050	.984
Region	EXPEXTCMt	303.011	1	303.011	105.120	**.000***	.200	1.000
	EXINFLOGt	328.518	1	328.518	96.656	**.000***	.187	1.000
Region * GradeLevel	EXPEXTCMt	42.785	3	14.262	4.948	**.002***	.034	.911
	EXINFLOGt	37.612	3	12.537	3.689	**.012***	.026	.802

** p<0.025*

The tests between subject effect results were tested at the alpha level

0.025 which was calculated by dividing the selected alpha level (0.05) into the number of dependent variables (2). All results are found to be significant, namely there exist statistically significant mean differences among the dependent variables EXPEXTCMt (express, extract and compute) and EXINFLOGt (express, infer logically) with respect to grade level, region and region*grade level interaction respectively. For the independent variable grade level, the dependent variable EXPEXTCMt has F (3,421) = 4.034, p=0.008, η^2=0.028; EXINFLOGt F (3,421) = 7.331, p=0.000, η^2=0.050. For the independent variable region, the dependent variable EXPEXTCMt has values F (1,421) = 105.120, p=0.000, η^2=0.200; EXINFLOGt F (1,421) = 96.656, p=0.000, η^2=0.187. For the interaction region*grade level, the dependent variable EXPEXTCMt has values F (3,421) = 4.948, p=0.002, η^2=0.034; EXINFLOGt F (3,421) =3.689, p=0.012, η^2=0.026. The eta-squared effect sizes are small except for the variables region where the effect size is large. In order to detect significantly different groups post hoc analyses were carried out for grade level since it has more than 3 categories and estimated marginal means were taken into consideration for the variable region. From the inspection of mean scores among students it was found out that for EXPEXTCMt (express, extract and compute) students from Ankara region (*M=6.46, SD= 1.57*) have higher scores than students from Northern Cyprus region (*M=4.66, SD= 1.92*) and also for the dependent variable EXINFLOGt (express, infer logically) students from Ankara region (*M=5.39, SD= 1.96*) have obtained higher scores than students from Northern Cyprus region (*M=3.38, SD= 1.84*).

For the independent variable grade level, multiple comparisons from the post hoc tests were taken into account since it has more than three categories. From the Table 68, by using Bonferroni adjustment, it was revealed that for the dependent variable EXPEXTCMt (express, extract and compute) fourth and fifth year students (*M=6.08, SD= 1.67*) have reported significantly higher scores than the second grade students (*M=5.25, SD= 1.91*) and than the third year students (*M=5.33, SD= 2.17*). In addition, it is was found out that for the EXINFLOGt (express, infer logically), first year students (*M=4.90, SD= 1.83*) have higher scores than second year students (*M=3.77, SD=2.36*) and fourth and fifth year students (*M=5.08, SD=2.14*) have acquired significantly higher scores than second year students (*M=3.77, SD=2.36)* and also than third year students (*M=4.18, SD=1.92*).

Table 68 Multiple Comparisons across Grade Level

Dependent Variable		(I) Grade Level	(J) Grade Level	Mean Difference (I-J)	Std. Error	Sig.
EXPEXTCMt	Bonferroni	1	2	.6083	.24204	.074
			3	.5302	.24487	.186
			4 ve 5	-.2236	.24029	1.000
		2	1	-.6083	.24204	.074
			3	-.0781	.22696	1.000
			4 ve 5	-.8319*	.22201	**.001**
		3	1	-.5302	.24487	.186
			2	.0781	.22696	1.000
			4 ve 5	-.7538*	.22510	**.005**
		4 ve 5	1	.2236	.24029	1.000
			2	.8319*	.22201	**.001**
			3	.7538*	.22510	**.005**
EXINFLOGt	Scheffe	1	2	1.1301*	.26282	**.000**
			3	.7119	.26590	.068
			4 ve 5	-.1803	.26093	.924
		2	1	-1.1301*	.26282	**.000**
			3	-.4183	.24645	.411
			4 ve 5	-1.3104*	.24107	**.000**
		3	1	-.7119	.26590	.068
			2	.4183	.24645	.411
			4 ve 5	-.8921*	.24442	**.004**
		4 ve 5	1	.1803	.26093	.924
			2	1.3104*	.24107	**.000**
			3	.8921*	.24442	**.004**
	Bonferroni	1	2	1.1301*	.26282	.000
			3	.7119*	.26590	.046
			4 ve 5	-.1803	.26093	1.000
		2	1	-1.1301*	.26282	**.000**
			3	-.4183	.24645	.542
			4 ve 5	-1.3104*	.24107	**.000**
		3	1	-.7119*	.26590	.046
			2	.4183	.24645	.542
			4 ve 5	-.8921*	.24442	**.002**
		4 ve 5	1	.1803	.26093	1.000
			2	1.3104*	.24107	**.000**
			3	.8921*	.24442	**.002**

* *p<0.025*

The interaction between region and grade level was found to be significant with respect to the dependent variables EXPEXTCMt (express, extract and compute) and EXINFLOGt (express, infer logically) (see figures 18 and 19 below).

According to the Figure 22, in the overall sense, for both dependent variables, students from Ankara region outscored students from Northern Cyprus region. For the variable EXPEXCMt(express, extract, compute) second year students from Ankara tend to score higher than the first years students from Ankara region whereas, second year students score lower than the first year students from the Northern Cyprus region. In addition, third year students of Ankara tend to score slightly lower than the second year students of Ankara region while third year students from Northern Cyprus scored remarkably higher than the second year students of Northern Cyprus. The score of the fouth and fifth year students is slightly lower than the third year students of Ankara whereas fourth and fifth year students tend to score noticeably higher than the third year students from Northern Cyprus region.

According to the Figure 23, in the general sense for the dependent variable EXINFLOGt (express, infer logically) students from Ankara region scored higher than the students from Northern Cyprus region at all grade levels. However, there is no significant interaction between students' scores from Ankara and Northern Cyprus among the grade levels 3 and 4&5. Second year students of Ankara scored slighlty higher than the first year students of Ankara whereas second year students scored remarkably lower than the first year students at Northern Cyprus. Second year students from Ankara region scored slightly higher than third year students of Ankara region whereas, third year students from Northern Cyprus region scored markedly higher than second year students of Northern Cyprus. Although fourth and fifth year students for both regions scored higher than the third year students there exists no interaction between the grade level and region as it could be observed from the parallel lines of the graph in the Figure 23.

Table 69 Descriptives with respect to Region*Grade Level for EXPEXTCMt

Region	Grade Level	Mean	Std. Deviation	N
Students from Ankara	1	6.2029	1.79525	69
	2	6.6731	1.33902	52
	3	6.5778	1.51491	45
	4&5	6.5238	1.51186	63
	Total	6.4716	1.56870	229
Students from Northern Cyprus	1	4.4706	2.21127	17
	2	4.0794	1.47344	63
	3	4.4531	2.13757	64
	4&5	5.5893	1.70322	56
	Total	4.6550	1.91948	200
Total	1	5.8605	1.99507	86
	2	5.2522	1.91414	115
	3	5.3303	2.16904	109
	4&5	6.0840	1.66509	119
	Total	5.6247	1.96141	429

Table 70 Descriptives with respect to Region*Grade Level for EXINFLOGt

Region	Grade Level	Mean	Std. Deviation	N
Students from Ankara	1	5.1739	1.78191	69
	2	5.3846	2.07840	52
	3	5.2000	1.85374	45
	4&5	5.8254	2.09099	63
	Total	5.4061	1.95927	229
Students from Northern Cyprus	1	3.7647	1.60193	17
	2	2.4286	1.64331	63
	3	3.4687	1.63269	64
	4&5	4.2321	1.88767	56
	Total	3.3800	1.83916	200
Total	1	4.8953	1.82808	86
	2	3.7652	2.36321	115
	3	4.1835	1.92048	109
	4&5	5.0756	2.14381	119
	Total	4.4615	2.15444	429

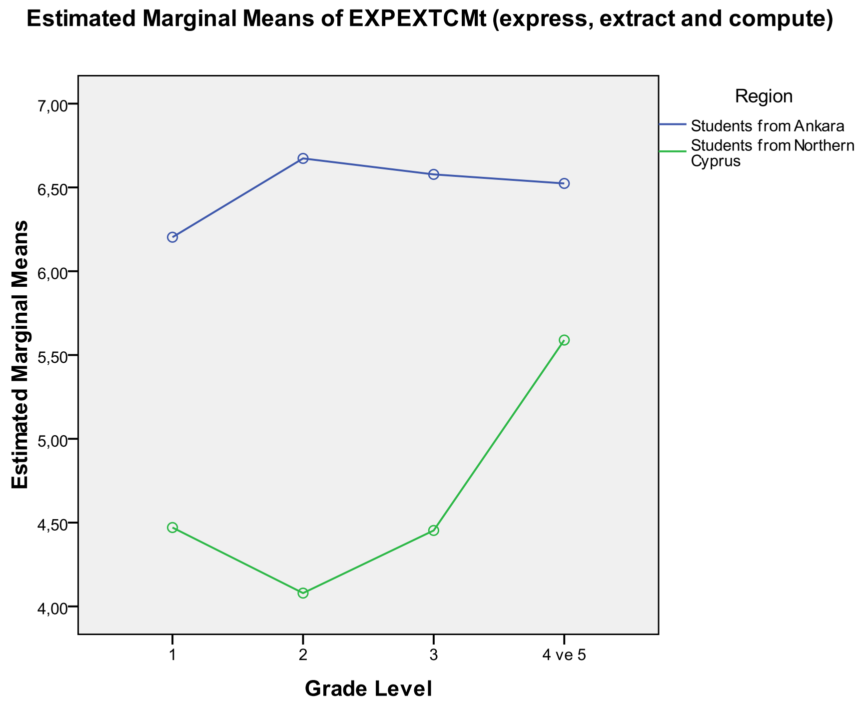


Figure 22 Region*Grade Level with respect to EXPEXTCMt

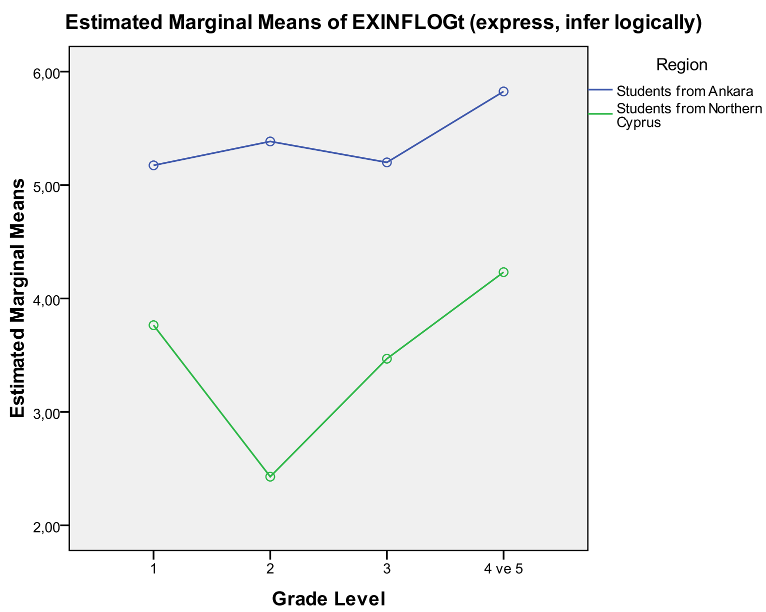


Figure 23 Region*Grade Level with respect to EXINFLOGt

4.14 Region, Gender and Grade Level Differences on the Total Test

Three-way univariate Analysis of Variance (ANOVA) was employed in order to investigate research questions 7.1 through 7.4 and corresponding hypotheses.The independent variables are region, grade level and gender, and the dependent variable is the total test score of the students where 18 observed variables were all added up together to obtain the total score. The descriptive statistics of minimum, maximum, mean, standandard deviation, skewness and kurtosis of the dependent variables with respect to the levels of independent variables were shown below at the Tables 71, 72 and 73:

Table 71 Descriptive Statistics with respect to Region

Students from Ankara					
	N	M	STD	SK	KR
Testscore	231	11.86	3.03	-0.52	0.22
Students from Northern Cyprus					
Testscore	200	8.03	3.02	0.16	-0.50
All Students					
Testscore	431	10.08	3.58	-0.14	-0.66

Table 72 Descriptive Statistics with respect to Grade Level

Grade Level 1					
	N	M	STD	SK	KR
Testscore	86	10.76	3.30	-0.28	-0.56
Grade Level 2					
Testscore	115	9.02	3.66	0.17	-0.84
Grade Level 3					
Testscore	109	9.51	3.48	-0.08	-0.41
Grade Levels 4&5					
Testscore	119	11.16	3.41	-0.36	-0.25
All Grade Levels					
Testscore	431	10.08	3.58	-0.14	-0.66

Table 73 Descriptive Statistics with respect to Gender

	N	M	STD	SK	KR
Female					
Testscore	281	9.79	3.53	0.01	-0.58
Male					
Testscore	148	10.68	3.59	-0.43	-0.54
All					
Testscore	431	10.08	3.58	-0.14	-0.66

From the Tables 71, 72, and 73, skewness and kurtosis values are within the acceptable range of ±1. In addition, the histograms with normal curves were illustrated in the Figures 24, 25 and 26 below:

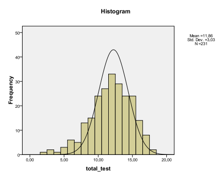
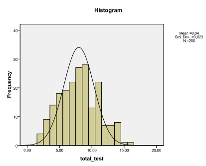
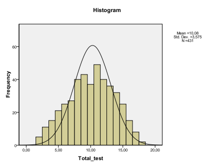
	Ankara	Northern Cyprus	All
Total_test_score			

Figure 24 Histograms with respect to Region

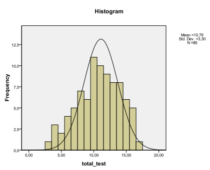
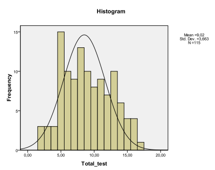
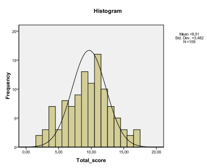
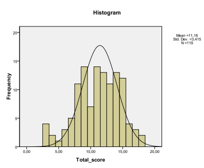
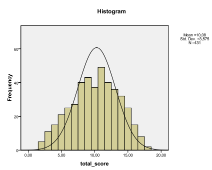
1	2	3	4-5	All
				

Figure 25 Histograms with respect to Grade Level

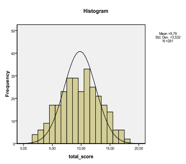
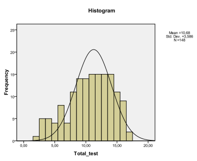
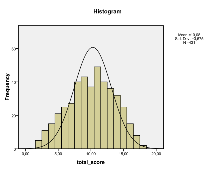
	Female	Male	All
Total_test_score			

Figure 26 Histograms with respect to Gender

It was assumed that there exist no correlated observations between subjects. For the univariate normality assumption, histograms with normal curve and skewness and kurtosis were inspected. Since there are more than 30 subjects for each cell conducting three-way ANOVA analysis is robust (Pallant, 2007, p. 286). For the equality of the error variances assumption is satisfied from Levene's test for the dependent variable.

Table 74 Levene's Equality of Error Variances

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
Total_test_score	1.043	15	411	0.409

Three-way ANOVA was conducted to test the null hypothesis regarding research questions 7.1 through 7.4 at both significance of level of 0.05. The Tests of Between-Subjects Effects results are shown in the Table 75:

Table 75 Tests of Between-Subject Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[b]
Region	1028.058	1	1028.058	128.640	**0.000***	0.238	1.000
Gender	108.970	1	108.970	13.635	**0.000***	0.032	0.958
GradeLevel	241.758	3	80.586	10.084	**0.000***	0.069	0.998
Region * Gender	71.202	1	71.202	8.909	**0.003***	0.021	0.846
Region * GradeLevel	159.879	3	53.293	6.669	**0.000***	0.046	0.974
Gender * GradeLevel	95.914	3	31.971	4.001	**0.008***	0.028	0.836
Region * Gender * GradeLevel	67.530	3	22.510	2.817	**0.039***	0.020	0.676
Error	3284.599	411	7.992				

***** *p<0.05*

From the Table 75 above, three-way ANOVA yielded significant results for all main and interaction effects with respect to region, gender and grade level at the level of significance 0.05.The main effects, F (1,411) =128.640, p=0.000, η^2=0.238 for *region*, F (1,411) =13.635, p=0.000, η^2=0.032) for *gender* and F

(3,411) =10.084, p=0.000, η^2=0.069) for *grade level*. The effect sizes vary from small to large (23.8% for region, 3.2% for gender and 6.9% for grade level).

Furthermore, the interaction between *region* and *gender* was found to be statistically significant; F (1, 411) =8.909, p=0.003, η^2=0.021). The partial eta-squared η^2 has small effect size (2.1%) for *region by gender* interaction. In addition, the interaction between *region* and *grade level* was also found to be statistically significant; F (3, 411) =6.669, p=0.000, η^2=0.046). The partial eta-squared η^2 has small effect size (4.6%) for the region by grade level interaction. Besides, the interaction between *gender* and *grade level* was found to be statistically significant; F (3, 411) =4.001, p=0.008, η^2=0.028). The partial eta-squared η^2 has again small effect size (2.8%) for the gender by grade level interaction. Moreover, the triple interaction among *region*gender*grade level* was found to be statistically significant as well; F (3, 411) =2.817, p=0.039, η^2=0.020). The partial eta-squared η^2 is again small (2%) for *region *gender*grade level* interaction.

In order to detect significantly different groups pairwise and multiple comparisons, post hoc analyses and profile plots were considered.

From the inspection of pairwise comparisons and mean scores among students it was found out that students from Ankara region (*M=11.86, SD= 3.03*) exhibited significantly higher scores than students from Northern Cyprus region (*M=8.38, SD= 3.02*). In addition, male students (*M=10.68, SD= 3.59*) obtained significantly higher scores than the female students (*M=9.79, SD= 3.53*) on the total test score of mathematical thinking and competency.

Furthermore, there exists also statistically significant main effect for grade level. From the Table 76, fourth and fifth (4&5) year students (*M=11.16, SD= 3.41*) scored significantly higher than the first (*M=10.76, SD= 3.30*), second (*M=9.02, SD= 3.66*) and third (*M=9.51, SD= 3.48*) year students on the total test score.

Table 76 Pairwise Comparisons with respect to Total Test Score

(I) Region	(J) Region	Mean Difference (I-J)	Std. Error	Sig.[a]
Students from Ankara	Students from Northern Cyprus	3.597*	0.317	**0.000***
Students from Ankara	Students from Northern Cyprus	-3.597*	0.317	**0.000***
(I) Gender				
Female	Male	-1.171*	0.317	**0.000***
Male	Female	1.171*	0.317	**0.000***
(I) Grade Level	(J) Grade Level			
1	2	0.717	0.476	0.796
	3	0.000	0.491	1.000
	4&5	-1.453*	0.485	**0.017***
2	1	-0.717	0.476	0.796
	3	-0.718	0.409	0.479
	4&5	-2.170*	0.401	**0.000***
3	1	0.001	0.491	1.000
	2	0.718	0.409	0.479
	4&5	-1.452*	0.419	**0.004***
4&5	1	1.453*	0.485	**0.017***
	2	2.170*	0.401	**0.000***
	3	1.452*	0.419	**0.004***

* *p<0.05*

For the independent variable grade level, multiple comparisons from the post hoc tests were taken into account since it has more than three categories. From the Table 77, by using the Bonferroni adjustment, it was revealed that fourth and fifth year students (*M=11.16, SD= 3.41*) have reported significantly higher scores than second year students (*M=9.02, SD= 3.66*) and than third year students (*M=9.51, SD= 3.48*). In addition, it was found out that first year students (*M=10.76, SD= 3.30*) have higher scores than second year students (*M=9.02, SD=3.66*) and than third year students (*M=9.51, SD=3.48*) on the total test score.

Table 77 Multiple Comparisons across Grade Level

	(I) Grade Level	(J) Grade Level	MeanDiff.(I-J)	Std. Error	Sig.
Scheffe	1	2	1.7384*	0.40301	**0.000**
		3	1.2044*	0.40941	**0.036**
		4&5	-0.4038	0.40011	0.797
	2	1	-1.7384*	0.40301	**0.000**
		3	-0.5340	0.37971	0.578
		4&5	-2.1423*	0.36966	**0.000**
	3	1	-1.2044*	0.40941	**0.036**
		2	0.5340	0.37971	0.578
		4&5	-1.6083*	0.37662	**0.000**
	4&5	1	0.4038	0.40011	0.797
		2	2.1423*	0.36966	**0.000**
		3	1.6083*	0.37662	**0.000**
Bonferroni	1	2	1.7384*	0.40301	**0.000**
		3	1.2044*	0.40941	**0.021**
		4&5	-0.4038	0.40011	1.000
	2	1	-1.7384*	0.40301	**0.000**
		3	-0.5340	0.37971	0.962
		4&5	-2.1423*	0.36966	**0.000**
	3	1	-1.2044*	0.40941	**0.021**
		2	0.5340	0.37971	0.962
		4&5	-1.6083*	0.37662	**0.000**
	4&5	1	0.4038	0.40011	1.000
		2	2.1423*	0.36966	**0.000**
		3	1.6083*	0.37662	**0.000**

*$p<0.05$

The Table 78 below represents subsequent descriptive statistics for the interaction between region, gender and grade level regarding the total test score.

Table 78 Descriptives of Region*Gender*Grade Level on the Total Test

Region	Gender	Grade Level	Mean	Std. Deviation	N
Students from Ankara	Female	1	10.9130	2.96518	46
		2	12.3939	2.79441	33
		3	11.4375	2.85044	32
		4&5	12.7187	2.79671	32
		Total	11.7762	2.92974	143
	Male	1	12.3043	2.85139	23
		2	11.4737	2.50263	19
		3	12.6154	3.17644	13
		4&5	11.9677	3.83392	31
		Total	12.0465	3.19156	86
	Total	1	11.3768	2.98083	69
		2	12.0577	2.70376	52
		3	11.7778	2.96103	45
		4&5	12.3492	3.34162	63
		Total	11.8777	3.02662	229
Students from Northern Cyprus	Female	1	5.8889	2.57121	9
		2	6.2439	2.13050	41
		3	7.8810	2.66140	42
		4&5	9.2727	2.87219	44
		Total	7.7059	2.86257	136
	Male	1	10.8750	2.03101	8
		2	7.0000	2.07020	22
		3	8.0500	3.36350	20
		4&5	11.8333	2.65718	12
		Total	8.7742	3.23617	62
	Total	1	8.2353	3.41924	17
		2	6.5079	2.12415	63
		3	7.9355	2.87938	62
		4&5	9.8214	2.99762	56
		Total	8.0404	3.01744	198
Total	Female	1	10.0909	3.43874	55
		2	8.9865	3.92216	74
		3	9.4189	3.25200	74
		4&5	10.7237	3.30090	76
		Total	9.7921	3.53805	279
	Male	1	11.9355	2.70722	31
		2	9.0732	3.18897	41
		3	9.8485	3.95381	33
		4&5	11.9302	3.51456	43
		Total	10.6757	3.58610	148
	Total	1	10.7558	3.30040	86
		2	9.0174	3.66343	115
		3	9.5514	3.47018	107
		4&5	11.1597	3.41478	119
		Total	10.0984	3.57543	427

The interaction between *region*gender* was found to be statistically significant (see Table 75). The Figure 27 and the Table 75 indicated significant region by gender interaction. Mean scores of male students at Ankara are higher than the male student in Northern Cyprus region. For the students from Ankara region, male students slightly surpass female students however, in Northern Cyprus region the difference in mean scores among male and female students are greater as compared to the students of Ankara region yet still male students outscored female students. Nevertheless, the prevalence of male students' scores over female students is a valid trend for both regions.

Table 79 Mean and Std. Error Region*Gender

Region	Gender	Mean	Std. Error
Students from Ankara	Female	11.866	0.239
	Male	12.090	0.320
Students from Northern Cyprus	Female	7.322	0.302
	Male	9.440	0.390

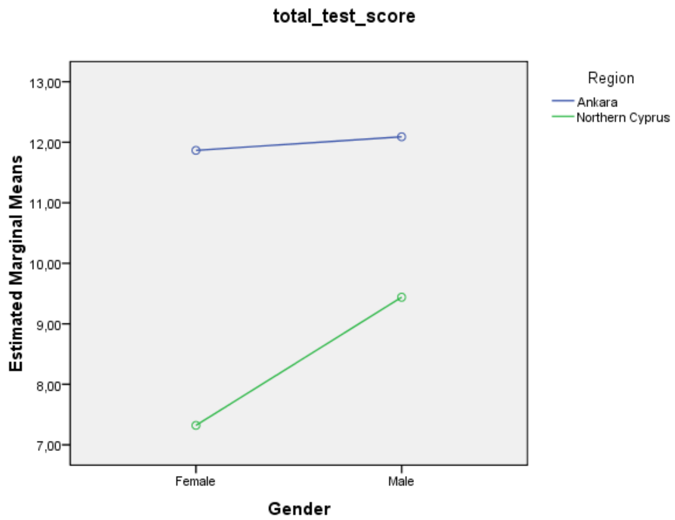


Figure 27 Region*Gender with respect to total test score

The interaction between *region*grade level* was also found to be statistically significant (see Table 75). From the table 75 and figure 28 below, it could be concluded that there exists significant interaction among region and grade level. Explicitly, at all grade levels students from Ankara region scored higher than the students from Northern Cyprus region. From the multiple comparisons Table 80, first year students of Northern Cyprus region scored significantly higher than the second and third year students of Northern Cyprus. In addition, fourth and fifth year students of Northern Cyprus obtained better scores than the second and third year students of Northern Cyprus students. Although the mean differences are not as evident as the scores of the students in Northern Cyprus region, this trend is also valid for the students of Ankara region. There mean scores are increasing slightly for the students of Ankara region as the grade level increases.

Table 80 Mean and Std. Error Region*Grade Level

Region	Grade Level	Mean	Std. Er.
Students from Ankara	1	11.609	0.361
	2	11.934	0.407
	3	12.026	0.465
	4&5	12.343	0.356
Students from Northern Cyprus	1	8.382	0.687
	2	6.622	0.374
	3	7.965	0.384
	4&5	10.553	0.460

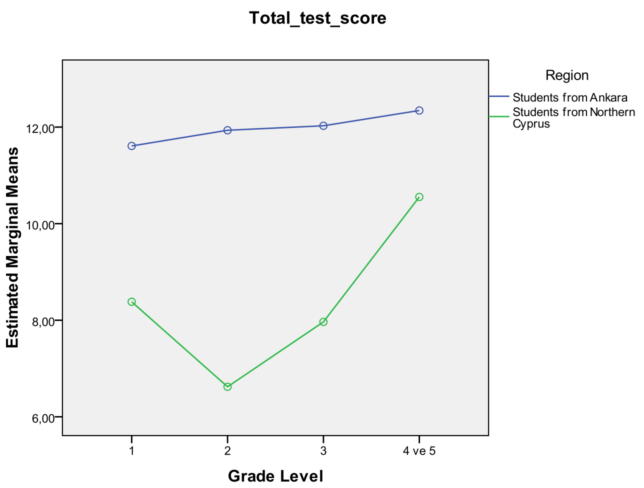


Figure 28 Region*Grade Level with respect to total test score

The interaction between *gender*grade level* was also found to be statistically significant (see Table 75). From the Table 75 and Fgure 29 below, there exists significant interaction among gender and grade level. Except for the second year students, at all grade levels male students have outscored female students on the whole. First year male students scored better than the second year male students whereas, second year female students scored higher grades than first year students. In addition, third and fourth-fifth year male students scored better than second year male students. This is also valid for female students and additionally than the first year female students.

Table 81 Mean and Std. Error Gender*Grade Level

Gender	Grade Level	Mean	Std. Error
Female	1	8.401	0.515
	2	9.319	0.331
	3	9.659	0.332
	4&5	10.996	0.328
Male	1	11.590	0.580
	2	9.237	0.443
	3	10.333	0.504
	4&5	11.901	0.481

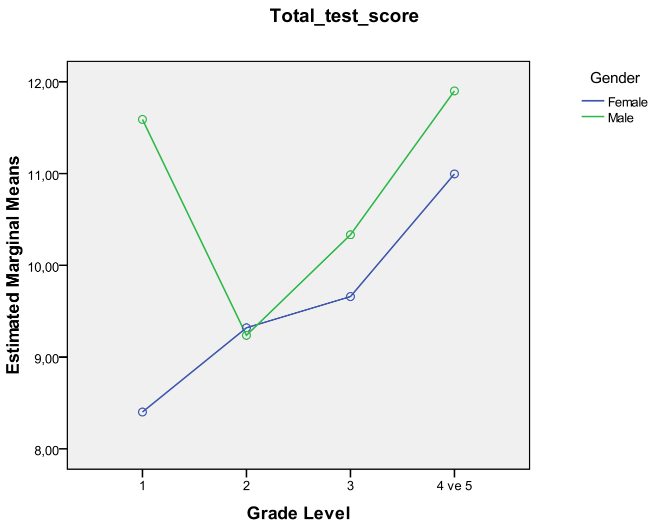


Figure 29 Gender * Grade Level with respect to total test score

Moreover, triple interaction among *region*gender*grade level* was also found to be statistically significant (see Table 75 above). From the table 75 and the Figures 30, 31, 32 and 33 the interaction among *region, gender and grade level* could be concluded. From the Figure 30 at Ankara region, first and third year male students scored higher on the total test than first and third female students while second and fourth&fifth year female students have higher scores than second and fourth&fifth male students. First year male students have obtained better scores than second year male students whereas this is reverse for female students.Third year male students scored better than second year male students on the other hand, this is reverse for female students. Lastly, fourth and fifth year male students scored less than third year male students conversely; again there exists a reverse trend for female students.

From the Figure 31 at Northern Cyprus region, except for the third year students, in the overall sense, male students have obtained higher scores than females. As the grade level increases female students score higher on the total test. However, first year male students scored better than second year male students and the rest of the grade levels the trend is same for the male students.

Table 82 Mean and Std. Error Region*Gender*Grade Level

Region	Gender	Grade Level	Mean	Std. Error
Students from Ankara	Female	1	10.913	0.417
		2	12.394	0.492
		3	11.438	0.500
		4&5	12.719	0.500
	Male	1	12.304	0.589
		2	11.474	0.649
		3	12.615	0.784
		4&5	11.968	0.508
Students from Northern Cyprus	Female	1	5.889	0.942
		2	6.244	0.441
		3	7.881	0.436
		4&5	9.273	0.426
	Male	1	10.875	0.999
		2	7.000	0.603
		3	8.050	0.632
		4&5	11.833	0.816

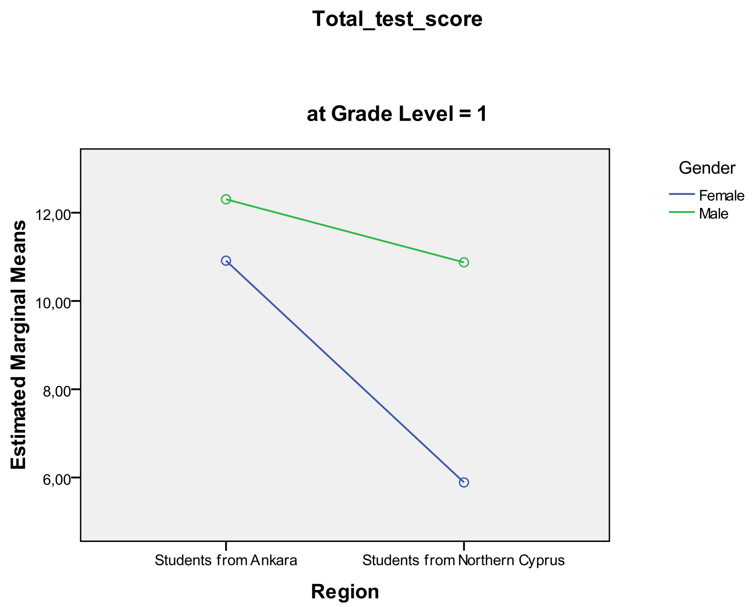


Figure 30 Region*Gender*GradeLevel (=1)

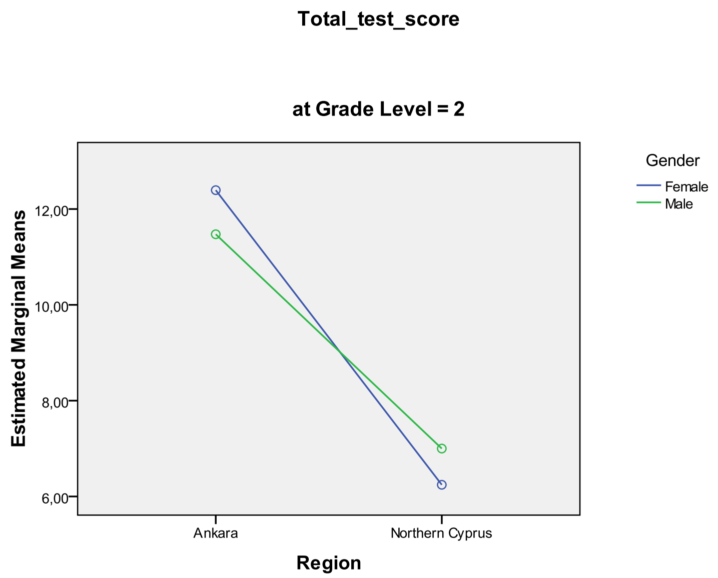


Figure 31 Region*Gender*GradeLevel (=2)

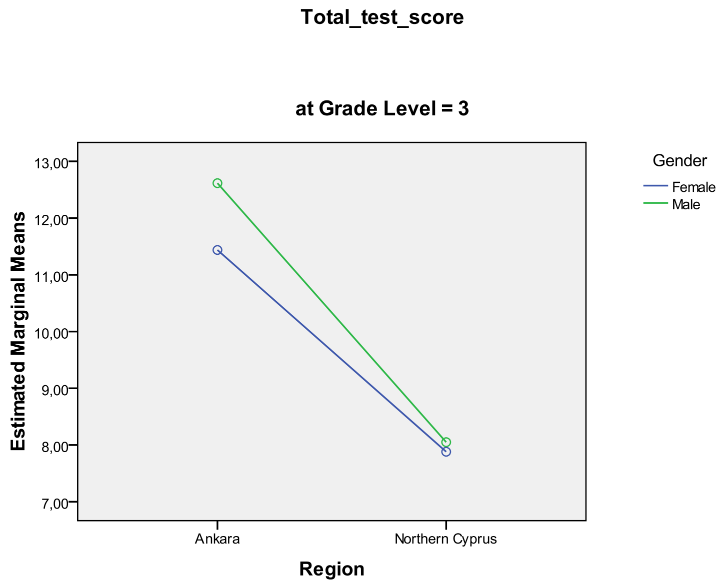


Figure 32 Region*Gender*GradeLevel (=3)

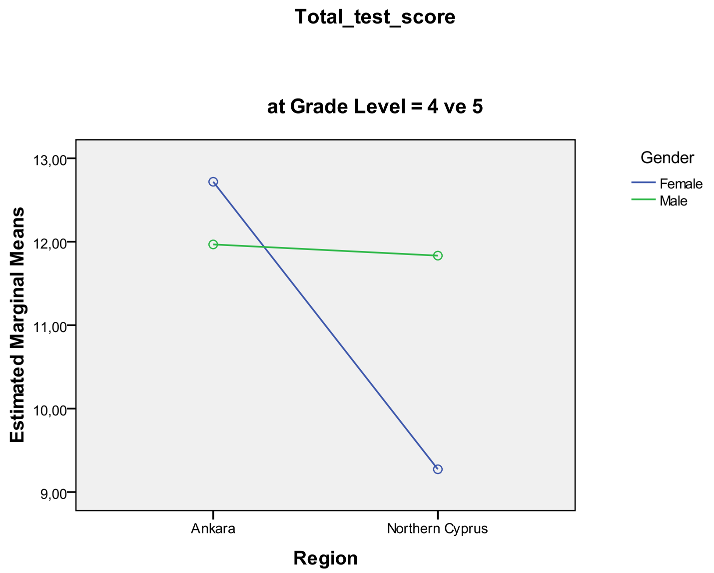


Figure 33 Region*Gender*GradeLevel (=4)

4.15 Summary of the Findings

Regarding the research question 1, *"What are the affective factors perceived by university students' and prospective teachers' in terms of approaches to studying, self-efficacy and problem solving strategies?"* and the research question 2,*"What are the main factors related to university students' and prospective teachers' mathematical thinking and reasoning competency?"* separate exploratory factor analyses (EFA) were employed to identify factor structures of the survey and the test. Findings revealed that, the survey comprise of five dimensions namely; 'meaning orientation' (MEANORTi), 'mathematics self-efficacy (MSEFFICi)', 'motivation (MOTi)', 'disorganized study methods (DISORSTDi)' and 'surface approach (SURAPPi)' that were measured by 33 observed variables and has a Cronbach's alpha (α) reliability of 0.871. Additionally, the test initially revealed 4 factors one of which is named as 'Express, extract and compute (EXPEXTCM)' that has an acceptable reliability above 0.60. However, due to high correlations among the other three identified factors and their low reliabilities, these three factors were combined to form a single factor named as 'Express, infer logically' (EXINFLOG). The Cronbach's alpha (α) reliability of the test with 18 observed variables is 0.762. Afterwards, confirmatory factor analyses (CFA) were conducted later to test the initially identified model fit for the survey and the test separately. Results revealed that, initial survey model of 5 latent variables indicated adequate fit to the data. Additionally, 2-factor model for the test exhibited best fit to the data.

In order to answer the research question 3.1 *"What linear structural model explains affective factors that are related to students' competency in mathematical thinking and reasoning?"* and the research question 3.2 *"What linear structural model explains the interrelationships between affective factors and competency in mathematical thinking and reasoning among students"*structural equation modeling techniques were conducted. In total, three main structural models were tested to determine among which of these models indicate the best fit to the data with respect to the relevant literature. The direct and total effects of the standardized path coefficients for all tested models were presented in the Table 85 below.

For the first tested model (survey-test) five subdimensions of the survey were included as latent independent variables and two aforesaid dimensions of the test were included as latent dependent variables. In addition, a path was defined from

EXPEXTCM to EXINFLOG (B=0.77, $p<0.05$) based on the program suggestions and the literature. It was found out that the variable MSEFFIC has a significant positive direct and total effect on the latent dependent variable EXINFLOG ($\Gamma=0.23$, $p<0.05$) and has significant positive direct effect on the latent dependent variables EXPEXTCMP ($\Gamma=0.21$, $p<0.05$) and the variable MSEFFIC also has a significant positive direct and total effect on EXPEXTCMP ($\Gamma=0.21$, $p<0.05$). In addition, the latent independent variable MOT has a direct ($\Gamma=-0.32$, $p<0.05$) and total ($\Gamma=-0.32$, $p<0.05$) negative significant effect on EXPEXTCMP.

For the second model (survey-testt) five subdimensions of the survey were included as latent independent variables as in the previous model however this time the observed variables for each factor of the test were added together for the purpose of reducing the number of observed variables that were included in the model testing. In addition, a path from EXPETCM to EXINLOG (B=0.54, $p<0.05$) and another path from observed variable DOSt1Q33 to the latent variable SURAPP were added and with respect to the modification suggestions. It was found out that the independent variable MEANORT has a significant positive indirect effect on the dependent variable EXINLOG ($\Gamma=0.104$, $p<0.05$) and has a direct and total positive significant effect on the dependent variables EXPETCM ($\Gamma=0.19$, $p<0.05$). The variables MSEFFIC has a significant positive total effect on the variable EXINLOG ($\Gamma=0.20$, $p<0.05$). Additionally, the variable MOT has a significant negative indirect effect on the variable EXINLOG ($\Gamma=-0.155$, $p<0.05$) and it also has a significant negative direct and total effects on the dependent latent variable EXPETCM ($\Gamma=-0.28$, $p<0.05$). Furthermore, the latent independent variable DISORSD has a significant positive direct and total effects on the variable EXPETCM ($\Gamma=0.14$, $p<0.05$).

For the thirth model (surveyi-test), index scores of the five latent variables from the survey were included as latent independent variables and the two aforesaid dimensions of the test were included as latent dependent variables. In addition, a path from EXPEXTCM to EXINFLOG (B=0.78, $p<0.05$) was added based on the suggested program modification indices, high correlations and relevant literature. It was revealed that, there are significant positive direct (Γ=0.14, $p<0.05$) and total (Γ=0.22, $p<0.05$) effects of SURAPPi on EXINFLOG. In addition, there exist positive indirect (Γ=0.13, $p<0.05$) and total (Γ=0.19, $p<0.05$) effects of MSEFFICi on EXINFLOG and also there exist negative indirect (Γ=-0.19, $p<0.05$) and total (Γ=-0.17, $p<0.05$) effects of MOTi on EXINFLOG. Furthermore, there exist also direct positive and total (Γ=0.17, $p<0.05$) effects of MSEFFICi on EXPEXTCM and negative direct (Γ=-0.25, $p<0.05$) and total effects MOTi on EXPEXTCM.

Regarding the research question 4, "*Do similar structural relationships related to approaches to studying, self-efficacy and problem solving strategies and competency in mathematical thinking and reasoning hold across students from two regions namely; Ankara and Northern Cyprus*?" among three previously tested structural models tested, the third structural model (surveyi-test) that yielded best fit indices to the entire data were considered as satisfactory for validating this model across two regions (Ankara and Northern Cyprus). In order to validate whether the surveyi-test model holds for two regions, covariance matrices obtained for Ankara (*N=231*) and Northern Cyprus (*N=200*) samples separately and the model was tested for each region respectively. The model yielded adequate fit to the data for both regions. For Northern Cyprus sample, however there exist no statistically significant path coefficients of the model. On the other hand, for Ankara sample, there are direct and total positive effects of SURAPPi on EXINFLOG. There are positive direct and total effects of MSEFFICi and there is negative effect of MOTi on EXPEXTCM. In addition, there exists negative indirect effect of MOTi and positive total effect of SURAPPi on EXINFLOG. There exist positive total effect of MSEFFIC, and negative total effect of MOTi on EXPEXTCM. Furthermore, there exists

For both regions, there are positive direct and total effects of SURAPPi on EXINFLOG. In addition, there exist positive indirect and total effects of MSEFFICi on EXINFLOG and negative indirect and total effects of MOTi on EXINFLOG. There exist also direct positive and total effects of MSEFFICi on EXPEXTCM and negative direct and total effects MOTi on EXPEXTCM.

For the purpose of answering the main research question 5,"*What are the differences among factors attributed to approaches to studying, self-efficacy and problem solving strategies with respect to the gender, grade level*" with respect to the sub-research question 5.1 "*What are the differences among these factors with respect to university students and prospective teachers at Turkey and at Northern Cyprus regarding gender?*" , the question 5.2 "*What are the differences among these factors across university students and prospective teachers regarding grade level?*" and the question 5.3 "*Are there any significant differences among these factors with respect to gender and grade level across university students and prospective teachers?"* two-way multivariate analysis of variance (MANOVA) was employed where gender and grade level are included as independent variables and five index scores of the survey that are; 'meaning orientation' (MEANORTi), 'mathematics self-efficacy (MSEFFICi)', 'motivation (MOTi)', 'disorganized study methods (DISORSDi)', 'surface approach (SURAPPi)' are included as dependent variables in the analysis.

Significant differences among dependent variables were found with respect to gender and grade level at the alpha (α) significance level of 0.05. On the other hand, there exists no significant interaction among gender and grade level on the set of composite factors. From followup analyses, it was revealed that female students (*M=0.10, SD= 0.93*) reported notably higher scores in the meaning orientation dimension than male students (*M= -0.18, SD= 1.08*). Furthermore, third year students (*M=0.17, SD=0.97*) have been using disorganized study methods more often than second year students (*M= -0.34 SD=0.97*). Besides, fourth and fifth year students (*M=0.18, SD=1.03*) have reported that they use disorganized study methods more frequently than second year students (*M= -0.34, SD=0.97*).

Moreover, another two-way Multivariate Analysis of Variance (MANOVA) was performed in order to investigate research question 6.1, " *What are the differences among these factors across university students and prospective teachers at Ankara and at Northern Cyprus?*", the question 6.2, "*What are the differences among these factors across university students and prospective teachers regarding* *grade level?*” and the research question 6.3, “*Are there any significant differences among these factors with respect to region and grade level across university students and prospective teachers?*”. The independent variables are region and grade level, and the dependent variables as EXPEXTCMt (express, extract and compute) and EXINFLOGt (express, infer logically) where observed variables comprising each factor were added together to create a total score for each dimension of the test.

Significant differences were found among dependent variables with respect to region and grade level separately at the alpha (α) level of significance 0.05. Furthermore, the interaction between region and grade level were also found to be significant on these composite set of factors. There exist statistically significant mean differences among the dependent variables EXPEXTCMt (express, extract and compute) and EXINFLOGt (express, infer logically) with respect to grade level, region and region*grade level interaction respectively.

From the inspection of mean scores among students it was found out that for EXPEXTCMt (express, extract and compute) students from Ankara region (*M=6.46*, *SD= 1.57*) have higher scores than students from Northern Cyprus region (*M=4.66, SD= 1.92*) and also for the dependent variable EXINFLOGt (express, infer logically) students from Ankara region (*M=5.39, SD= 1.96*) have obtained higher scores than students from Northern Cyprus region (*M=3.38, SD= 1.84*). For the grade level, it was revealed that for the dependent variable EXPEXTCMt (express, extract and compute) fourth and fifth grade level students (*M=6.08, SD= 1.67*) have reported significantly higher scores than the second grade students (*M=5.25, SD= 1.91*) and than the third year students (*M=5.33, SD= 2.17*). In addition, it is was found out that for the variable EXINFLOGt (express, infer logically), first year students (*M=4.90, SD= 1.83*) have higher scores than second year students (*M=3.77, SD=2.36*) and; fourth and fifth year students (*M=5.08, SD=2.14*) have acquired significantly higher scores than second year students (*M=3.77, SD=2.36)* and also than third year students (*M=4.18, SD=1.92*).

For the significant interaction between region and grade level with respect to the both dependent variables EXPEXTCMt (express, extract and compute) and EXINFLOGt (express, infer logically), students from Ankara region scored higher than the students from Northern Cyprus region. For the variable EXPEXCMt (express, extract, compute) second year students from Ankara tend to score higher than the first years students from Ankara region whereas, second year students score lower than the first year students from the Northern Cyprus region. In addition, third year students of Ankararegion tend to score slightly lower than the second year students of Ankara region while third year students from Northern Cyprus scored remarkably higher than the second year students of Northern Cyprus. The score of the fouth and fifth year students is slightly lower than the third year students of Ankara whereas fourth and fifth year students tend to score noticeably higher than the third year students from Northern Cyprus region.

For the dependent variable EXINFLOGt (express, infer logically) students from Ankara region scored higher than the students from Northern Cyprus region at all grade levels. However, there is no significant interaction between students' scores from Ankara and Northern Cyprus among the grade levels 3 and 4-5. Second year students of Ankara scored slighlty higher than the first year students of Ankara whereas second year students scored remarkably lower than the first year students at Northern Cyprus. Second year students from Ankara region scored slightly higher than third year students of Ankara region whereas, third year students from Northern Cyprus region scored markedly higher than second year students of Northern Cyprus. Although fourth and fifth year students for both regions scored higher than the third year students there exists no interaction between the grade level and region.

Three-way univariate Analysis of Variance (ANOVA) was employed in order to investigate research questions 7.1" *What are the differences across university students and prospective teachers at Ankara and at Northern Cyprus on the total test in competency in mathematical thinking and reasoning?* ", the question 7.2, "*What are the differences across university students and prospective teachers on the total test regarding grade level?*", the research question 7.3, "*What are the* *differences across university students and prospective teachers regarding gender?*" and the research question 7.4, "*Are there any significant differences across the total test with respect to region, grade level and gender across university students and prospective teachers?*". The independent variables are region, grade level and gender, and the dependent variable is the total test score of the students where 18 observed variables were all added up together to obtain the total score. Three-way ANOVA yielded significant results for all main and interaction effects with respect to region, gender and grade level.

It was found out that students from Ankara region (*M=11.86, SD= 3.03*) exhibited significantly higher scores than students from Northern Cyprus region (*M=8.38, SD= 3.02*). In addition, male students (*M=10.68, SD= 3.59*) obtained significantly higher scores than the female students (*M=9.79, SD= 3.53*) on the total test score of mathematical thinking and competency. Furthermore, there exists also statistically significant main effect for grade level. Besides, fourth and fifth year students (*M=11.16, SD= 3.41*) scored significantly higher than the first (*M=10.76, SD= 3.30*), second (*M=9.02, SD= 3.66*) and third (*M=9.51, SD= 3.48*) year students on the total test score. It was additionally revealed that fourth and fifth year students (*M=11.16, SD= 3.41*) have reported significantly higher scores than second year students (*M=9.02, SD= 3.66*) and than third year students (*M=9.51, SD= 3.48*). In addition, it was found out that first year students (*M=10.76, SD= 3.30*) have higher scores than second year students (*M=9.02, SD=3.66*) and than third year students (*M=9.51, SD=3.48*) on the total test.

The interaction between *region*gender* was found to be statistically significant. Mean scores of male students at Ankara are higher than the male student in Northern Cyprus region. For the students from Ankara region, male students' scores are slightly higher than female students however, in Northern Cyprus region the difference in mean scores among male and female students are greater as compared to the students of Ankara region yet still male students outscored female students. Nevertheless, the prevalence of male students' scores over female students is a valid trend for both regions.

The interaction between *region*grade level* was also found to be statistically significant. Explicitly, at all grade levels students from Ankara region scored higher than the students from Northern Cyprus region. From the multiple comparisons table 67, first year students of Northern Cyprus region scored significantly higher than the second and third year students of Northern Cyprus. In addition, fourth and fifth year students of Northern Cyprus obtained better scores than the second and third year students of Northern Cyprus students. Although the mean differences are not as evident as the scores of the students in Northern Cyprus region, this trend is also valid for the students of Ankara region. There mean scores are increasing slightly for the students of Ankara region as the gradelevel increases.

The interaction between *gender*grade level* was also found to be statistically significant Except for the second year students, at all grade levels male students have outscored female students on the whole. First year male students scored better than the second year male students whereas, second year female students scored higher grades than first year students. In addition, third and fourth-fifth year male students scored better than second year male students. This is also valid for female students and additionally than the first year female students.

Moreover, triple interaction among *region*gender*grade level* was also found to be statistically significant. Among the first year students, students from Ankara region surpass students from Northern Cyprus Region. Inadditon, males performed better than females for both regions. Interaction comes from the notable difference in the mean scores of male students than female students in Northern Cyprus area whereas there is much narrower difference among mean scores of males and females from Ankara region. Among the second year students form both regions, although the trend of prevelance of males over females is same, females outperformed male students at Ankara while males performed slightly better than females at Northern Cyprus region. For the third year students, the trend favoring Ankara region is same however, there exists almost no difference in the scores between female and male students in Northern

Cyprus but again males surpass females at Ankara region. Lastly and most distinctly, fourth and fifth year students performed better yet the score of the male students for both regions are equal. The interaction is apparent due to male students' remarkably high scores over females in Northern Cyprus whereas females outscored males in Ankara region.

CHAPTER 5

DISCUSSION, CONCLUSION AND IMPLICATIONS

This discussion, conclusion of the outcomes of the study, potential educational implications, limitations and suggestions for further research were presented in this chapter.

5.1 Discussion of the Results

In the present study, analyses pertaining to the first three research questions basically focused on exploring the affective factors namely approaches to studying, self-efficacy and problem solving strategies, that are perceived by university students (mathematics and secondary mathematics education) and prospective teachers'(early childhood, elementary and classroom teacher education) and to study the interrelationships among these variables and the mathematical thinking and reasoning competency.

In this respect, relevant items from Approaches to Studying Inventory(ASI) from Ramsden and Entwistle (1981) was adopted into Turkish as it was formerly used by Hei (1999) in her doctoral research on Taiwanese and Turkish university students too. In addition, the test on mathematical thinking and reasoning competency was developed by the researcher and was administered to the same sample of 431 students and prospective teachers.

In the original study of Entwistle and Ramsden, the ASI consists of 64 items with five factors with 16 subdimensions. In this study, from the Approaches to Studying Inventory only these dimensions as meaning oritentation (deep approach, relating ideas, use of evidence and intrinsic motivation subdimensions), reproducing orientation (surface approach, syllabus-boundness, fear of failure), strategic orientation (extrinsic and achievement motivations) and non-academic motivation(disorganized study methods) as well as mathematics self-efficacy, student home-family background characteristics and problem solving strategies dimensions were included. Yet, the study revealed five main remarkable factors explicitly; meaning orientation (with the exclusion of intrinsic motivation), mathematics self-efficacy, motivation (the combination of intrinsic, achievement and extrinsic motivation), disorganized study methods and surface approach. Besides, the test on mathematical thinking and reasoning competency that consisted of 26 items in total revealed two main dimensions as “express, extract and compute” that were related to more fundamental mathematical thinking processes and “express, infer logically” that requires higher order mathematical thinking and reasoning processes.

Standardized path coefficients with absolute values less than 0.10 are considered as having a small effect, the values around 0.30 are regarded as medium and values above 0.50 indicate large effect sizes (Kline, 1998). In addition, effect sizes are classified as follows in terms of multiple correlation coefficients (R^2); for the values up to 0.01 indicate small, around 0.09 show medium and for the values above than 0.25 indicate large effect sizes according to Cohen’s work(1988) (as cited in Kline, 1998).

The three Tables 83, 84 and 85 demonstrate the summary results for all tested models in this study with respect to the standardized path coefficients and their ranges, and the effect sizes for each latent dependent variable that were used in all the models included in this respectively.

Table 83 Standardized Path Coefficients of All Tested Models

Survey-test model(N=431)	EXINFLOG			EXPEXTCMP		
	Direct	Indirect	Total	Direct	Indirect	Total
MEANORT	-0.18	0.16	-0.02	0.20	-	0.20
MSEFFIC	0.06	0.17	**0.23**	**0.21**	-	**0.21**
MOT	0.09	-0.25	-0.16	**-0.32**	-	**-0.32**
DISORSTD	-0.06	0.11	0.05	0.14	-	0.14
SURAPP	0.09	-0.05	0.05	-0.06	-	-0.06
Survey-testt model(N=431)	EXINLOG			EXPETCM		
MEANORT	-0.11	**0.104**	0.002	**0.19**	-	**0.19**
MSEFFIC	0.11	0.084	**0.20**	0.15	-	0.15
MOT	0.05	**-0.155**	-0.11	**-0.28**	-	**-0.28**
DISORSD	-0.04	0.079	0.03	**0.14**	-	**0.14**
SURAPP	0.05	-0.021	0.03	-0.04	-	-0.04
Surveyi-test model(N=431)	EXINFLOG			EXPEXTCMP		
MEANORTi	-0.09	0.06	-0.02	0.08	-	0.08
MSEFFICi	0.06	**0.13**	**0.19**	**0.17**	-	**0.17**
MOTi	0.02	**-0.19**	**-0.17**	**-0.25**	-	**-0.25**
DISORSDi	-0.01	0.10	0.09	0.13	-	0.13
SURAPPi	**0.14**	0.07	**0.22**	0.09	-	0.09
Surveyi-test model (Ankara,N=200)	EXINFLOG			EXPEXTCMP		
MEANORTi	-0.10	-0.02	-0.12	-0.02	-	-0.02
MSEFFICi	-0.04	0.18	0.14	**0.23**	-	**0.23**
MOTi	-0.01	**-0.26**	**-0.27**	**-0.33**	-	**-0.33**
DISORSDi	0.04	0.12	0.16	0.15	-	0.15
SURAPPi	**0.27**	0.08	**0.35**	0.10	-	0.10
Surveyi-test model (Northern Cyprus, N=231)	EXINFLOG			EXPEXTCMP		
MEANORTi	-0.08	0.09	0.01	0.16	-	0.16
MSEFFICi	0.108	0.08	0.18	0.14	-	0.14
MOTi	0.037	-0.08	-0.05	-0.16	-	-0.16
DISORSDi	0.004	0.14	0.14	0.27	-	0.27
SURAPPi	0.19	0.06	0.25	0.11	-	0.11

*: Bold face values indicate significant direct and total effects.

Table 84 Standardized Path coefficient Ranges for All Tested Models

Tested Models	Path Coefficients Range	
	Min.	Max.
Survey-test model(N=431)	-0.32	0.23
Survey-testt model(N=431)	-0.28	0.20
Surveyi-test model(N=431)	-0.25	0.22
Surveyi-test model(Ankara,N=200)	-0.33	0.35
Surveyi-test model(NorthernCyprus,N=231)	-0.16	0.27

Table 85 Squared Multiple Correlations for All tested Models

Tested Models	Squared Multiple correlations(R^2)	
	EXINFLOG	EXPEXTCMP
Survey-test model(N=431)	0.64(0.09)	0.11
Surveyi-test model(N=431)	0.65(0.12)	0.12
Surveyi-test model(Ankara,N=200)	0.72(0.19)	0.16
Surveyi-test model(NorthernCyprus,N=231)	0.35(0.12)	0.17
	EXINLOG	EXPETCM
Survey-testt model(N=431)	0.32(0.05)	0.09

*: values in the parentheses represent reduced form R^2coefficients

The direct and total effects of all the models tested in the present study were shown in the Table 83. From the Table 84, the significant standardized path coefficients have small to medium effects on the two latent dependent variables 'express, extract and compute' and 'express, infer logically'. For the first three models, considering the magnitude, the latent variable motivation has the strongest yet the negative effect on both latent dependent variables. For the fourth model though, the surface approach study method has the strongest but positive effect on the higher order mathematical competency of the participants.

From the Table 85, considering the effect sizes which were denoted by R^2, both latent dependent variables have small to medium effect sizes for all tested models. Furthermore, for the survey-test model, 5% of the total variance explained on higher order mathematical thinking skills and the total variance explained on basic mathematical competency skills was 11%. For the surveyi-test model, 12% of the total variances explained on fundamental and higher order mathematical thinking skills. For the survey-testt model, 5% of the total variance explained on higher order mathematical thinking skills and the total variance explained on basic mathematical competency skills was 9%. For the comparison across regions, it was revealed that for Ankara region, of the surveyi-test model the total variance explained on the high order mathematical thinking skills is 19% and 16% on the fundamental thinking skills whereas 12% of the total variance is explained on the higher order thinking skills and 17% of the variance is explained on the fundamental thinking skills for the Northern Cyprus sample of the same model tested. Obtaining small to medium effect sizes for this study is also an expected outcome for most of the educational studies.

Comparison of the path diagrams, direct total effects of the latent variables on the above constructs yielded various noteworthy outcomes. Firstly, all the latent independent variables (exogenous) have small to medium effects on the dependent variables (endogenous) including insignificant standardized path coefficients.

The comparison of the goodness of fit indices for all tested models was givenin the Appendix. These indices indicate indicate adequate fit for all the models to the data.

For the first model, mathematics self-efficacy has small positive total effect on express, infering logically mathematical thought process and has moderate positive direct and total effects on the latent dependent variable express, extract and compute. This finding is in line with the previous studies, since it was deemed that self-efficacy is among the strong predictor of the academic performance in mathematics (Mousoulides&Philippou, 2005; Pajares, 1996; Pintrich&DeGroot, 1990; OECD, 2006). On the contrary, the exogenous variable motivation has the moderate negative direct and total effect only on the more fundamental mathematical thinking skills i.e. express, extract and compute. As possible reason for this outcome might be the fact that students and prospective teachers who participated to this study were deemed to hold high motivational beliefs regardless of their true mathematical capability. This surprising result however might also partly result from the characteristics of the participants where half of the sample was prospective teachers which they seemed to hold high motivational beliefs explicitly in terms of intrinsic, extrinsic and achievement motivation regardless of their true nature of their mathematical ability.

For the second model, meaning orientation (deep learning approach, use of evidence, relating ideas) has a positive small indirect effect on higher order mathematical thinking skills (EXINLOG) and has positive small direct and total effects on fundamental mathematical thinking skills (EXPETCM). The common nature of the items that constitute the both fundamental and higher order mathematical thinking skills require the extraction of meaning from the problem, linking the piece of information pertaining to the real life situations, using evidences cautiously and actively relating the new piece of information with the previously known one in order to proceed through steps of solving these mathematical problems. These approaches actually represent the meaning orientation dimension stand-alone with the exclusion of intrinsic motivation subdimension. What's more, the exogenous variable motivation has a small negative indirect effect on the higher order mathematical thinking skill and has negative small to medium direct and total effects on the fundamental mathematical thinking skill. This finding perhaps could be replicated with larger sample. Another noteworthy and yet contradictory result is that; disorganized study methods has small positive direct and total contribution to participants' fundamental mathematical competency. In other words, students who frequently display disorganized study methods could solve fundamental mathematical problems successfully, though; a similar inference could not be deduced for higher order thinking skills.

For the third model, although low, as expected mathematics self-efficacy has an indirect positive effect on the higher order mathematical thinking skill and has small positive direct and total effects on the fundamental mathematical thinking skill. This finding complies with the existing literature. On the other hand, supporting the results of the previous findigs of the abovementioned models, motivation has small negative indirect and total effects on the higher order mathematical skills whereas it has small to medium negative direct and total effects on the fundamental skills. Additionally, the variable surface approach has a small positive direct and total effect on higher order thinking skills. This may result from the nature of the items might impose participants to focus on the ‘signs’ or unrelated parts of the task where the information is simply memorized and, facts and concepts are associated unreflectively (Ramsden, 1988).

For testing the equality of the factor structure across two regions in particular, Ankara (N=200) and Northern Cyprus (N=231), firstly the entire sample (N=431) was splitted into two and the third model yielding adequate fit indices for the whole data was tested for each region separately. No significant paths were found to exist in the tested model across the Northern Cyprus sample (N=231). On the other hand, for Ankara region, mathematics self-efficacy has positive moderate direct and total effects on the fundamental mathematical thinking skills and as also emerged for the entire sample model, motivation has negative moderate indirect and total effects on the higher order thinking skills and negative moderate direct and total effects on the fundamental thinking skills. As comply with the entire sample, for Ankara region participants, surface approach has positive moderate direct and total effects on the higher order mathematical thinking skills.

In the overall sense, for all the models tested in this study (except for the Northern Cyprus sample) the motivation dimension which consists of dominantly intrinsic, an extrinsic and an achievement related motivation items has been consistently found to have a negative small, significant impact on both basic and higher order mathematical thinking competency of the students and prospective teachers. This finding is somehow contradictory and does not comply with the existing literature. Although the coefficients are significant in this comparison they do not exhibit strong relationship. A meaningful explanation for this might be that the participants hold high motivational beliefs regardless or unaware of their true mathematical competency and reasoning. Nevertheless, because of the low impact of this particular variable it is not easy to draw any evocative implication from this outcome. Also, the nature of the items included might be the result of this finding. The items are related more in the learning for own's sake as was indicated in Ramsden (1997) rather than goal oriented.

On the other hand, mathematics self-efficacy and meaning orientation in the overall scene have significant positive influence on the basic and higher order mathematical competency of the participants. This findings have laso been supported by the previous studies where self-efficacy is among the strong predictor of achievement in mathematics and the student with meaning orientation approach of studying have high achievement in mathematics. Another surpising and yet contradictory result is that the surface approach study methods to some extent positively endorse participants' higher order mathematical thinking and reasoning competency skills. Meaning, students who use surface approach study methods more often, they are able to solve problems that require logical inference related competency. Another unexpected outcome is that, despite its low influence disorganized study methods were found to affect postively the basic mathematical competency of the participants.

Pertaining to *gender* and *grade level* related differences across the dimensions of survey, significant diversity were found to exist with respect to gender and grade level separately. Though the effect size here is small, female students seemed to have remarkably higher scores than male students on the meaning orientation dimension (apart from intrinsic motivation subdimension). This result conflicts with previous research finding in favor of male students (Berberoğlu & Hei, 2009).However, Berberoglu and Hei's (2003) work was apparently different than of the current study in terms of student characteristics where only mathematics and education based students participated in the present study whereas students from social sciences, science, engineering and literature&arts faculties were the main participants which could explain the inconsistency of the outcome. Another striking finding is that, fourth and fifth year students have reported to use disorganized study methods more frequently than second year students. In the same manner, third year students seem to use disorganized study methods more often than second year students. It could be commonly stated that as the grade level advances students tend to use disorganized study methods more frequently because partly due to the work load of the courses taken. Further reason for this might be that students tend to shift their focus from academic to non-academic orientation as they advance in their university studies. It may also be due to too much homework load. However no gender by grade level interaction was observed in the present study. The lack of significant interaction effect does not provide the expected support for the hypothesis that the two are interrelated in enhancing academic outcomes.

Furthermore, regarding region and grade level differences concering students' and prospective teachers' competency in mathematical thinking and reasoning herewith measured by two subdimensions i.e. fundamental (express, extract, compute) and more elaborate (express, infer logically) thought processes, although the effect sizes were small, significant differences were detected with respect to *grade level* and *region by grade level* interaction.

As for the *region by grade level* interaction, the students from Ankara region on the whole obtained higher score on both fundamental and elaborate matehamtical competency skills than student from Northern Cyprus. One noteworthy trend is that, in both subdimensions, first year students of Northern Cyprus region scored better than second year students while the reverse is true for Ankara region. The difference might be due to the fresh contribution of the high school mathematics curriculum to the competency of the freshmen students however, for Ankara region, as students advance from first to second grade their mathematical thinking skills improve with the help of the mathematics curriculum of the university. In addition, valid for both dimensions, while second year students of Ankara region performed slightly better than third year students of Anakra region the reverse is remarkably true, for students from Northern Cyprus region. Third year students of Northern Cyprus region seem to become more experienced and they could be able to articulate their basic and elaborate mathematical competency skills. In terms of basic skills, fourth and fifth year students from Ankara region scored slightly lower than the third year students whereas in both dimensions fourth and fifth year students scored remarkably better than third year students of Northern Cyprus region. Only for elabororate skills fourth and fifth year students from Ankara region scored better than third year students. There exists almost ignorable positively increasing difference among the first and the fourth and fifth year students from Ankara region in terms of basic skills and slight increase in terms of elaborate skills. However there is a remarkable increment among the first year and last year students of Northern Cyprus which is also valid for the elaborate skills dimension. For the Northern Cyprus region, as the grade level advance students apparently acquire necessary mathematical thinking competency skills. This may be due to the curriculum followed at the universities and teacher training academy. Students from Ankara region came from mathematics related departments and in the literature it was claimed that exposure to mathematics more than any other disciplines might have a positive impact to acquire adequate mathematical thinking and reasoning abilities (Inglis & Simpson, 2008). On the other hand, data collected from Northern Cyprus region was mainly from prospective teachers of earlychildhood education and classroom teacher education. By inspecting the curriculum of the academy, it could be argued that they are exposed less frequently to mathematics courses and henceforth have less opportunity to encounter with problems that may foster their thinking skills. In addition, it was stated that prospective teachers tend to avoid taking mathematics courses and perfom poorly in mathematics tests (Leung, 2001)

Fourth and fifth year students seem to have better scores than second year students and third year students separately in the fundamental skills dimension. This was an expected result since it is consistent with the fact that as the grade level advances students acquire more competencies in mathematical thinking and reasoning. This result is also valid for the more elaborate dimension however; a surprising outcome was found that first year students' elaborate mathematical thinking competeceny skills are better than the second year students. This result may be due to the participant characteristics and also high school mathematics curriculum's contribution to freshman students' reasoning and competency when dealing with problems requiring the logical inferencing and evaluation of the conditions should be considered here.

In addition, a significant large effect of *region* based difference was found to exist on the both composite subdimensions. It was found out that, students from Ankara region have remarkably outscored students from Northern Cyprus region in both fundamental and more elaborate skill dimensions. This might be due to the student characteristics for each region. For instance, students from Ankara region are enrolled to competitive public universities whereas students from Northern Cyprus region come from yet less competing private universities and teacher training academy. In addition, students from Northern Cyprus region are mainly prospective teachers whereas students from Ankara region more often come from mathematics and mathematics education based departments meaning they frequently demonstrate their mathematical competency and reasoning.

In the overall sense, results concerning the differences attributed to competency in mathematical thinking and reasoning with respect to region, grade level and gender region, gender, grade level and all dual and triadic interactions were found to be significant and the effect size for region is large and for grade level is moderate and for the rest of the attributes the effect sizes are small.

Consistent with the previous findings of this study, once more students from Ankara region performed better than students from Northern Cyprus region on the total test. This result may be due to characteristics of the two samples. Students from Ankara region might expose to more mathematics courses than students form Northern Cyprus region based on the department related differences.

For male students scoring better than female students, Cole (1997) commented on the gender related differences in standardized tests favoring male students.

As students advance in their education they tend to be more competent as compared to their peers at lower grade levels.

Region by gender interaction comes from the mean differences observed in Northern Cyprus students where females have less mean scores than males while in Ankara sample, the mean of the females is almost same with the male students. This reveals a gap among female and male students of Northern Cyprus however, in Ankara region the gap is closing.

For *region by grade level* interaction, although as the grade level advances, there is a slight positive increase in the scores of the students from Ankara region on the other hand, there exist while first year students outscored second year students there exist a remarkable increase in the scores from second to fourth and fifth grade level students of Northern Cyprus region although their overall performance is considerably low in comparison to the student of Ankara region. This may result from the private and public university differences across regions.

Gender by grade level interaction occurs as the grade level advances female students tend to obtain higher scores whereas this is also true for male students except first year male students have higher scores than second year male students. Except for second year, male students tend to score better than female students. There exist no difference among males and females ath the second year in terms of mathematical thinking and reasoning competency.

For the triple interaction of *region by gender by grade level*, Moreover, triple interaction among *region*gender*grade level* was also found to be statistically significant. Among the first year students, students from Ankara region surpass students from Northern Cyprus Region. Inadditon, males performed better than females for both regions. Interaction comes from the notable difference in the scores of male students than female students in Northern Cyprus area whereas there is much narrower difference among mean scores of males and females from Ankara region. Among the second year students from both regions, although the trend of prevelance of males over females is same, females outperformed male students at Ankara while males performed slightly better than females at Northern Cyprus region. For the third year students, the trend favoring Ankara region is same however, there exists almost no difference in the scores between female and male students in Northern Cyprus but again males surpass females at Ankara region. Lastly and most distinctly, fourth and fifth year students performed better yet the score of the male students for both regions are equal. The interaction is apparent due to male students' remarkably high scores over females in Northern Cyprus whereas females outscored males in Ankara region. Yet, there exists gender related difference in the mathematical thinking and reasoning skills of the students as a general trend. Male students performed better than female students is consistent with the literature (Cole, 1997; Royer et. al., 1999).

5.2 Conclusions

There are four major aims of this study. First one was to identify affective, factors pertaining to, approaches to studying, self-efficacy, problem solving strategies, mathematical thinking and reasoning competency and home-background characteristics of university students and prospective teachers. Secondly, to sought for a structural model among pre-identified factors that elucidates best the collected data. Thirdly, to evaluate the equality of the factor structures across Ankara and Northern Cyprus regions in order to identify similarities and differences across these two regions. Fourthly, the differences among pre-identified factors regarding approaches to studying, self-efficacy, problem solving strategies, mathematical thinking and reasoning competency were investigated with respect to gender, region and grade level one by one and their dual and triple interaction effects were considered as well.

Based on the outcomes of the study, following conclusions could be drawn:

1. Five factors were identified regarding approaches to studying, self-efficacy, and problem solving strategies namely; meaning orientation (deep approach, relating ideas, use of evidence), mathematics self-efficacy, motivation (intrinsic, extrinsic and achievement), disorganized study methods and surface approach.
2. Two factors were identified regarding mathematical thinking and reasoning competency of student and prospective teachers namely; 'express, extract and compute' that constitutes basic skills and 'express, infer logically' that represents more elaborate skills.

Similarities among the Results of the Three Proposed Models Tested

3. Mathematics self-efficacy has a positive moderate total impact on students and prospective teachers' logical inferencing and evaluating conditional statements in real life situations which is in line with the relevant literature
4. Motivation has moderate negative direct and total effects on the fundamental thinking skills that is; expressing, extracting and computing mathematically.
5. Mathematics self-efficacy has positive moderate direct and total effects on fundamental skills in the first and third models.
6. Motivation has moderate negative indirect effects on the elaborate skills in the second and third models.

Differences among the Results of the Three Proposed Models Tested

7. Meaning orientation has positive small indirect effect on the elaborate skills and has positive moderate direct and total effects on the fundamental skills for the second model which is consistent with the previous research findings in general.
8. Mathematics self-efficacy has positive small indirect and total effects on the elaborate skills for the third model.
9. Motivation has a negative small total effect on the elaborate skills of the third model.

Similarities between the Results of the Third Model tested across regions (All, Ankara and Northern Cyprus region)

10. Surface approach learning method has positive moderate direct and total effects on the elaborate skills for the entire sample as well as for Ankara region.
11. Motivation has moderate negative direct and total effects on the fundamental thinking skills for all and Ankara region.
12. Motivation has moderate negative indirect and total effects on the elaborate skills for all and Ankara region.
13. Mathematics self-efficacy has positive moderate direct and total effects on fundamental skills for all and Ankara region.

Differences between the Results of the Third Model Tested across Regions

14. Mathematics self-efficacy has positive small indirect and total effects on the

elaborate skills for the entire sample.

15. No significant relationships were detected for the Northern Cyprus region.

Differences with Respect to Gender, Region and Grade Level

16. There exists significant mean difference among male and female students in the meaning orientation dimension. Female students seem to be more meaning oriented than male students. Nevertheless, only small amount of variance could be explained by gender on the factors.
17. There is a significant mean difference among fourth&fifth year students and third year students, and also among third year students and second year students in the use of disorganized study methods although the effect is again small. The fourth&fifth year and third year students use disorganized study methods more often than second year students.
18. No significant interaction between gender and grade level was found to exist among the mean scores of the five factors explicitly; meaning orientation, mathematics self-efficacy, motivation, disorganized study methods and surface approach dimensions.
19. Small yet significant differences were observed in mean scores of both fundamental and elaborate skill dimensions among fourth&fifth year and second year students and fourth& fifth year and third year students. Fourth and fifth year students are more competent than second and third year students in terms of basic computational skills and logical inferencing skills. Inaddition, first year students mean scores on elaborate mathematical thinking and reasoning skills are higher than the second year students.
20. There exist significant region based mean differences upon the scores obtained in both fundamental and elaborate mathematical thinking and reasoning dimensions. The variance explained by region upon these factors is large. The mean scores of students from Ankara region are significantly higher than the mean scores of students from Northern Cyprus region in both basic and elaborate mathematical thinking and reasoning competency skills.
21. Significant interaction between region and grade level was found to exist among the mean scores of the basic and elaborate skill dimensions. However,

the effect is small.

22. There is a significant mean difference upon the score of total mathematical thinking and reasoning competency with respect to region. Large amount of variance is explained by region upon the total mathematical thinking and reasoning competency. Students from Ankara region have significantly higher scores than students from Northern Cyprus region.
23. There exists significant yet to a small degree mean difference among the total mean scores of male and female students. Male students outscored females on the total score of mathematical thinking and reasoning competency.
24. There exists moderate level, significant mean difference among fourth&fifth year students and first, second, third year students in the total mean score of mathematical thinking and reasoning competency. Fourth& fifth year students performed better than the rest of the grade levels. In addition, first year students have significantly higher scores than the second and third year students.
25. To a small degree, there exists significant interaction between region and gender upon the total mean score. Males outperformed female students of Northern Cyprus on the total test whereas the mean scores of females and males are almost equal for students from Ankara region.
26. Yet to a small degree, there exists significant interaction among region and grade level upon the total mean score.
27. There exists significant yet to a small degree, gender by grade level interaction upon the total mean score.
28. There exists significant yet to a small degree region by gender by grade level triple interaction upon the total mean score.

5.3 Implications

In the light of the results and conclusions of the study as well as the relevant literature following educational suggestions could be recommended:

1. Mathematical thinking and reasoning should be endorsed in the classrooms starting from the early stages of education. Particularly, in the current

educational system, students are not very familiar with real-life situated problems. Therefore when they face with authentic items their performance is only restricted to what they have encountered so far regarding the curriculum. Hence, situations that require the improvement of mathematical thinking could be encouraged by the instructors.

2. As consistent with the literature, self-efficacy though here has a moderate effect, it is believed to be among strong predictors of mathematics achievement. Therefore, teachers and instructors should be aware of this situation and be able to find way to improve their students' mathematics self-efficacy.
3. It was observed that although some students hold high motivational attitudes they seem to be unaware of their true ability on mathematical thinking and reasoning competency. Motivation usually effects positively mathematics achievement. Any contradictory result may be an indicator of students' capability of their mathematics achievement.
4. Students tend to become more non-academic oriented as the grade level advances. Therefore, they are in face to face with using more disorganized study methods than the earlier years of their study. This may also result from their exposure to excessive homework, projects load etc. Course loads such as homeworks, projects etc. and schedules could be reorganized by taken this into consideration by instructors.
5. Yet to date, there exist still a gap yet narrowing due to the societal change between male and female students' mathematics achievement in favor of males. This gap could be partly overcome by teachers and instructors by providing equal opportunities and considering gender based perceptional differences in classrooms.
6. Based on the regional differences, more curricular opportunities could be genereated for prospective teachers of Northern Cyprus to improve their mathematical thinking and reasoning abilities.

5.4 Limitations

Utilizing self-report survey yields to depend on the honesty and the insight of the participants that could lead to some point response bias and tend to be unreliable to some extent.

The two instruments were administered on single occasion in order to locate same students rather than conducting them on two separate occasions. However, this type of administration might lead students to pay less attention in responding the two questionnaires due to more time is required to complete them together. On the other hand, it guaranties to obtain response of same students for both questionnaire and survey.

Every effort is made to ensure that students do not regard the test neither as a test for measuring their mathematical ability nor their intelligence. However, it is possible that some students perceive it in that way and this could have some effect on their answers.

The mathematical thinking and reasoning competency test was designed by the researcher and was based upon the table of specifications that was constituted from various relevant frameworks. Although every attempt was made to ensure that items do not require specific knowledge, some participants may not be familiar with all of the items. As result, this could provoke guessing and skipping of the items hence misleading to some extent an inaccurate measurement of the mathematical thinking and reasoning competency.

5.5 Recommendations for Further Research

1. To improve the generalization of the findings, additional data could be collected as a future work.
2. One of the most striking results was the negative relationship between motivation and mathematical thinking and reasoning competency that needed indepth attention and investigation particularly for the preservice teachers.
3. Only one model was tested across two regions, various models with different contributing factors could also be tested and evaluated with respect to region

and other attributes as well as.

4. The instruments used in this study could be improved to obtain more reliable results. The outcomes could be supported and strengthen with interviews of selected participants.
5. Self-efficacy items concerning mathematics as a future project could be substituted with mathematics related tasks that measure self-efficacy since imagining doing a mathematical task and actually engaging with it may differ response of the students as stated by Pajares (1996).

REFERENCES

Arıkan, S. (2010). *Construct Valdity and Factor Structure of Student Selection Examination acroos subgroups.* Ankara: METU unpublished dissertation.

Baker, M. E. (2004). *Mathematical Problem Solving Skills in Undergraduate Preservice Teacher Education Students.* Grand Forks: University of North Dakota Dissertation.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* NY: Prentice-Hall.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control.* New York: W.H. Freeman and Co.

Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology, 41*, 586-598.

Berberoğlu, G., & Hei, L. M. (2009). a Comparison of University Students' Approaches to Learning Across Taiwan and Turkey. *International Journal of Testing, 3*(2), 173 - 187.

Bessant, K. C. (1995). Factors associated with types of mathematics anxiety in college students. *Journalfor Research in Mathematics Education, 26*, 327-345.

Biggs, J. B. (1979). Individual differences in study processes and the quality of learning outcomes. *Higher Education, 8*, 381-394.

Biggs, J. B. (1987). *Student approaches to learning and studying.* Melbourne: Australian Council for Education.

Biggs, J. B. (1990). *Teaching for desired learning outcomes.* (I. N. Entwistle(Ed.), Ed.) London:Routledge: Handbook of Educational Ideas and Practices.

Bloom, B. S., & Engelhart, M. D. (1956). *Taxonomyof Educational Objectives: The Classification of Educational Goals:Handbook I: Cognitive Domain.* NY: Longmans.

Bos, K., & Kuiper, W. (1999). Modeling TIMSS data in a European comparative perspective:Exploring influencing factors on achievement in mathematics in grade 8. *Educational Research and Evaluation, 5*(2), 157-179.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* Hillsdale, NJ: Erlbaum.

Cole, N. S. (1997). *The ETS gender study: How males and females perform in* *educational setting.* Princeton, NJ: Educational Testing Service.

Crocker, L., & Algina, J. (1982). *Introduction to Classical and Modern Test Theory.* Orlando: Holt, Rinehart and Winston, Inc.

D'Angelo, J. P., & West, D. B. (2000). *Mathematical Thinking Problem Aolving and Proofs* (2nd Edition ed.). NJ: Prentice-Hall, Inc.

Drew, P. Y., & Watkins, D. (1998). Affective variables, learning approaches and academic achievement: a causal modelinginvestigation with Hong Kong tertiary students. *British Journal of Educational Psychology, 68*, 173-188.

Durand-Guerrier, V. (2003). Which notion of implication is the right one? From logical considerations to a didactic perspective. *Educational Studies in Mathematics, 53*, 5-34.

Edwards, B. S., Dubinsky, E., & McDonald, M. A. (2005). Advanced Mathematical Thinking. *An International Journal of Mathematical Thinking and Learning, 7*(1), 15-25.

Entwistle, N. J., & Ramsden, P. (1983). *Understanding Student Learning.* London: Croom Helm.

Entwistle, N. J., & Tait, H. (1994). *The Revised Approaches to Study Inventory.* Edinburgh University:Centre for Research into Learning and Instruction.

Entwistle, N. J., Hanley, M., & Hounsell, D. J. (1979). Identifying distinctive approaches to study. *Higher Education, 8*, 365-380.

Epp, S. S. (2003). The Role of Logic in Teaching Proof. *The American Mathematical Monthly, 10*(10), 886-899.

Evans, J. (2000). *Adults' mathematical thinking and emotions.* London: RoutledgelFalmer.

Fennema, E., Carpenter, T. P., Franke, M. L., Levi, L., Jacobs, V. R., & Empson, S. B. (1996). A longitudinal study of learning to use children’s thinking in mathematics instruction. *Journal for Research in Mathematics Education, 27*(4), 403-434.

Fraenkel, J. R., & Wallen, N. E. (2003). *How to Design and Evaluate Research in Education.* New York: McGraw-Hill higher Education.

George, D., & Mallery, P. (2001). *SPSS for Windows Step by Step: A Simple Guide and Reference.* Boston: Allyn & Bacon.

Gonske, T. L. (2002). *Relationships Among Mathematics Anxiety. Beliefs About the Natureof Mathematics and the Learning of Mathematics. and Students' LearningApproaches in Non-traditional Students at tlze*

Community College. Colorado: Doctor of Philosophy dissertation, University of Northern Colorado.

Güzel, Ç. İ., & Berberoğlu, G. (2005). An Anaylsis of the Programme for International Student Assessment 2000(PISA2000) Mathematical Literacy Data for Brazilian,Japanese and Norvegian Students. *Studies in Educational Evaluation, 31*, 283-314.

Harel, G., & Sowder, L. (2007). Toward Comprehensive Perspectives on the Learning and Teaching of Proof. In F. Lester, *Second Handbook of Research on Mathematics Teaching and Learning.* National Council of Teachers of Mathematics.

Hei, L. M. (1999). *Comparison of University Students' Approaches to Studying across turkey and Taiwan.* Ankara: METU Disseration.

Henningsen, M., & Stein, M. K. (1997). Mathematical tasks and student cognition: Classroom-based factors that support and inhibit high-level mathematical thinking and reasoning. *Journal for Research in Mathematics Education, 28*(5), 524-549.

Inglis, M., & Simpson, A. (2004). Mathematicians and the Selection Task. *Proceedings of the 28th Conference of the InternationalGroup for the Psychology of Mathematics Education*, *3,* pp. 89-96.

Inglis, M., & Simpson, A. (2008). Conditional inference and advanced mathematical study. *Educational Studies in Mathematics, 63*(3), 187-204.

Işıksal, M., & Aşkar, P. (2003). the Scales of Perceived Mathematics and Cmputer Self-Efficacy for Elementary students. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 25*, 109-118.

Işıksal, M., & Çakıroğlu, E. (2006). Pre-service Mathematics Teachers' efficacy beliefs toward Mathematics and Mathematics Teaching. *Hacettepe Üniversitesi Eğitim Fakültsi Dergisi, 31*, 74-78.

Jöreskog, K. G., & Sörbom, D. (1993). 8: Structural equation modeling with the SIMPLIS command language (Computer software manual). New Jersey: Scientific Software Internation, Inc.

Jöreskog, K. G., & Sörbom, D. (1993). *LISREL 8.71: User's reference guide [Computer Software Manual]*. Chicago: Scientific Software International.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrica*(39), 31-36.

Keeves, J. P. (1986). Aspiration, motivation and achievement: different methods of analysis and different results. *International Journal of Educational*

Research, 10, 115-243.

Kelloway, K. (1998). *Using LISREL for Structural Equation Modeling: A Researcher's Guide.* Calofornia: SAGe Publications, Inc.

Kline, R. B. (1998). *Principles and practice of Structural Equation Modeling.* NewYork: The Guilford Press.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and.* Englewood Cliffs, NJ: Prentice-Hall.

Lee, W. (1999). *The Relationship Between Students' Proof-Writing Ability and Van Hiele Levels Of Geometric Thought in a College Geometry Course. Doctoral Dissertation.* University of Northern Colorado, UMI.

Leung, H.-k., & Man, Y.-k. (2005). Relationships between affective constructs and mathematics achievement: A modeling approach. *Paper presented at Redesigning Pedagogy International Conference: Research, Policy, Practice, Singapore.*

Leung, S. H. (2001). Structural equation modeling of affects and learning approach in mathematics education. *The Mathematics Education into the 21st Century ProjectProceedings of the International ConferenceNew Ideas in Mathematics Education*, (pp. 1-6). Australia.

Marlon, F., & Säljö, R. (1976). On qualitative differences in learning: I. Outcome and process. *British Journal of Educational Psychology, 46*, 4-11.

Marton, F., & Säljö, R. (1976). On qualitative differences in learning: 1-Outcomes and process. *British Journal of Educational Psychology, 46*, 4-11.

Marton, F., & Säljö, R. (1997). *Approaches to learning.* Edinburgh: Scottish Academic Pr.

Marzano, R. J., Brandt, R., Hughes, C., Jones, B., Presseisen, B., Rankin, B., et al. (1988). *Dimensions of Thinking: A framework for curriculum and instruction.* Alexandria, VA: Association for Supervision and Curriculum Development.

McKnight, P. E., McKnight, K. E., Sidani, S., & Figueredo, A. J. (2007). *Missing Data A Gentle Introduction.* NY: A Division of Guilford Publications, Inc.

Ministry of National Educaton. (2005). Ortaöğretim Matematik Programı (9-12. sınıflar).

Minnaert, A., & Jansen, P. J. (1992). Success and progress in higher education: a structural model of studying. *British Journal of Educational Psychology, 62,* 184-192.

Mousoulides, N., & Philippou, G. (2005). Students' motivational beliefs, self-regulation strategies and mathematics achievement. In I. H. (Eds.) (Ed.), *Proceedings of the 29th Conference of theInternational Group for the Psychology of Mathematics Education*, *3*, pp. 321-328. Melbourne Australia.

Mousoulides, N., & Philippou, G. (2005). Students' Motivational Beliefs, Self-Regulation Strategies and Mathematics Achievement. In H. L. In Chick (Ed.). *3*, pp. pp. 321-328. Melbourne: Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education.

Murray-Harvey, R. (1993). Identifying characteristics of successful tertiary students using path analysis. *Australian Educational Researcher, 20*(3), 63-81.

Muthen, B. (2005). Obtaining scaled chi-square difference tests. *Journal of Applied Psychology, 31*(20), 19-25.

National Council of Teachers of Mathematics. (2000). Principles and Standards for School Mathematics.

NCTM. (1991). *Professional standards for teaching mathematics.* VA: Reston.

OECD. (2003). PISA 2003 Assessment Framework.

OECD. (2006). *Learning for Tomorrow's world: First Results from PISA 2006.* Paris: OECD Publications.

Pajares, F. (1996). Self Efficacy Beliefs in Academic Settings. *Review of Educational Research, 66*(4), 543-578.

Pajares, F. (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. *Contemporary Educational Psychology, 21*, 325-344.

Pajares, F. (1996). Self-Efficacy Beliefs in Academic Settings. *Review of Educational Research, 66*(4), 543-578.

Pajares, F., & Miller, M. D. (1997). Mathematics self-efficacy and mathematical problem-solving:Implications of using varying forms of assessment. *Journal of Experimental Education, 65*, 213–228.

Pallant, J. (2007). *SPSS Survival Manual A Step by Step Guide to Data Analysis using SPSS for Windows.* NY, USA: Mc GrawHill Open University Press.

Papanastasiou, C. (2000). Effects of Attitudes and Beliefs on Mathematics Achivement. *Studies in Educational Evaluation, 26*, 27-42.

Papanastasiou, C. (2000). Internal and external factors affecting achievement in mathematics:Some findings from TIMSS. *Studies in Educational Evaluation, 26*, 1-7.

Patterson, M., Perry, E., Decker, C., Eckert, R., Klaus, S., Wendling, L., et al. (2003). Factors Associated with High School Mathematics Performance in the United States. *Studies in Educational Evaluation, 29*, 91-108.

PCMI. (2007). *The Park City Mathematics Institute (PCMI)*. Retrieved 12 25, 2010, from http://mathforum.org/pcmi/assessment1.4.07finalwithappendix.pdf

Pimta, S., Tayruakham, S., & Nuangchalerm, P. (n.d.). Factors Influencing Mathematic Problem-Solving Ability of Sixth Grade Students. *Journal of Social Sciences, 5*(4), 381-385.

Pintrich, P. R., & De Groot, E. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*(1), 33-50.

Prosser, M., & Trigwel, K. (1999). *Understanding learning and teaching.* Buckingham: SRHE and Open University Press.

Ramsden, P. (1988). *Studying learning: Improving teaching Improving learning: new perspectives.* (Ramsden, Ed.) Kogan Page, Great Britain.

Ramsden, P. (1997). The context of learning in academic departments. In F. H. in Marton, *The Experience of Learning* (pp. 198-216). Edinburgh: Scottish Academic Press.

Ramsden, P., & Entwistle, N. J. (1981). Effects of academic departments on students approaches to studying. *British Journal of Educational Psychology, 51*, 368–383.

Rasmussen, C., Zandieh, M., King, K., & Teppo, A. (2005). Advancing Mathematical Activity:A Practice-Oriented View ofAdvanced Mathematical Thinking. *An International Journal of Mathematical Thinking and Learning, 7*(1), 51-73.

Royer, J. M., Tronsky, L. N., Chan, Y., Jackson, S. J., & Marchant, H. I. (1999). MAth fact retrieval as the cognitive mechanism underlying gender differences in mathematical test performance. *Contemporary Educational Psychology,, 24*, 181-266.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D. A. Grouws, *Handbook of research on mathematics teaching* (p. 340−370). Hillsdale,

NJ: Lawrence Erlbaum Associates, Inc.
Schreiber, J. B. (2002). Institutional and student factors and their influence on advanced mathematics achievement. *The Journal of Educational Research, 95*(5), 274-286.
Schreiber, J. B., Stage, F. K., King, J., Nora, A., & Barlow, E. A. (2006). Reporting Structural Equation Modeling and Confirmatory Factor Analysis Results: A Review. *The Journal of Educational Research, 99*(6), 323-337.
Schumacker, R. E., & Lomax, R. G. (2004). *A Beginner's Guide to Structural Equation Modeling.* New Jersey: Lawrence Erlbaum Associates.
Selden, A., & Selden, J. (2005). Perspectives on Advanced Mathematical Thinking. *An Internationa Journal of Mathematical Thinking and Learning, 7*(1), 1-13.
Sternberg, R. J. (1996). *The Nature of Mathematical Thinking.* NJ: Lawrence Erlbaum Associates.
Stevens, J. P. (2002). *Applied Multivariate Statistics for the Social Sciences.* New Jersey: Lawrence Erlbaum Associates, Publishers.
Tabachnick, B. G., & Fidell, L. S. (2001). *Using Multivariate Statistics* (4th Edition ed.). MA: Allyn& Bacon a Pearson Education Company.
Tall, D. (1991). The Transition to Advanced Mathematical Thinking. In P. i. (ed.) (Ed.), *Handbook of Research on MathematicsTeaching and Learning* (pp. 495-511). New York: Macmillan.
TIMSS. (2003). Mathematics Cognitive Domains:TIMSS 2003 DEVELOPMENTAL PROJECT FOURTH AND EIGHTH GRADES.
Umay, A. (2001). İlköğretim Matematik Öğretmenliği Programının Matematiğe karşı Özyeterlik Algısına Etkisi. *Journal of Qafqaz University*, 1-8.
Wason, P. (1968). Reasoning about a rule. *Quarterly Journal of Experimental Psychology, 20*, 273-281.
Watkins, D. (1986). Learning processes and background characteristics as predictors of tertiary grades. *Educational and Psychological Measurement, 46*, 199-203.
Yayan, B., & Berberoğlu, G. (2004). Reanalysis of the TIMSS 1999 Mathematics Assessment Data of the Turkish students. *Studies in Educational Evaluation, 30*, 87-104.
Zeegers, P. (2001). Approaches to learning in science: A longitudinal study. *British Journal of Educational Psychology, 71*, 115–132.

APPENDIX A

MATHEMATICAL THINKING AND REASONING COMPETENCY TEST

Gönüllü Katılım ve Bilgilendirme Formu

Bu çalışma Orta Öğretim Matematik Alanları Eğitimi doktora çalışmasının bir kısmı olarak öğrencilerin demografik bilgileri, çalışma alışkanlıkları, özyeterlik ve problem çözme stratejilerinin akıl yürütme ve matematiksel düşünmeyle ilişkisini anlamaya yardımcı olmak üzere hazırlanmıştır.

İlk ölçekte günlük hayata dair 26 tane akıl yürütme ve matematiksel düşünme sorusu için katılımcıların doğru seçeneği işaretlemeleri istenmektedir. İkinci ölçekte katılımcıların demografik bilgiler kısmını doldurduktan sonra 51 soruluk görüş ölçeğinde, kendi düşüncelerine en yakın buldukları ilgili seçenekleri işaretlemeleri istenmektedir.

Bu çalışma matematik eğitim ve öğretimini geliştirmek, özellikle üniversite öğrencilerinin matematiksel düşünme, akıl yürütme ilgili deneyimlerinin iyileştirilmesini hedeflemektedir.

Araştırma sırasında toplanan tüm kişisel bilgiler kesinlikle gizli tutulacaktır. Tüm veriler sadece araştırmacı tarafından saklanacak ve sadece çalışma kapsamında kullanılacaktır. Kimliğinizi açığa çıkaracak ad, soyad, bölüm,sınıf,cinsiyet, ortalama vs... gibi kişisel bilgiler kesinlikle gizli tututulacaktır.

Çalışma hakkında bilgi almak için araştırmacıya aşağıdaki adresten ulaşabilirsiniz:

Seren Başaran: sbasaran@ii.metu.edu.tr
tel: 0090 312 210 7870
ODTÜ Enformatik Enstitüsü
ODTÜKent Spor Merkezi Karşısı
06531 ODTÜ –ANKARA - TÜRKİYE

Bu çalışmaya katılımınız kesinlikle gönüllü olup istediğiniz takdirde çalışmanın her aşamasında hiçbir koşul olmaksızın katılmaktan vazgeçebilirsiniz. Çalışma sonlandırılmadan vazgeçtiğiniz takdirde verdiğiniz bilgiler kullanılmayıp imha edilecektir. Çalışmaya katılım tamamen gönüllü olup verdiğinizi bilgiler sizin için kesinlikle risk teşkil etmemektedir.

✂--

Yukarıdaki bilgileri okudum. Çalışmaya gönüllü olarak katılmak istiyorum.

Katılımcının imzası: ____________________ Tarih:_______

Akıl Yürütme ve Matematiksel Düşünme Ölçeği

Soruları dikkatlice okuyup, doğru olduğunu düşündüğünüz ilgili seçeneği (√) ya da (**X**) koyarak işaretleyiniz. ***Lütfen tüm soruları yanıtlayınız***. Her sorunun sadece ***tek bir doğru*** yanıtı vardır.

1. "İnsanların tümünü bazı zaman kandırabilirsiniz." ifadesinin mantıksal olarak ***olumsuzu*** aşağıdakilerden hangisidir?
    a. İnsanların en az birini hiçbir zaman kandıramazsınız.
    b. İnsanların bazılarını bazı zaman kandırabilirsiniz.
    c. İnsanların hiçbirini hiçbir zaman kandırmazsınız.
    d. İnsanların bazılarını herzaman kandıramazsınız.
    e. İnsanların en az birini herzaman kandırabilirsiniz.
2. "Dersteki tüm öğrenciler birinci sınıftadır." ifadesinin mantıksal olarak ***olumsuzu*** aşağıdakilerden hangisidir?
    a. Dersteki en az bir öğrenci birinci sınıfta değildir.
    b. Dersteki en az bir öğrenci birinci sınıftadır.
    c. Dersteki hiçbir öğrenci birinci sınıfta değildir.
    d. Dersteki hiçbir öğrenci birinci sınıftadır.
    e. Derste birinci sınıfta olmayan hiçbir öğrenci yoktur.
3. Hale sokakta üç kişiye rastlıyor. Bunların herbiri her zaman yalan ya da her zaman doğru söylemektedir. Bu kişilerin Hale'ye söyledikleri aşağıdadır:

    A : " Üçümüz de yalan söylüyoruz."

    B: " Sadece aramızdan iki kişi yalan söylüyor"

    C: " Benim dışındaki ikisi yalan söylüyor."

    Bu durumda hangisi/(leri) ***doğruyu*** söylemektedir?

    a. A kişisi
    b. B kişisi
    c. C kişisi
    d. A ve B kişileri
    e. B ve C kişleri

4. Bir adam elindeki x lira y kuruşluk çeki bozdurmak isteğinde banka memuru yanlışlıkla ona y lira x kuruş nakit vermiştir. Adam bu parayla k kuruşluk bir gazete aldığında geri kalan para gerçek çek değerinin 2 katıdır. Aşağıdakilerden hangisi yukarıdaki ifadenin matematiksel olarak ***doğru*** gösterimidir?

   a. 98y-199x=k
   b. 199y-98x=k
   c. y*x-k=2x*y
   d. 8y-19x=k
   e. x*y-k=2y*x

5. Berk bilyelerini üçer üçer saydığında geriye bir bilye kalmakta, beşer beşer saydığında iki bilye, yedişer yedişer saydığında ise geriye dört bilye kalmaktadır. k, m, n tamsayılar ve x bilye sayısı ise, aşağıdakilerden hangisi bu durumun matematiksel olarak ***doğru*** gösterimidir?

   a. $x = 3k + 2 = 5m + 3 = 7n + 5$
   b. $x = 3k + 1 = 5m + 2 = 7n + 4$
   c. $x = k + 3 = 2m + 5 = 4n + 7$
   d. $x = 3k - 1 = 5m - 2 = 7n - 4$
   e. $x = k - 3 = 2m - 5 = 4n - 7$

6. Aşağıda, bir termometre üzerinde gösterilen derece (^{0}C) ve bunlara karşılık Fahrenheit(F) sıcaklık değerleri verilmiştir:

^{0}C	0	5	10	15	20	25	30
F	32	41	50	59	68	77	86

“ Sıcaklık sabah termometrenin en düşük derecesindeydi ama öğleyin sıcaklık derece olarak orta seviyeye gelmiştir.” ifadesinin Fahrenheit ölçeğindeki karşılığı aşağıdakilerden hangisidir?

   a. 77 F
   b. 68 F
   c. 59 F
   d. 86 F
   e. 95 F

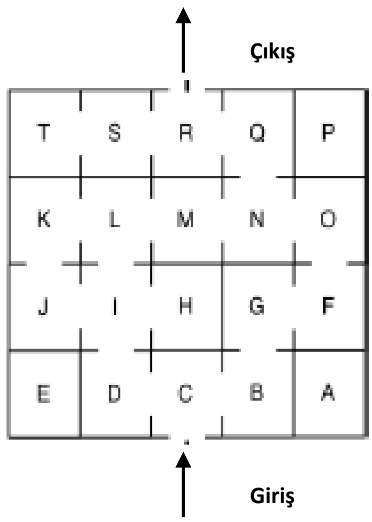
7. F ve C sırasıyla Fahrenheit ve Celsius sıcaklık değerlerini göstersin. Bu değerler arasındaki ilişki *F= (9/5)C+32* ile gösterilmiştir. Kaç derecede Fahrenheit ve Celcius sıcaklık değerleri birbirine eşit olur?

   a. -40^0C
   b. -45^0C
   c. -80^0C
   d. 45^0C
   e. 40^0C

8. Sinema salonunda bir film "çeyrek geçe"lerde başlamaktadır. Bir önceki seansın süresi uzadığından, film bu kez 10 dakika gecikmeli başlamıştır. Film 90 dakika sürüyorsa, filmin bitiş zamanı aşağıdakilerden hangisidir?

   a. Beş kala
   b. Beş geçe
   c. On kala
   d. On geçe
   e. Çeyrek kala

9. Can'nın harflerle adlandırılmış odalardan oluşan bir labirentten aynı kapıyı iki kez kullanmadan geçerek Giriş'ten başlayıp Çıkış'ta bitirmelidir. Buna göre aşağıdaki durumlar için ***doğru (D)***, ***yanlış(Y)*** ya da ***yeterli bilgi yok(YBY)*** şeklindeki yanıtlardan *size göre en doğru* olanını şeçiniz.



i. Can P'den geçer.
a)D b)Y c)YBY

ii. Can N'den geçer.
a)D b)Y c)YBY

iii. Can M'den geçer.
a)D b)Y c)YBY

iv. Can O'dan geçtiyse F'den degeçmiştir.
a)D b)Y c)YBY

v. Can K'dan geçtiyse L'den de geçmiştir.
a)D b)Y c)YBY

vi. Can L'den geçtiyse K'dan da geçmiştir. a)D b)Y c)YBY

10. Aşağıdaki gibi sadece tek yüzü görünen dört kart verilmiştir. Her kartın bir yüzünde bir rakam, diğer yüzünde de bir harf yazılıdır. Kural: ***"Eğer bir kartın bir yüzünde sesli bir harf varsa, diğer yüzündeki rakam çifttir."*** Kuralın doğruluğunu test etmek için hangi kart(lar)ın arkasına bakmanız gerekir?(*Not: a,e,ı,i,o,ö,u,ü harflerine sesli harf denir*)

E	K	6	9

a. Sadece E kartının arka yüzüne bakmak yeterlidir.
b. Sadece K kartının arka yüzüne bakmak yeterlidir.
c. E ve 6 kartlarının arka yüzlerine bakmak yeterlidir.
d. E ve 9 kartlarının arka yüzlerine bakmak yeterlidir.
e. K ve 6 kartlarının arka yüzüne bakmak yeterlidir.

11. Bir gazetenin haberine göre üniversitelerin, ekonominin iş verebileceğinden %25 daha fazla mezun verdiği bildirilmiştir. Buna göre aşağıdakilerden hangi sonucu çıkarabiliriz?

a. Her dört mezundan birinin işsiz kalma olasılığı vardır.
b. Her beş mezundan birinin işsiz kalma olasılığı vardır.
c. Her iki mezundan birinin işsiz kalma olasılığı vardır.
d. Her üç mezundan birinin işsiz kalma olasılığı vardır.
e. Her altı mezundan birinin işsiz kalma olasılığı vardır.

12. Bir evin değeri ilk yıl %20 artmış, sonraki yıl %18 azalmıştır. Buna göre, aşağıdakilerden hangisi <u>***doğrudur***</u>?

a. Evin değeri ne artmış ne azalmıştır.
b. Evin değeri toplamda %2 azalmıştır.
c. Evin değeri toplamda %2 artmıştır.
d. Evin değeri toplamda %1.6 artmıştır.
e. Evin değeri toplamda %1.6 azalmıştır.

13. Yeni açılan bir mağaza müşterilerine indirim yapmaktadır. Kasiyer %15'lik indirimin bir malın değerine önce uygulanıp daha sonra oluşan değerden %5'lik verginin alınacağını, müşteri ise malın %5'lik vergisi eklendikten sonra oluşan değere %15 indirimin uygulanması gerektiğini iddia etmektedir. Buna göre aşağıdakilerden hangisi ***doğrudur***?

a. Her iki durumda da malın son değeri aynıdır.

b. Müşteri kendi iddiasıyla daha az ödeyecektir.

c. Müşteri kendi iddiasıyla daha fazla ödeyecektir.

d. Kasiyerin kendi iddiasıyla müşteri daha az ödeyecektir.

e. Kasiyerin kendi iddiasıyla müşteri daha fazla ödeyecektir.

14. Bir dersten sabah ve akşam gruplarında AA notu alan kız ve erkek öğrenciler dağılımı ve yüzdelikleri aşağıdaki tabloda verilmiştir:

Grup	Kız	AA alanlar	%	Erkek	AA alanlar	%	Toplam	AA alanlar	%
Sabah	9	2	0.22	10	2	0.20	19	4	0.21
Akşam	9	6	0.67	14	9	0.64	23	15	0.65
Toplam	18	8	0.44	24	11	0.46	42	19	0.45

Bu tabloya göre aşağıdakilerden hangisi ***yanlıştır***?

a. Her grup için, AA notu alan kızların oranı AA notu alan erkeklere göre daha fazladır.

b. Toplamda, AA notu alan kızların oranı AA notu alan erkeklere göre daha azdır.

c. Sabah grubunda AA alan öğrenciler akşam grubuna göre daha fazladır.

d. Toplamda sınıfın neredeyse yarısı dersten AA ile geçmiştir.

e. Akşam grubunda, AA notu alan erkeklerle kızların oranı neredeyse eşittir.

15. Nüfus sayım görevlisi bir evdeki kadınla konuşmaktadır. Kadın evde kocası ve üç kızının bulunduğunu söylemiştir. Görevli, kadına kızlarının yaşlarını sorar; kadın da kızlarının yaşlarının çarpımının 36 ve toplamının da ev numarasına eşit olduğunu söyler.Görevli, kadına kızların yaşlarını anlayacak kadar yeterli bilgi vermediğini söyler. Kadın da en büyük kızının yukarıda uyuduğunu belirtir. Buna göre kızların yaşları aşağıdakilerden hangisidir?

a. 2,3,6
b. 1,4,9
c. 2,2,9
d. 1,6,6
e. Kızların yaşlarını hesaplamaya yetecek kadar bilgi verilmemiştir.

16. Bir yıl sonra eşimin yaşı evimin yaşının üçte bir kadar olacaktır. Dokuz yıl sonra benim yaşım, evimin şimdiki yaşının yarısı kadar olacaktır. Ben eşimden 10 yaş büyüğüm. Buna göre benim, eşimin ve evimin şimdiki yaşları sırasıyla aşağıdakilerden hangisidir?

a. Ben,eşim,evim:55, 45, 108
b. Ben,eşim,evim:45, 35, 108
c. Ben,eşim,evim:65, 55, 96
d. Ben,eşim,evim:35, 25, 96
e. Ben,eşim,evim:56, 46, 81

17. Bir kişi günde 8 saat uyumakta ve 1 Nisan geceyarısı uyumaya başlamaktadır. Bu kişi uyandıktan tam olarak 17 saat sonra tekrar uyumaktadır. Bu kişi Nisan ayı içinde hangi günde yine ***ilk*** uyandığı saatte uyanacaktır?

a. 10 Nisan
b. 20 Nisan
c. 24 Nisan
d. 25 Nisan
e. 26 Nisan

18. Bir okulda kız öğrencilerin yarısı ve erkek öğrencilerin üçte biri İngilizce bilmektedir. Tüm öğrencilerin üçte ikisi erkek olduğuna göre İngilizce bilen kız öğrencilerin İngilizce bilen tüm öğrencilere oranı kaçtır?

a. $3/7$
b. $^{6}{}_{7}$
c. $^{1}{}_{2}$
d. $^{2}{}_{3}$

19. Bir satranç turnuvasında 32 tane oyuncu yarışmaktadır. Yarışmacılar ilk turda ikili olarak eşleştirilmiştir. Her karşılaşmanın birincisi ikinci tura geçer. Yarışma sadece bir tek kazanan kalıncaya kadar devam etmektedir. Buna göre oynanan toplam karşılaşma sayısı aşağıdakilerden hangisidir?

a. 30
b. 16
c. 31
d. 24
e. 18

20. Bir sınıftaki tüm öğrencilerin boyları ölçülmüştür. Sınıftaki erkek öğrencilerin boy ortalaması 160 cm, kız öğrencilerin boy ortalaması ise 150 cm'dir. Ayşe sınıfta bulunan öğrenciler arasında 180 cm'lik boyuyla en uzun, Mert ise 130 cm'lik boyuyla sınıftaki öğrenciler arasında en kısadır. Boy ölçümünün yapıldığı gün iki öğrenci derse gelmemiştir. Ertesi gün bu iki öğrenci de derse gelince tekrar tüm sınıf için boy ölçümü yapılıp kız ve erkek öğrencilerin boy ortalamalarının değişmediği görülmüştür. Buna göre aşağıdaki durumlardan hangisi ***doğrudur***?

a. Eksik olan öğrencilerin ikisi de kızdır.
b. Eksik öğrencilerden biri öğrenci kız diğeri erkektir.
c. Tüm öğrencilerin boy ortalaması eksik öğrenciler de katılınca değişmemiştir.
d. Mert son durumda da halen sınıfın en kısasıdır.
e. Eksik olan öğrenciler farklı boydadır.

21. Aşağıdaki tabloda karbon dioksit (CO_2) emilim ve yayılmasına neden olan faktörler ve günlük miktarları verilmiştir. Buna göre aşağıdakilerden hangisi ***doğrudur***?

Ormanlar	150000 ton (CO_2 emilim/gün)
Okyanus	125000 ton (CO_2 emilim/gün)
Buzullar	125000 ton (CO_2 emilim/gün)
Yanardağlar	150000 ton (CO_2 yayılma /gün)
Uçuşlar	200000 ton (CO_2 yayılma/gün)
Araçlar	50000 ton (CO_2 yayılma/gün)

a. CO_2 yayılması CO_2 emiliminden daha fazladır.
b. CO_2 yayılması CO_2 emiliminden daha azdır.
c. Uçuşlar ve araçlardan CO_2 yayılması iki kat artarsa, CO_2 emilimi ve yayılmasını dengelenmek için okyanus ve buzullardan CO_2 emiliminin iki katına çıkması gerekir.
d. Uçuşlar iptal edilirse CO_2 yayılması ile emilimi eşit miktarda olacaktır.
e. Buzullar erirse CO_2 emilimi artacaktır.

Katılımınız için teşekkürler!!!

APPENDIX B

THE SURVEY

Bölüm 1: Bu bölümde sizinle iligili bazı bilgiler sorulmaktadır. Lütfen ilgili yerlere (√) ya da (**X**) koyarak işaretleyiniz. **Tüm soruları boş bırakmadan yanıtlayınız**.

1. Bölümünüz:____
2. Genel akademik ortalamanız:________
3. Cinsiyetiniz:
   a)Kız b)Erkek
4. Sınıfınız:
   a) Hazırlık b) 1. Sınıf c) 2.Sınıf d) 3.Sınıf e) 4.Sınıf
5. Hangi orta ögretim kurumundan mezun oldunuz?
   a) Genel Lise b)Kolej c) Anadolu Lisesi d)Meslek Lisesi
   e) Başka ise belirtiniz:____________________
6. Babanızın eğitim düzeyi nedir?
   a) Okur-yazar değil b)İlkokul c)Ortaokul d)Lise e)Üniversite
7. Annenizin eğitim düzeyi nedir?
   a)Okur-yazar değil b)İlkokul c)Ortaokul d)Lise e)Üniversite
8. Siz hariç kaç kardeşşiniz? (Sizden büyük ve küçük olanlar dahil)
   a)Kardeşim yok b)1 c)2-3 d)4-5 e)6 ve üstü
9. Kendinize ait ders kitapları dahil ortalama kaç kitabınız var?
   a)0-10 b)11-24 c)25-100 d)100'den fazla
10. Mesleki alanınız dışında dergi, kitap vs. ne kadar sıklıkla okuyorsunuz?
    a)Hemen her gün b)Haftada 1-2 kez c)Ayda 1-2 kez d) Hemen hiç
11. Ders çalışmaya ve ödevlerinize hergün ortalama ne kadar zaman ayırıyorsunuz?
    a)Hemen hiç b)1 saat ve daha az c)2-3 saat d)4-5 saat e)6 saat ve fazla
12. Evinizde aşağıdakilerden hangileri vardır (Her sırada sadece bir kutuyu işaretleyiniz):

	Var	Yok
Bilgisayar..	□	□
İnternet erişimi..................................	□	□
Çalışmak için ayrı oda........................	□	□
Çalışma masası………..........................	□	□
Çalışmalarınız için yardımcı kitaplar..	□	□

Bölüm 2: Verilen cümlelerden hiçbirinin kesin cevabı yoktur. Her cümleyle ilgili görüş, kişiden kişiye değişebilir. Bunun için vereceğiniz yanıtlar kendi görüşünüzü yansıtmalıdır. Her cümleyle ilgili görüş belirtirken önce cümleyi dikkatle okuyunuz, sonra cümlede belirtilen düşüncenin, sizin düşünce ve duygunuza ne derecede uygun olduğuna karar veriniz. Bu cümleler için ifade edilen düşüncelere sizin ne derece katılıp katılmadığınızı belirtmeniz için "*Kesinlikle Katılmıyorum*", "*Katılmıyorum*", "*Kararsızım*", "*Katılıyorum*", "*Kesinlikle Katılıyorum*" seçenekleri verilmiştir. Lütfen **tüm** soruları dikkatlice okuyup **boş bırakmadan,** sizin için en uygun seçeneği işaretleyiniz.

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Bana zor gibi görünen konuları anlamak için çok çaba harcarım.	□	□	□	□	□
2. Derslerde dinlediğim şeylerin doğruluğunu sorgularım.	□	□	□	□	□
3. Okuduğum şeylerin anlamını tam olarak kavramaya çalışırım.	□	□	□	□	□
4. Bir konuyla uğraşırken kendime yeni bilginin gerektiği sorular sorarım.	□	□	□	□	□
5. Farklı konular arasında ilişki kurmaya çalışırım.	□	□	□	□	□
6. Yeni fikirlerle gerçek hayattaki olaylar arasında bağlantı kurmaya çalışırım.	□	□	□	□	□
7. Bir konuda yazmadan önce konu hakkında epey bilgi edinirim.	□	□	□	□	□
8. Farklı fikirlerin birbiriyle nasıl uyuştuğuna bakarım.	□	□	□	□	□
9. Uygulamalı çalışmaları rapor ederken dikkate alırım.	□	□	□	□	□
10. Yeterli kanıt olmadıkça sonuca varmakta dikkatli davranırım.	□	□	□	□	□
11. Mantıklı bir sonuca varmayı gerektiren problemler ilgimi çeker.	□	□	□	□	□
12. Bir makale veya raporu okurken eldeki verilerin sonuç için yeterli olup olmadığını kontrol ederim.	□	□	□	□	□
13. Bu bölümde olmamın sebebi, ilgilendiğim konularda daha fazla bilgi sahibi olmaktır.	□	□	□	□	□
14. Akademik konuları çalışmanın çoğu kez gerçekten heyecan verici olduğunu düşünüyorum.	□	□	□	□	□
15. Derslerde tartışılan ilginç konular hakkında daha çok şey öğrenmek isterim.	□	□	□	□	□

Table (continued)

16. Akademik konularla ilgili ders bittikten sonra da araştırma yapmayı sürdürürüm.	□	□	□	□	□
17. Hocalar basit gerçekleri gereksizce güçleştirmekten hoşlanıyor gibiler.	□	□	□	□	□
18. Öğrenmek zorunda olduklarımızın birçoğunu ezberleyerek öğrenirim.	□	□	□	□	□
19. Okurken ileride kullanışlı olabilecek gerçekleri ezberlemeye çalışırım.	□	□	□	□	□
20. Teknik terimleri anlamanın en iyi yolu kitap tanımlarını ezberlemektir.	□	□	□	□	□
21. Genellikle, okuduklarım üzerinde akıl yürütmeye pek vaktim olmaz.	□	□	□	□	□
22. Okuduğum şeyleri iyice anlamaya fırsat olmadan okuyorum.	□	□	□	□	□
23. Rapor veya ödevlerde tam olarak ne yapmam gerektiğinin söylenmesini isterim.	□	□	□	□	□
24. İyi yapılandırılmış ve düzenlenmiş dersleri tercih ederim.	□	□	□	□	□
25. Ödevleri tamamlamak için gerekenlerin dışında oldukça az okurum.	□	□	□	□	□
26. Belirli zaman süresi içinde rekabete dayanan ödevler bende sıkıntı yaratır.	□	□	□	□	□
27. Bir sınavda ilk soruya zayıf bir yanıt verirsem paniğe kapılırım.	□	□	□	□	□
28. Derslerde soruları sözlü yanıtlamak zorunda kalmak bende sıkıntı yaratır.	□	□	□	□	□
29. Aldığım derslerin ileride bana iyi bir iş imkanı sağlayacağını düşünüyorum.	□	□	□	□	□
30. Bu bölümde olmamın sebebi daha iyi bir iş bulmama yardımcı olacağıdır.	□	□	□	□	□
31. Derslere, ileride meslek yaşantıma destek sağlayacakları için katlanıyorum.	□	□	□	□	□
32. Aldığım derslerden çok alacağım derecelerle ilgileniyorum.	□	□	□	□	□
33. Çalışma zamanımı etkin bir şekilde organize etmek zor geliyor.	□	□	□	□	□
34. İşleri en sona bırakma alışkanlığım dönem sonunda beni aşırı bir yükle karşı karşıya bırakır.	□	□	□	□	□
35. Akşamları dikkatimi bir konuda toplayamadığımdan ödev yaparken verimim düşük olur.	□	□	□	□	□

Table (continued)

36.	Akşamları çalışmaya başlarken epey ağırdan alırım.	□	□	□	□	□
37.	Rekabeti severim; beni harekete geçirir	□	□	□	□	□
38.	Buradaki derslerimde gerçekten başarılı olmam benim için önemlidir.	□	□	□	□	□
39.	Arkadaşlarımdan daha başarılı olmak benim için önemlidir.	□	□	□	□	□
40.	Yeterince uğraşırsam her türlü matematik problemini çözebilirim.	□	□	□	□	□
41.	Matematiksel yapılar ve teoremleri kullanarak yeni keşifler yapabilirim.	□	□	□	□	□
42.	Matematikte yeni bir durumla karşılaştığımda nasıl davranmam gerektiğini bilirim.	□	□	□	□	□
43.	Matematiğe çevremdekiler kadar hakim olmanın benim için imkansız olduğuna inanırım.	□	□	□	□	□
44.	Anlamasam bile hocamızın gösterdiği matematiksel çözümü kabul ederim.	□	□	□	□	□
45.	Problem çözerken bir sonraki adımda ne yapacağıma karar vermekte zorlanırım.	□	□	□	□	□
46.	Problemi çözmeye başlamadan önce bir sonraki adıma nasıl yaklaşacağımı düşünürüm.	□	□	□	□	□
47.	Problemi çözdükten sonra geriye dönüp kontrol etmem.	□	□	□	□	□
48.	Problem çözerken, soruyu tekrar tekrar okurum.	□	□	□	□	□
49.	Problem çözerken, birden fazla çözüm yöntemi düşünürüm.	□	□	□	□	□
50.	Problem çözerken, takıldığım zaman başka bir yöntem denerim.	□	□	□	□	□
51.	Problem çözerken,sonuca hemen ulaşmazsam vazgeçerim.	□	□	□	□	□

Katılımınız için teşekkürler!!!

APPENDIX C

SPECIFICATIONS OF THE MTRC TEST

Table 86 Table of Specifications of the MTRC Test

NO	Type	Difficulty	Disciplines involved	Problem solving processes	RS	CC	Key
1	Logical inferencing (Language&Proof)	moderate	Propositional Logic	Understand logical statements in real life contexts. Represent problem in mathematical context using quantified statements. Negate quantified statements. Re-represent them in real life context.	LDR	R	A
2	Logical inferencing (Language&Proof)	moderate	Propositional Logic	Understand logical statements in real life contexts. Represent problem in mathematical context using quantified statements. Negate quantified statements. Re-represent them in real life context.	LDR	R	A
3	Logical inferencing (Language&Proof)	difficult	Propositional Logic	Understand logical statements in real life contexts, represent problem in mathematical context. Analyze by cases. Evaluate result by eliminating irrelevant cases.	LDR	RF	B
4	Expressing given situation Mathematically	easy	arithmetic	Understand problem. Represent the problem mathematically.	AR	R	A
5	Expressing given situation Mathematically	easy	Modular arithmetic	Understand problem. Represent the problem mathematically.	AR	R	B
6	Extract given information from a table	easy	arithmetic	Understand given situation. Extract necessary information from given values in a table.	AR	R	C
7	Applying appropriate computational skills	easy	arithmetic	Understand given problem. Using computational skills to solve the problem	QR	R	A
8	Applying appropriate computational skills	easy	arithmetic	Understand given problem. Using computational skills to solve problem	QR	R	A
9i	Evaluating conditional statements in everyday language/logical inferencing	easy	Propositional logic	Understand the given situation. Evaluate given situation with respect to the conditions.	LDR	R	B
9ii	Evaluating conditional statements in everyday language/logical inferencing	easy	Propositional logic	Understand the given situation. Evaluate the given situation with respect to the conditions.	LDR	R	A

Table 86(continued)

9iii	Evaluating conditional statements in everyday language/logical inferencing	easy	Propositional logic	Understand the given situation. Evaluate the given situation with respect to the conditions.	LDR	R	C
9iv	Evaluating conditional statements in everyday language/logical inferencing	easy	Propositional logic	Understand the given situation. Evaluate the given situation with respect to the conditions.	LDR	R	A
9v	Evaluating conditional statements in everyday language/logical inferencing	easy	Propositional logic	Understand the given situation. Evaluate the given situation with respect to the conditions.	LDR	R	A
9vi	Evaluating conditional statements in everyday language/logical inferencing	moderate	Propositional logic	Understand the given situation. Evaluate the given situation with respect to the conditions.	LDR	R	C
10	Evaluating conditional statements in everyday language/logical inferencing. Complex multiple choice.	moderate	Propositional logic	Understand problem. Evaluate given condition.	LDR	C	D
11	Expressing and computing given situation Mathematically	moderate	arithmetic	Understand problem. Represent problem mathematically. Apply appropriate computational skills to solve the problem	QR	R	B
12	Expressing and computing given situation Mathematically	easy	Modular arithmetic	Understand problem. Represent the problem mathematically. Apply appropriate computational skills to solve the problem	QR	R	E
13	Expressing and computing given situation Mathematically	easy	Modular arithmetic	Understand problem. Represent problem mathematically. Apply computational skills to solve problem	QR	R	A
14	Extract given information from table. Complex multiple choice	Easy	Modular arithmetic	Understand given situation. Extract the necessary information from the given values in the table.	AR	R	C
15	Evaluating whether necessary information is given for computing result	difficult	arithmetic	Understand problem. Represent problem mathematically. Checking whether given information is sufficient to compute result or not. Apply appropriate computational skills to solve the problem	LDR	RF	C
16	Expressing and computing given situation mathematically	easy	arithmetic	Understand problem. Represent the problem mathematically. Apply appropriate computational skills to solve the problem	QR	R	B
17	Expressing and computing given situation mathematically	moderate	Modular arithmetic	Understand problem. Represent the problem imathematically. Apply appropriate computational skills to solve the problem	QR	R	D
18	Expressing and computing given situation mathematically	moderate	arithmetic	Understand problem. Represent the problem mathematically. Apply appropriate computational skills to solve the problem	QR	R	A

Table 86 (continued)

19	Expressing and computing given situation mathematically	easy	Counting-arithmetic	Understand problem. Represent the problem mathematically. Apply appropriate computational skills to solve the problem	QR	R	C
20	Verifying the truth of each case stated in options. Complex multiple choice.	difficult	arithmetic	Understand problem. Represent the problem mathematically. Analyze by cases.	QR	RF	E
21	Extract given information from table	easy	arithmetic	Understand given situation. Extract the necessary information from the given values in the table.	QR	R	C
*22	Express given statement visually	easy	graph	Understand given situation. Represent problem in visual way.	AR	R	B
*23	Expressing and computing given situation mathematically	easy	arithmetic	Understand problem. Represent the problem mathematically. Apply appropriate computational skills to solve the problem	QR	R	E

*: These items were used only at the pilot administration of the test.

**Reasoning Skills (RS):

Analytic reasoning (AS): learners must apply principles of formal logic in determining necessary& sufficient conditions or in determining if implication of causality occurs among the constraints and conditions provided in the problem.

Quantitative reasoning (QR): learner must apply properties and procedures related to number operations form mathematics to solve problem.

Logico-deductive reasoning (LDR): conclusions (new knowledge) follow from premises (old knowledge) through the application of arguments (syllogisms, rules of inference).

***Cluster Competency (CC): Reproduction, Reflection

Reproduction (R): standard representations & definitions, routine computations procedures problem solving

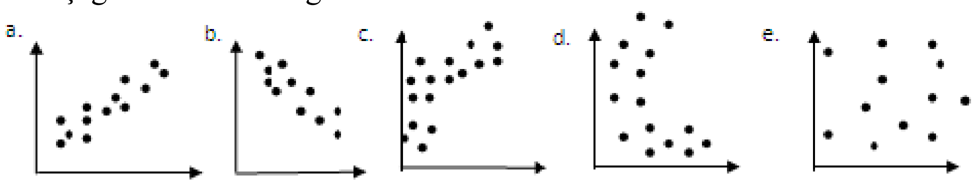
Reflection (RF): Complex problem solving and posing, reflection&insight, original mathematical approach, multiple complex methods, generalization

Note: Above fields in the test specification were adapted from PISA 2003 problem solving framework.

APPENDIX D

EXCLUDED ITEMS FROM THE FINAL VERSION OF THE TEST

22. Bahar mevsiminde havadaki nem oranı arttığında polen miktarı azalmaktadır. X nem oranı ve Y polen miktarı olmak üzere, bu durumu ***en iyi*** gösteren grafik aşağıdakilerden hangisidir?



23. Suyun 20 derecede donduğu ve 80 derecede kaynadığı bir T ısı ölçeği olsun. Fahrenheit ölçeğinde ısı x ise, T ölçeğinde ısı a ve b sabit sayılar için, $ax + b$'dir. T ölçeğinde 50 ısı değerinin Fahrenheit ölçeğindeki karşılığı aşağıdakilerden hangisidir?

   a. $\frac{50-b}{a}$
   b. $\frac{50-b}{2a}$
   c. $\frac{100-b}{a}$
   d. $\frac{100-b}{2a}$
   e. $\frac{100-2b}{a}$

APPENDIX E

TABLE OF SPECIFICATIONS FOR THE SURVEY

Meaning Orientation
Deep Approach: Q1-Q4
Relating Ideas: Q5-Q8
Use of Evidence: Q9-Q12
Intrinsic Motivation: Q13-Q16

Reproducing Orientation
Surface Approach: Q17-Q22
Sylabus-Boundedness: Q23-Q25
Fear of Failure: Q26-Q28

Strategic Orientation
Extrinsic Motivation: Q29-Q32
Achievement Motivation: Q37-Q39

Non-Academic Orientation
Disorganized Study Methods: Q33-Q36

Mathematics Self-Efficacy: Q40-Q43

Problem solving strategies: Q44-Q51

APPENDIX F

CHECKLIST FOR FACE AND CONTENT VALIDITY

Definition: This test was designed to measure the competency of university students in the specified set of cognitive thinking processes that were situated in real life problems in the scope of reasoning and mathematical thinking for all grade level students of mathematics, elementary and secondary mathematics education, early childhood and classroom teacher education.

Please put a check sign (√) and provide suggestions if any, to the following statements:

	Yes	Not Yet	Suggestions
Aims and format of the items are clear			
Content is suitable for undergraduate students of MATH, ECE, EME, SSME, CTE			
The content is comprehensive			
Sample of items are adequate			
Items match with the objectives			
The layout is clear and is legible			
Format of the items are appropriate			
There are no plausible distracters			
There is no ambiguity in the options			
Work space are allocated			
Language is appropriate and free of grammar and spelling errors			
Instructions are clear			
Items do not encourage guessing.			
Items are easy to read			

APPENDIX G

KEYWORDS USED IN LITERATURE SEARCH

Affective

Demographic

Mathematics Achievement

SEM

MANOVA

ANOVA

Structural Equation Modeling

Factor Structure Equality across Groups

Factorial Invariance across Groups

Approaches to Learning/Studying

Mathematical Thinking

Reasoning

Meaning Orientation (Deep Approach, Relating Ideas, Use of Evidence, Intrinsic Motivation),

Reproducing Orientation (Surface Approach, Syllabus-Boundness, Fear of Failure)

Strategic Orientation (Extrinsic and Achievement Motivation),

Non-Academic Orientation (Disorganized Study Methods),

Mathematics Self-Efficacy

Problem Solving Strategies/Behaviors

APPENDIX H

DESCRIPTIVE STATISTICS FROM CFA RESULTS

Table 87 Latent and Observed Variables from CFA

Latent Variables	Observed Variables		Mean	SD
MEANORT Meaning Orientation	RIdea1Q5	Farklı konular arasında ilişki kurmaya çalışırım.	3.93	0.83
	DAp3Q3	Okuduğum şeylerin anlamını tam olarak kavramaya çalışırım.	4.16	0.80
	RIdea2Q6	Yeni fikirlerle gerçek hayattaki olaylar arasında bağlantı kurmaya çalışırım.	3.88	1.00
	DAp4Q4	Bir konuyla uğraşırken kendime yeni bilginin gerektiği sorular sorarım.	3.58	0.94
	RIdea4Q8	Farklı fikirlerin birbiriyle nasıl uyuştuğuna bakarım.	3.74	0.89
	DAp2Q2	Derslerde dinlediğim şeylerin doğruluğunu sorgularım.	3.65	0.95
	RIdea3Q7	Bir konuda yazmadan önce konu hakkında epey bilgi edinirim.	3.70	0.92
	Evid4Q12	Bir makale veya raporu okurken eldeki verilerin sonuç için yeterli olup olmadığını kontrol ederim.	3.68	0.96
	Evid2Q10	Yeterli kanıt olmadıkça sonuca varmakta dikkatli davranırım.	3.94	0.88
	Evid1Q9	Uygulamalı çalışmaları rapor ederken bulguların farklı birkaç yorumunu dikkate alırım.	3.69	0.88
	SEff3Q42	Matematikte yeni bir durumla karşılaştığımda nasıl davranmam gerektiğini bilirim.	3.36	0.90
MSEFFIC Mathematics Self-Efficacy	SEff2Q41	Matematiksel yapılar ve teoremleri kullanarak yeni keşifler yapabilirim.	3.12	1.04
	SEff3Q42	Matematikte yeni bir durumla karşılaştığımda nasıl davranmam gerektiğini bilirim.	3.36	0.90
	SEff1Q40	Yeterince uğraşırsam her türlü matematik problemini çözebilirim.	3.76	1.00
	SEff4Q43	Matematiğe çevremdekiler kadar hakim olmanın benim için imkansız olduğuna inanırım.	3.83	1.00
	PSSt1Q44	Anlamasam bile hocamızın gösterdiği matematiksel çözümü kabul ederim.	3.12	1.07
	PSSt2Q45	Problem çözerken bir sonraki adımda ne yapacağıma karar vermekte zorlanırım.	3.44	0.92
	PSSt8Q51	Problem çözerken sonuca hemen ulaşmazsam vazgeçerim.	3.69	1.02

Table 87 (continued)

MOT Motivation(Intrinsic/ Achievement)	IMot2Q14	Akademik konuları çalışmanın çoğu kez gerçekten heyecan verici olduğunu düşünüyorum.	3.37	1.15
	IMot1Q13	Bu bölümde olmamın sebebi, ilgilendiğim konularda daha fazla bilgi sahibi olmaktır.	3.62	1.21
	IMot4Q16	Akademik konularla ilgili ders bittikten sonra da araştırma yapmayı sürdürürüm.	3.03	1.05
	AMot2Q38	Buradaki derslerimde gerçekten başarılı olmam benim için önemlidir.	3.83	1.00
	EMot1Q29	Aldığım derslerin ileride bana iyi bir iş imkanı sağlayacağını düşünüyorum.	3.47	1.18
	SEff2Q41	Matematiksel yapılar ve teoremleri kullanarak yeni keşifler yapabilirim.	3.12	1.04
	SEff1Q40	Yeterince uğraşırsam her türlü matematik problemini çözebilirim.	3.76	1.00
DISORSTD Disorganized Study Methods	DOSt4Q36	Akşamları çalışmaya başlarken epey ağırdan alırım.	2.71	1.16
	DOSt2Q34	İşleri en sona bırakma alışkanlığım dönem sonunda beni aşırı bir yükle karşı karşıya bırakır.	2.44	1.23
	DOSt3Q35	Akşamları dikkatimi bir konuda toplayamadığımdan ödev yaparken verimim düşük olur.	2.92	1.22
	DOSt1Q33	Çalışma zamanımı etkin bir şekilde organize etmek zor geliyor.	2.80	1.12
SURAPP Surface Approach	SAp3Q19	Okurken ileride kullanışlı olabilecek gerçekleri ezberlemeye çalışırım.	2.85	1.12
	SAp4Q20	Teknik terimleri anlamanın en iyi yolu kitap tanımlarını ezberlemektir.	3.59	1.03
	SAp2Q18	Öğrenmek zorunda olduklarımızın birçoğunu ezberleyerek öğrenirim.	3.11	1.14
	SAp5Q21	Genellikle, okuduklarım üzerinde akıl yürütmeye pek vaktim olmaz.	3.47	0.99
	SAp6Q22	Okuduğum şeyleri iyice anlamaya fırsat olmadan okuyorum.	3.46	1.07
EXPEXTCMP Express,Extract,Compute	ECp7R19	Bir satranç turnuvasında 32 tane oyuncu yarışmaktadır. Yarışmacılar ilk turda ikili olarak eşleştirilmiştir. Her karşılaşmanın birincisi ikinci tura geçer. Yarışma sadece bir tek kazanan kalıncaya kadar devam etmektedir. Buna göre oynanan toplam karşılaşma sayısı aşağıdakilerden hangisidir?	0.69	0.46
	ECp4R16	Bir yıl sonra eşimin yaşı evimin yaşının üçte bir kadar olacaktır. Dokuz yıl sonra benim yaşım, evimin yaşının yarısı kadar olacaktır. Ben eşimden 10 yaş büyüğüm. Buna göre benim, eşimin ve evimin şimdiki yaşları sırasıyla aşağıdakilerden hangisidir?	0.81	0.40

Table 87(continued)

	ExTb2R14	Bir dersten sabah ve akşam gruplarında AA notu alan kız ve erkek öğrenciler dağılımı ve yüzdelikleri aşağıdaki tabloda verilmiştir: Bu tabloya göre aşağıdakilerden hangisi *yanlıştır*?	0.70	0.46
	CpSkl1R7	F ve C sırasıyla Fahrenheit ve Celsius sıcaklık değerlerini göstersin. Bu değerler arasındaki ilişki $F = \frac{9}{5}C + 32$ ile gösterilmiştir. Kaç derecede Fahrenheit ve Celcius sıcaklık değerleri birbirine eşit olur?	0.81	0.39
	ECp2R12	Bir evin değeri ilk yıl %20 artmış, sonraki yıl %18 azalmıştır. Buna göre, aşağıdakilerden hangisi *doğrudur?*	0.63	0.48
	ECp6R18	Bir okulda kız öğrencilerin yarısı ve erkek öğrencilerin üçte biri İngilizce bilmektedir. Tüm öğrencilerin üçte ikisi erkek olduğuna göre İngilizce bilen kız öğrencilerin İngilizce bilen tüm öğrencilere oranı kaçtır?	0.70	0.46
	ExTb3R21	Aşağıdaki tabloda karbon dioksit(CO_2) emilim ve yayılmasına neden olan faktörler ve günlük miktarları verilmiştir. Buna göre aşağıdakilerden hangisi *doğrudur?*	0.71	0.45
	ECp1R11	Bir gazetenin haberine göre üniversitelerin, ekonominin iş verebileceğinden %25 daha fazla mezun verdiği bildirilmiştir. Buna göre aşağıdakilerden hangi sonucu çıkarabiliriz?	0.58	0.49
EXPLOGINF Express and infer logically	LInf1R1	"İnsanların tümünü bazı zaman kandırabilirsiniz." ifadesinin mantıksal olarak *olumsuzu* aşağıdakilerden hangisidir?	0.15	0.38
	LInf2R2	"Dersteki tüm öğrenciler birinci sınıftadır." ifadesinin mantıksal olarak *olumsuzu* aşağıdakilerden hangisidir?	0.15	0.36
	MEx1R4	Bir adam elindeki x lira y kuruşluk çeki bozdurmak isteğinde banka memuru yanlışlıkla ona y lira x kuruş nakit vermiştir. Adam bu parayla k kuruşluk bir gazete aldığında geri kalan para gerçek çek değerinin 2 katıdır. Aşağıdakilerden hangisi yukarıdaki ifadenin matematiksel olarak *doğru* gösterimidir?	0.38	0.49

Table 87 (continued)

ECp3R13	Yeni açılan bir mağaza müşterilerine indirim yapmaktadır. Kasiyer %15'lik indirimin bir malın değerine önce uygulanıp daha sonra oluşan değerden %5'lik verginin alınacağını, müşteri ise malın %5'lik vergisi eklendikten sonra oluşan değere %15 indirimin uygulanması gerektiğini iddia etmektedir. Buna göre aşağıdakilerden hangisi *doğrudur*?	0.39	0.49
LInf3R3	Hale sokakta üç kişiye rastlıyor. Bunların herbiri her zaman yalan ya da her zaman doğru söylemektedir. Bu kişilerin Hale'ye söyledikleri aşağıdadır: *A : " Üçümüz de yalan söylüyoruz."* *B: " Sadece aramızdan iki kişi yalan söylüyor"* *C: " Benim dışındaki ikisi yalan söylüyor."* Bu durumda hangisi/(leri) *doğruyu* söylemektedir?	0.23	0.42
EC3R9iii	Can'nın harflerle adlandırılmış odalardan oluşan bir labirentten aynı kapıyı iki kez kullanmadan geçerek Giriş'ten başlayıp Çıkış'ta bitirmelidir. Buna göre aşağıdaki durumlar için *doğru(D)*, *yanlış(Y)* ya da *yeterli bilgi yok(YBY)* şeklindeki yanıtlardan *size göre en doğru* olanını şeçiniz. Can M'den geçer.	0.57	0.50
EC6R9vi	Can L'den geçtiyse K'dan da geçmiştir.	0.43	0.50
EC4R9iv	Can O'dan geçtiyse F'den degeçmiştir.	0.85	0.36
EC5R9v	Can K'dan geçtiyse L'den de geçmiştir.	0.85	0.36
ECp5R17	Bir kişi günde 8 saat uyumakta ve 1 Nisan geceyarısı uyumaya başlamaktadır. Bu kişi uyandıktan tam olarak 17 saat sonra tekrar uyumaktadır. Bu kişi Nisan ayı içinde hangi günde yine *ilk* uyandığı saatte uyanacaktır?	0.43	0.50

APPENDIX I

COEFFICIENTS FOR SURVEY-TEST MODEL

I.1

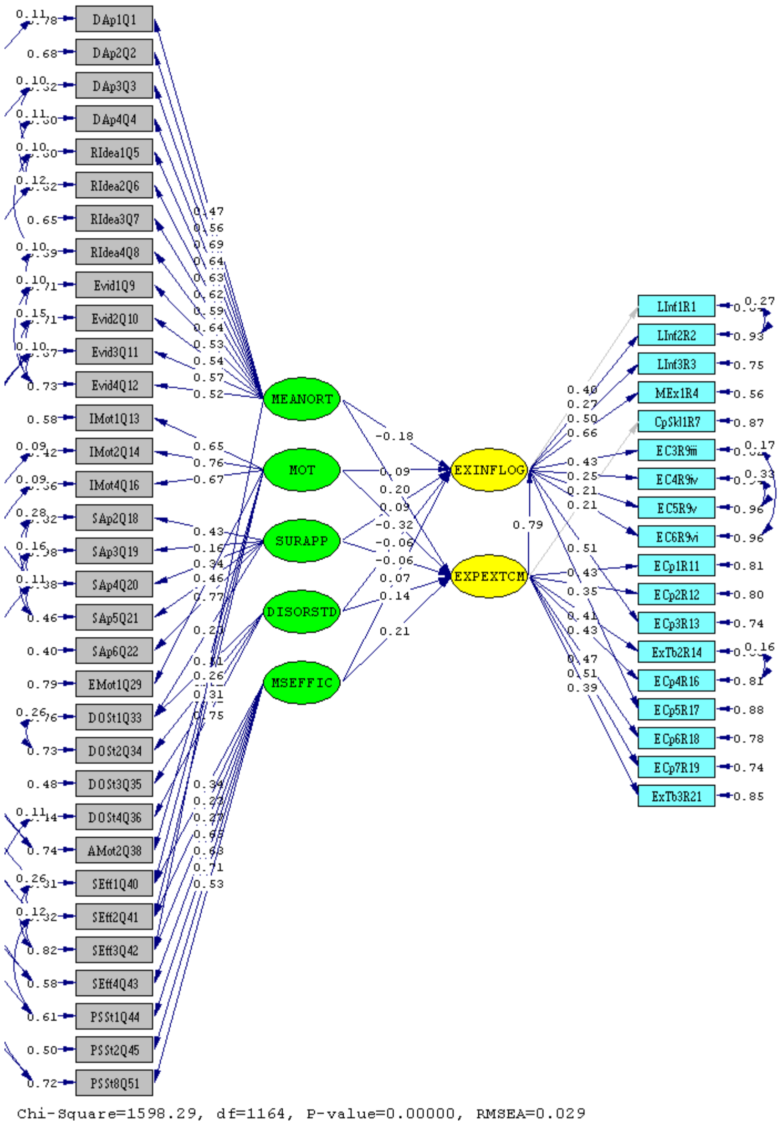


Figure 34 Basic Structural Model in Standardized Values for Survey-Test Model

I.2 COEFFICIENTS FOR SURVEY-TEST MODEL (cont.d)

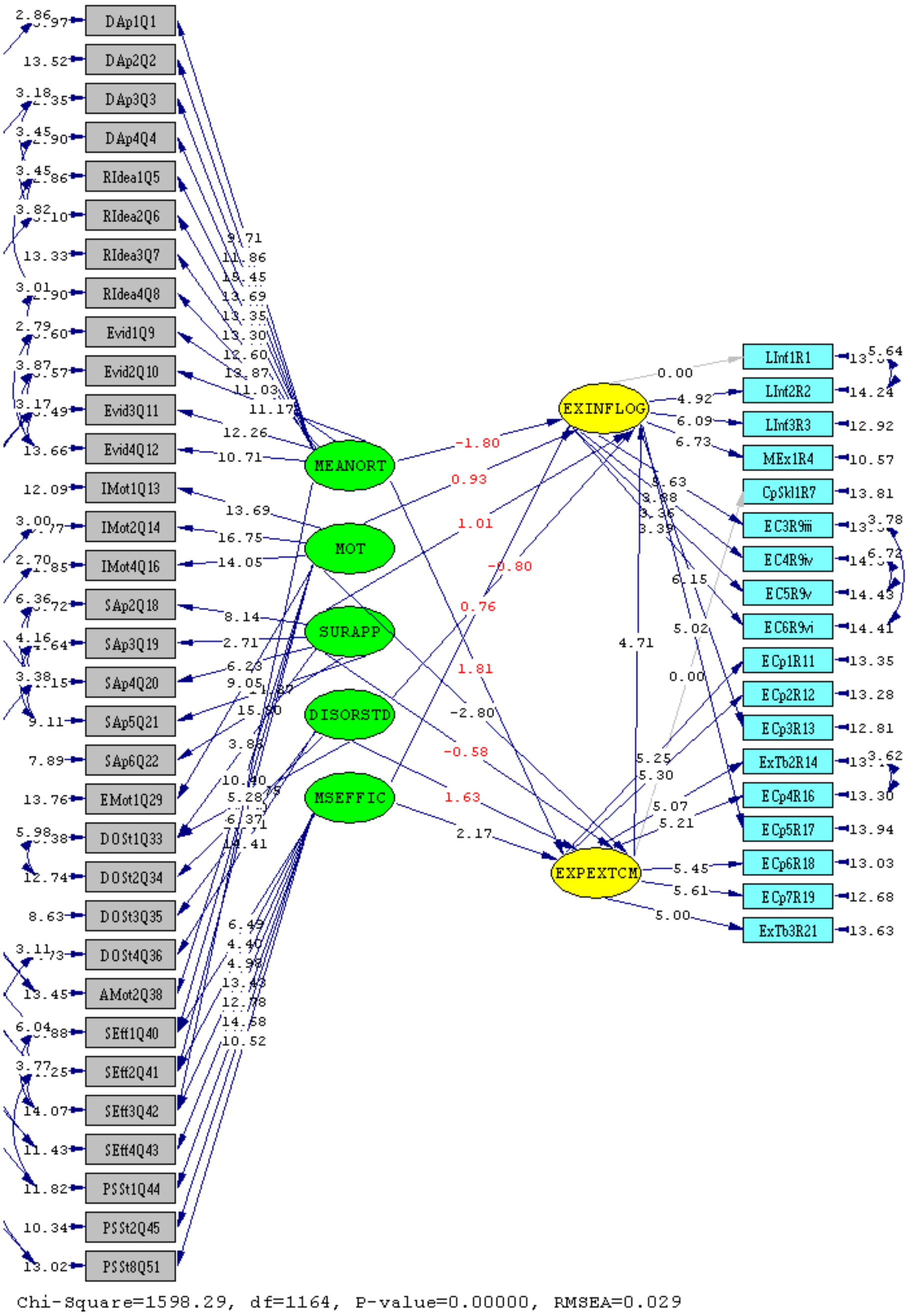


Figure 35 The Basic Structural Model in T-values for Survey-Test model

APPENDIX J

COEFFICIENTS FOR SURVEY-TESTt MODEL

J.1

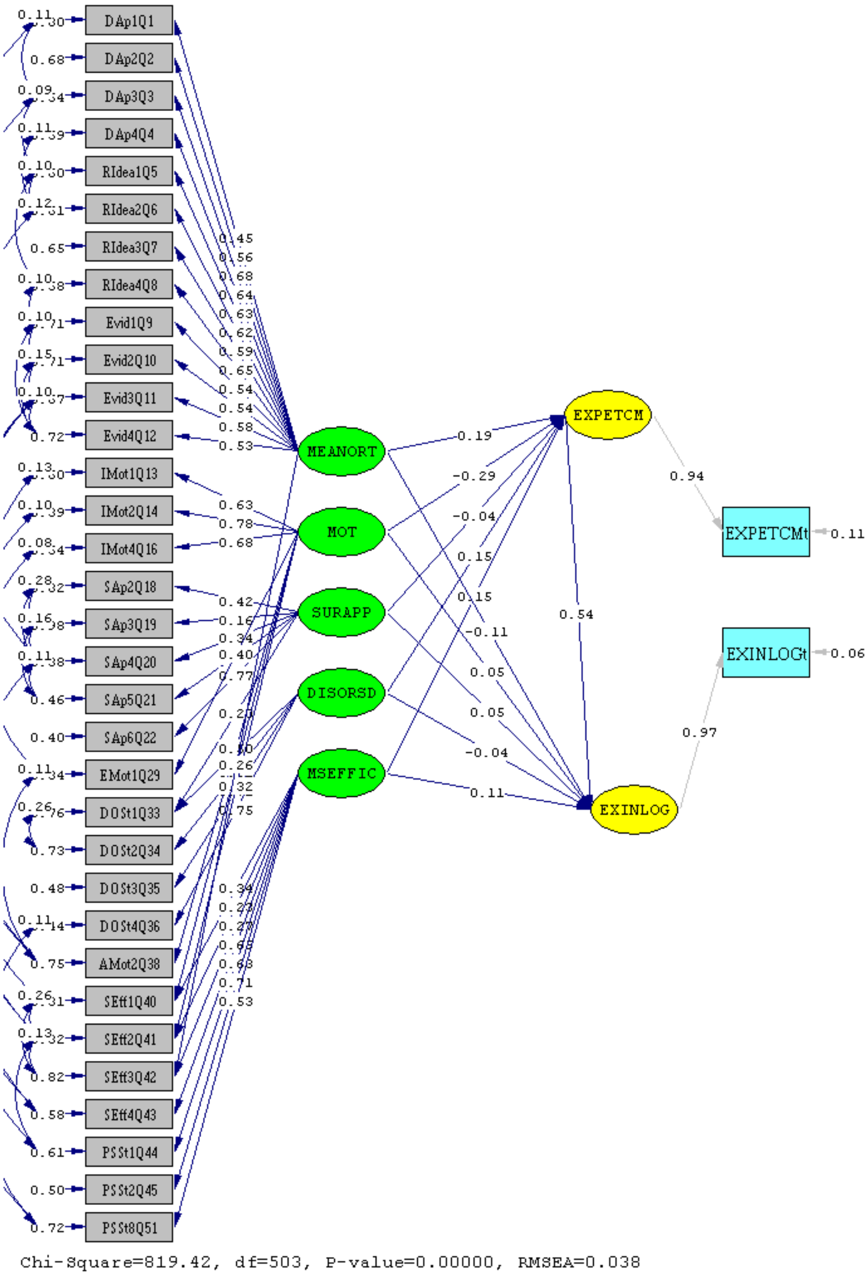


Figure 36 Basic Stuctural in Standardized Values for Survey- Testt Model

J.2 COEFFICIENTS FOR SURVEY-TESTt MODEL (cont’d)

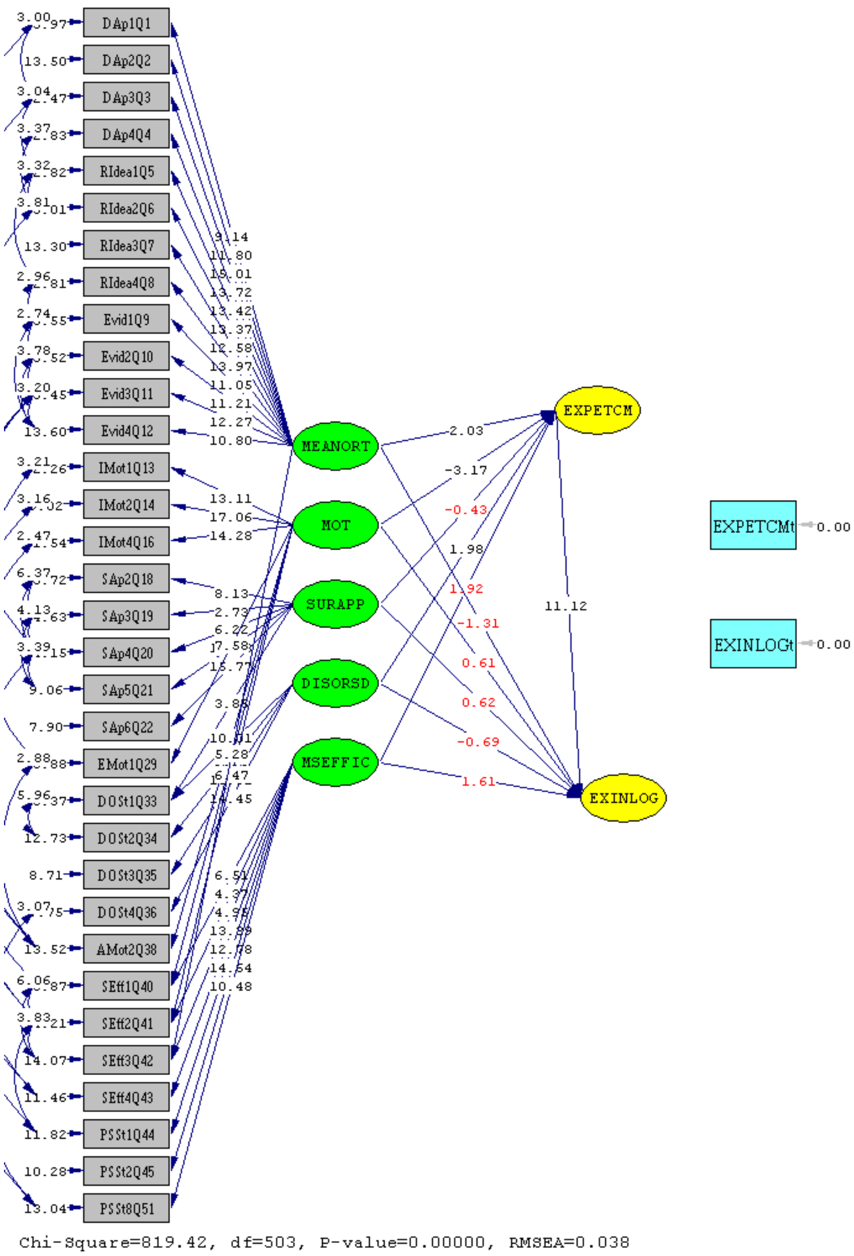


Figure 37 Basic Stuctural in T Values for Survey-Testt Model

APPENDIX K

COEFFICIENTS FOR SURVEYi-TEST MODEL

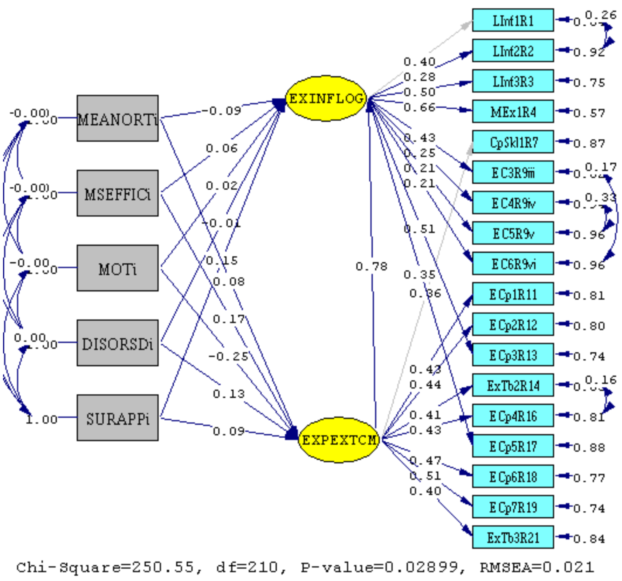


Figure 38 Basic Stuctural Model in Standardized Values for Surveyi-Test Model

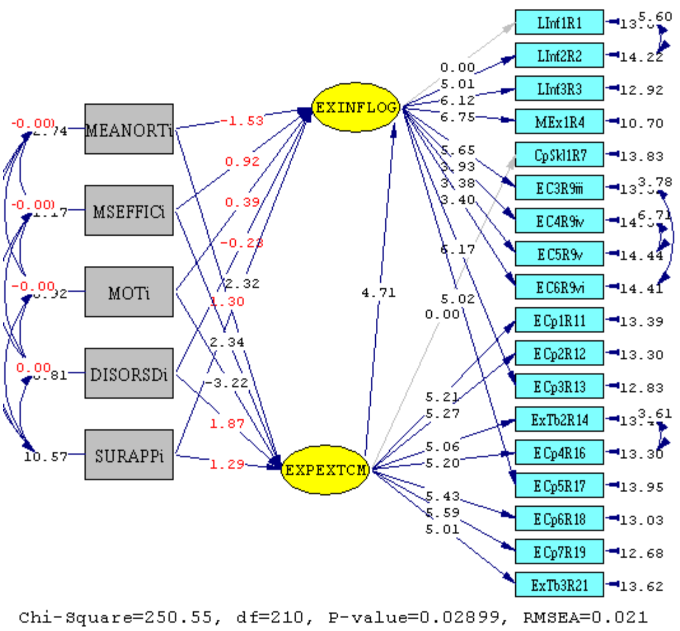


Figure 39 Basic Stuctural Model in T Values for Surveyi - Test (N=431)

APPENDIX L

COEFFICIENTS FOR SURVEYi-TEST MODEL FOR ANKARA

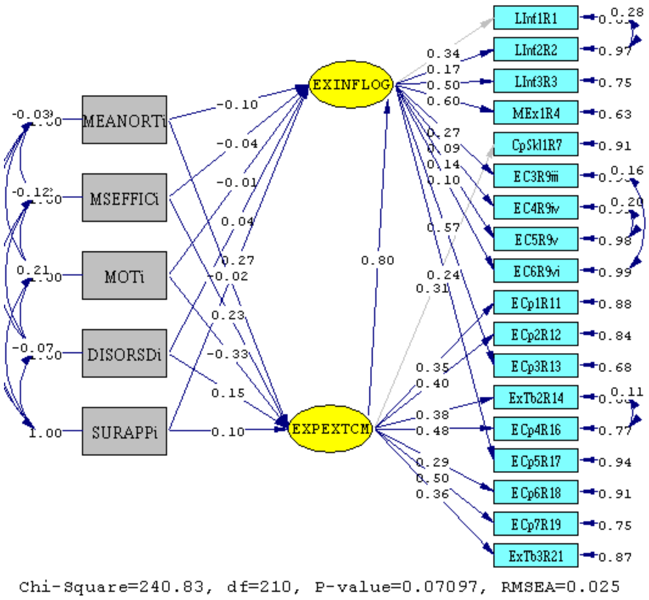


Figure 40 Standardized Basic Stuctural Surveyi-Test Model for Ankara region

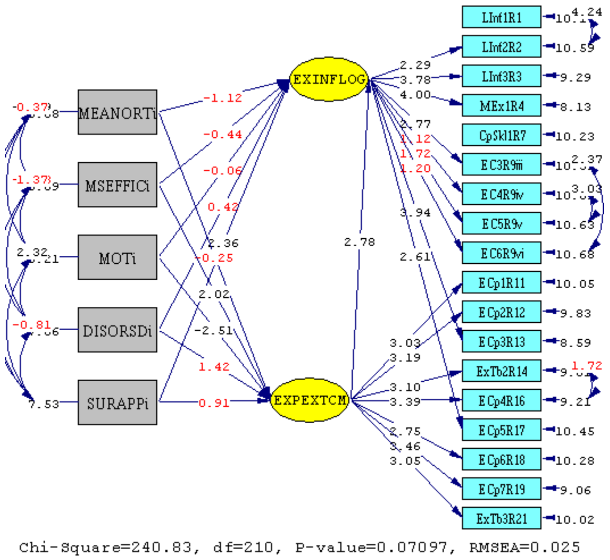


Figure 41Basic Stuctural Surveyi-Test Model in T Values for Ankara region

APPENDIX M

COEFFICIENTS FOR SURVEYi-TEST MODEL FOR NORTH CYPRUS

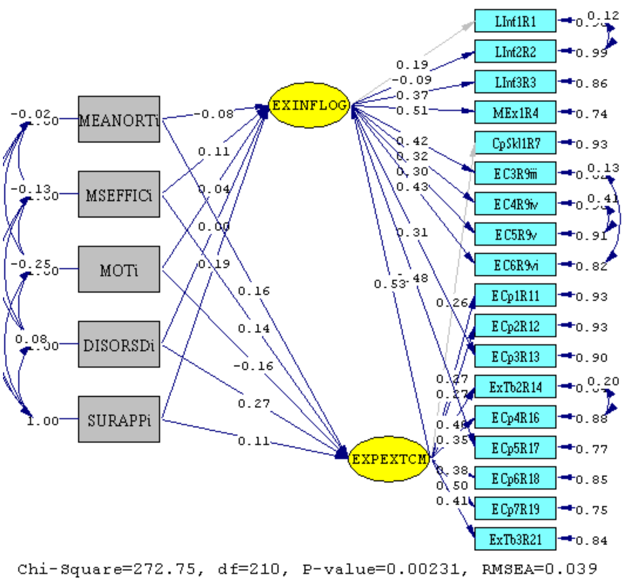


Figure 42 Standardized Basic Stuctural Surveyi-Test Model for Northern Cyprus

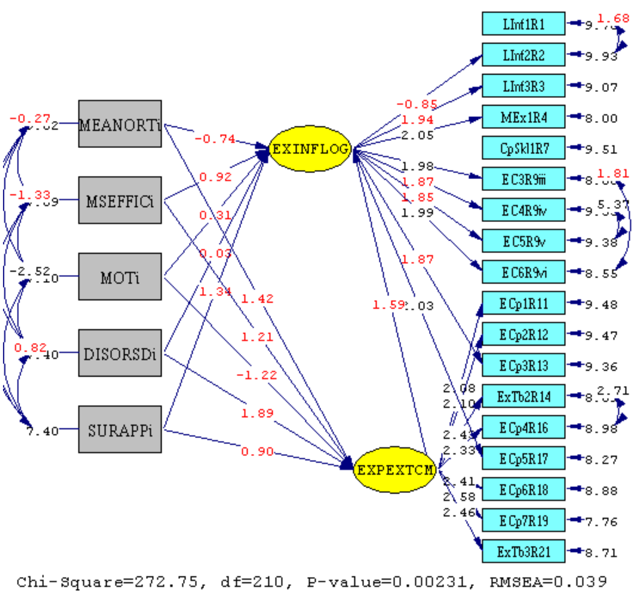


Figure 43Basic Surveyi-Test Model in T values for Northern Cyprus region

APPENDIX N

STRUCTURAL REGRESSION EQUATIONS FOR MODELS

```
        Structural Equations

EXINFLOG = 0.791*EXPEXTCM - 0.183*MEANORT + 0.0910*MOT + 0.0933*SURAPP - 0.0619*DISORSTD + 0.0652*MSEFFIC, Errorvar.= 0.359 ,
359 ,      (0.168)          (0.102)          (0.0983)     (0.0925)        (0.0776)          (0.0860)                        (0.121)
121)        4.715           -1.796            0.926        1.009          -0.798             0.758                          2. R1 =

            R1 = 0.641

EXPEXTCM = 0.204*MEANORT - 0.317*MOT - 0.0601*SURAPP + 0.143*DISORSTD + 0.214*MSEFFIC, Errorvar.= 0.887 , R1 = 0.113
           (0.113)         (0.113)     (0.103)         (0.0875)         (0.0987)                  (0.271)
            1.808          -2.797      -0.582           1.632            2.169                     3.278

        Reduced Form Equations

EXINFLOG =  - 0.0221*MEANORT - 0.159*MOT + 0.0458*SURAPP + 0.0510*DISORSTD + 0.234*MSEFFIC, Errorvar.= 0.914, R1 = 0.0864
4             (0.105)          (0.102)     (0.0998)        (0.0826)          (0.0955)
              -0.210           -1.561       0.459           0.617             2.454

EXPEXTCM = 0.204*MEANORT - 0.317*MOT - 0.0601*SURAPP + 0.143*DISORSTD + 0.214*MSEFFIC, Errorvar.= 0.887, R1 = 0.113
           (0.113)         (0.113)     (0.103)         (0.0875)         (0.0987)
            1.808          -2.797      -0.582           1.632            2.169
```

Figure 44 Structural Equations of the Survey-Test Model

```
 EXPETCM = 0.191*MEANORT - 0.285*MOT - 0.0378*SURAPP + 0.145*DISORSD + 0.154*MSEFFIC, Errorvar.= 0.915  , R1 = 0.0848
           (0.0945)        (0.0900)    (0.0878)        (0.0735)         (0.0804)                 (0.0741)
            2.025          -3.172      -0.431           1.979            1.921                    12.343

 EXINLOG = 0.544*EXPETCM - 0.107*MEANORT + 0.0477*MOT + 0.0462*SURAPP - 0.0437*DISORSD + 0.112*MSEFFIC, Errorvar.= 0.677  ,
  ,        (0.0490)        (0.0815)        (0.0788)     (0.0748)        (0.0634)          (0.0691)                 (0.0538)
8)          11.115         -1.307           0.606        0.618          -0.690             1.614                    12.57 R1

            R1 = 0.323

        Reduced Form Equations

 EXPETCM = 0.191*MEANORT - 0.285*MOT - 0.0378*SURAPP + 0.145*DISORSD + 0.154*MSEFFIC, Errorvar.= 0.915, R1 = 0.0848
           (0.0945)        (0.0900)    (0.0878)        (0.0735)         (0.0804)
            2.025          -3.172      -0.431           1.979            1.921

 EXINLOG =  - 0.00238*MEANORT - 0.108*MOT + 0.0256*SURAPP + 0.0354*DISORSD + 0.196*MSEFFIC, Errorvar.= 0.948, R1 = 0.0522
2             (0.0914)          (0.0870)    (0.0854)        (0.0713)         (0.0783)
              -0.0260           -1.237       0.300           0.496            2.499
```

Figure 45 Structural Equations of the Survey-Testt Model

```
EXINFLOG = 0.779*EXPEXTCM - 0.0940*MEANORTi + 0.0648*MSEFFICi + 0.0289*MOTi - 0.0169*DISORSDi + 0.176*SURAPPi,
=          (0.166)          (0.0613)          (0.0705)          (0.0742)      (0.0718)          (0.0758)
            4.705           -1.534             0.919             0.390        -0.235             2.322

            Errorvar.= 0.347 , R1 = 0.653
                       (0.118)
                        2.947

EXPEXTCM = 0.0888*MEANORTi + 0.190*MSEFFICi - 0.285*MOTi + 0.154*DISORSDi + 0.107*SURAPPi, Errorvar.= 0.879 , R1 = 0.121
           (0.0685)          (0.0814)         (0.0885)     (0.0824)         (0.0825)                  (0.270)
            1.297             2.339           -3.218        1.875            1.294                     3.260

        Reduced Form Equations

EXINFLOG =  - 0.0248*MEANORTi + 0.213*MSEFFICi - 0.193*MOTi + 0.103*DISORSDi + 0.259*SURAPPi, Errorvar.= 0.881, R1 = 0.119
19            (0.0654)          (0.0792)         (0.0800)     (0.0782)         (0.0852)
              -0.379             2.693           -2.411        1.324            3.041                                          +

EXPEXTCM = 0.0888*MEANORTi + 0.190*MSEFFICi - 0.285*MOTi + 0.154*DISORSDi + 0.107*SURAPPi, Errorvar.= 0.879, R1 = 0.121
           (0.0685)          (0.0814)         (0.0885)     (0.0824)         (0.0825)
            1.297             2.339           -3.218        1.875            1.294
```

Figure 46 Structural Equations of the Surveyi-Test Model (N=431)

```
        Structural Equations

EXINFLOG = 0.797*EXPEXTCM - 0.137*MEANORTi - 0.0491*MSEFFICi - 0.00650*MOTi + 0.0464*DISORSDi + 0.332*SURAPPi,
=          (0.286)          (0.122)          (0.113)           (0.116)        (0.111)           (0.141)
            2.784           -1.122           -0.436            -0.0562         0.419             2.362

           Errorvar.= 0.278 , R1 = 0.722
                     (0.176)
                      1.576

EXPEXTCM =  - 0.0324*MEANORTi + 0.266*MSEFFICi - 0.358*MOTi + 0.177*DISORSDi + 0.122*SURAPPi, Errorvar.= 0.843 , R1 = 0.157
157           (0.130)           (0.132)          (0.142)      (0.125)          (0.134)                      (0.434)
              -0.251             2.021           -2.512        1.418            0.910                        1.941          R1

        Reduced Form Equations

EXINFLOG =  - 0.163*MEANORTi + 0.163*MSEFFICi - 0.292*MOTi + 0.187*DISORSDi + 0.429*SURAPPi, Errorvar.= 0.813, R1 = 0.187
7             (0.130)          (0.116)          (0.126)      (0.120)          (0.157)
              -1.257            1.402           -2.315        1.560            2.738

EXPEXTCM =  - 0.0324*MEANORTi + 0.266*MSEFFICi - 0.358*MOTi + 0.177*DISORSDi + 0.122*SURAPPi, Errorvar.= 0.843, R1 = 0.157
57            (0.130)           (0.132)          (0.142)      (0.125)          (0.134)
              -0.251             2.021           -2.512        1.418            0.910                                      +
```

Figure 47 Structural Equations of the Surveyi-Test Model for Ankara Region

```
        Structural Equations

EXINFLOG = 0.525*EXPEXTCM - 0.0704*MEANORTi + 0.121*MSEFFICi + 0.0461*MOTi + 0.00435*DISORSDi + 0.212*SURAPPi,
=          (0.330)          (0.0949)          (0.132)          (0.151)       (0.130)            (0.158)
            1.593           -0.742             0.920            0.305         0.0334             1.339

           Errorvar.= 0.648 , R1 = 0.352
                     (0.609)
                      1.065

EXPEXTCM = 0.146*MEANORTi + 0.161*MSEFFICi - 0.203*MOTi + 0.306*DISORSDi + 0.122*SURAPPi, Errorvar.= 0.832 , R1 = 0.168
           (0.103)          (0.133)          (0.167)      (0.162)          (0.136)                      (0.582)
            1.420            1.208           -1.220        1.890            0.898                        1.429

        Reduced Form Equations

EXINFLOG = 0.00603*MEANORTi + 0.206*MSEFFICi - 0.0606*MOTi + 0.165*DISORSDi + 0.276*SURAPPi, Errorvar.= 0.878, R1 = 0.122
2          (0.0869)           (0.150)          (0.149)       (0.142)          (0.177)
            0.0694             1.369           -0.407         1.163            1.557

EXPEXTCM = 0.146*MEANORTi + 0.161*MSEFFICi - 0.203*MOTi + 0.306*DISORSDi + 0.122*SURAPPi, Errorvar.= 0.832, R1 = 0.168
           (0.103)          (0.133)          (0.167)      (0.162)          (0.136)
            1.420            1.208           -1.220        1.890            0.898
```

Figure 48 Structural Equations of the Surveyi-Test Model for Northern Cyprus Region

APPENDIX O

CUT-OFF CRITERIA FOR FIT INDICES AND THE VALUES

Table 87 Cut-off Criteria for Goodness of Fit Indices

Fit Index	Criterion
Chi-Square ($\chi 2$)	Ratio of χ^2 to *df* <5
Degrees of Freedom(*df*)	
Root Mean Square Error of Approximation (RMSEA)	< 0.05 smaller the better
Root Mean Square Residual (RMR)	
Standardized Root Mean Square Residual (S-RMR)	
Parsimony Goodness of Fit Index (PGFI)	higher the better
Parsimony Normed Fit Index (PNFI)	
Normed Fit Index (NFI)	> 0.90
Non-Normed Fit Index (NNFI)	
Comparative Fit Index (CFI)	
Incremental Fit Index (IFI)	
Relative Fit Index (RFI)	
Goodness of Fit Index (GFI)	
Adjusted Goodness of Fit Index (AGFI)	

APPENDIX P

FIT INDICES FOR ALL TESTED MODELS

Table 88 Goodness of Fit Indices for All Tested Models

Fit Index	Survey-test (N=431)	Survey-testt (N=431)	Surveyi-test (N=431)	Surveyi-test (Ankara)	Surveyi-test (Northern Cyp.)
Chi-Square (χ^2)	1643.96	818.45	254.57	255.83	273.19
Degrees of Freedom(*df*)	1164	503	210	210	210
Root Mean Square Error of Approx. (RMSEA)	0.029	0.038	0.021	0.025	0.039
Root Mean Square Residual (RMR)	0.040	0.067	0.012	0.015	0.019
Std. Root Mean Square Residual (S-RMR)	0.052	0.054	0.041	0.056	0.064
Parsimony Goodness of Fit Index (PGFI)	0.766	0.720	0.724	0.697	0.680
Parsimony Normed Fit Index (PNFI)	0.806	0.785	0.729	0.577	0.510
Normed Fit Index (NFI)	0.883	0.929	0.878	0.695	0.614
Non-Normed Fit Index (NNFI)	0.959	0.966	0.971	0.906	0.833
Comparative Fit Index (CFI)	0.963	0.971	0.976	0.922	0.861
Incremental Fit Index (IFI)	0.963	0.971	0.976	0.927	0.873
Relative Fit Index (RFI)	0.872	0.916	0.853	0.633	0.535
Goodness of Fit Index (GFI)	0.873	0.902	0.952	0.917	0.894
Adjusted Goodness of Fit Index (AGFI)	0.855	0.877	0.937	0.890	0.860

APPENDIX Q

THE SIMPLIS SYNTAX FOR THE CFA OF THE TEST

```
Confirmatory Factor Analysis of the Test

Observed Variables
LInf1R1 LInf2R2 LInf3R3 MEx1R4 MEx2R5 ExTb1R6 CpSkl1R7 CpSkl2R8
EC1R9i EC2R9ii EC3R9iii EC4R9iv EC5R9v EC6R9vi LInf4R10 ECp1R11
ECp2R12 ECp3R13 ExTb2R14 ESInf1R15 ECp4R16 ECp5R17 ECp6R18
ECp7R19 VTrth1R2 ExTb3R21 DAp1Q1 DAp2Q2 DAp3Q3 DAp4Q4
RIdea1Q5 RIdea2Q6 RIdea3Q7 RIdea4Q8 Evid1Q9 Evid2Q10 Evid3Q11
Evid4Q12 IMot1Q13 IMot2Q14 IMot3Q15 IMot4Q16 SAp1Q17 SAp2Q18
SAp3Q19 SAp4Q20 SAp5Q21 SAp6Q22 SBnd1Q23 SBnd2Q24 SBnd3Q25
FFail1Q26 FFail2Q27 FFail3Q28 EMot1Q29 EMot2Q30 EMot3Q31 EMot4Q32
DOSt1Q33 DOSt2Q34 DOSt3Q35 DOSt4Q36 AMot1Q37 AMot2Q38
AMot3Q39 SEff1Q40 SEff2Q41 SEff3Q42 SEff4Q43 PSSt1Q44 PSSt2Q45
PSSt3Q46 PSSt4Q47 PSSt5Q48 PSSt6Q49 PSSt7Q50 PSSt8Q51
Correlation Matrix From File SURVEY-TESTonly.COR
Sample Size 431
Latent Variables:  EXINFLOG EXPEXTCMP
Relationships:

ExTb2R14 ECp4R16 CpSkl1R7 ECp2R12 ECp6R18 ECp7R19 ExTb3R21
ECp1R11 = EXPEXTCMP

LInf2R2 LInf1R1 MEx1R4 ECp3R13 LInf3R3 EC6R9vi EC3R9iii EC5R9v
EC4R9iv ECp5R17 = EXINFLOG

Let the Errors of EC5R9v and EC4R9iv Correlate
Let the Errors of LInf2R2 and  LInf1R1 Correlate
Let the Errors of EC5R9v and EC4R9iv Correlate
Let the Errors of EC6R9vi and EC3R9iii Correlate
Let the Errors of ECp4R16 and ExTb2R14 Correlate

Number of Decimals = 3
Path Diagram
Method of Estimation: Maximum Likelihood
Admissibility Check =Off
Iterations = 5000
Print Residuals
End of Problem
```

APPENDIX R

THE SIMPLIS SYNTAX FOR THE CFA OF THE SURVEY

```
R.1 Confirmatory Factor Analysis of the Survey
Observed Variables
LInf1R1 LInf2R2 LInf3R3 MEx1R4 MEx2R5 ExTb1R6 CpSkl1R7 CpSkl2R8
EC1R9i EC2R9ii EC3R9iii EC4R9iv EC5R9v EC6R9vi LInf4R10 ECp1R11
ECp2R12 ECp3R13 ExTb2R14 ESInf1R15 ECp4R16 ECp5R17 ECp6R18
ECp7R19 VTrth1R2 ExTb3R21 DAp1Q1 DAp2Q2 DAp3Q3 DAp4Q4
RIdea1Q5 RIdea2Q6 RIdea3Q7 RIdea4Q8 Evid1Q9 Evid2Q10 Evid3Q11
Evid4Q12 IMot1Q13 IMot2Q14 IMot3Q15 IMot4Q16 SAp1Q17 SAp2Q18
SAp3Q19 SAp4Q20 SAp5Q21 SAp6Q22 SBnd1Q23 SBnd2Q24 SBnd3Q25
FFail1Q26 FFail2Q27 FFail3Q28 EMot1Q29 EMot2Q30 EMot3Q31 EMot4Q32
DOSt1Q33 DOSt2Q34 DOSt3Q35 DOSt4Q36 AMot1Q37 AMot2Q38
AMot3Q39 SEff1Q40 SEff2Q41 SEff3Q42 SEff4Q43 PSSt1Q44 PSSt2Q45
PSSt3Q46 PSSt4Q47 PSSt5Q48 PSSt6Q49 PSSt7Q50 PSSt8Q51
Correlation Matrix From File SURVEY-TESTonly.COR
Sample Size 431
Latent Variables: MEANORT MOT SURAPP DISORSTD MSEFFIC
Relationships:
DAp1Q1  DAp2Q2  DAp3Q3  DAp4Q4  RIdea1Q5  RIdea2Q6  RIdea3Q7
RIdea4Q8  Evid1Q9  Evid2Q10  Evid3Q11  Evid4Q12 SEff3Q42 = MEANORT
SEff1Q40  SEff2Q41  SEff3Q42  SEff4Q43  PSSt1Q44  PSSt2Q45  PSSt8Q51
= MSEFFIC
IMot1Q13  IMot2Q14  IMot4Q16  EMot1Q29  AMot2Q38  SEff2Q41
SEff1Q40 = MOT
DOSt1Q33  DOSt2Q34  DOSt3Q35  DOSt4Q36  = DISORSTD
SAp2Q18  SAp3Q19  SAp4Q20  SAp5Q21  SAp6Q22  = SURAPP

Let the Errors of  SAp3Q19  and SAp2Q18 Correlate
Let the Errors of  SEff3Q42 and SEff2Q41 Correlate
Let the Errors of  DOSt2Q34 and DOSt1Q33 Correlate
Let the Errors of  SEff2Q41 and SEff1Q40 Correlate
Let the Errors of  SAp4Q20 and SAp3Q19 Correlate
Let the Errors of  SEff3Q42 and SEff1Q40 Correlate
Let the Errors of  SAp4Q20 and SAp2Q18 Correlate
Let the Errors of  RIdea1Q5 and DAp3Q3 Correlate
Let the Errors of  RIdea2Q6 and RIdea1Q5 Correlate
Let the Errors of  RIdea2Q6 and DAp4Q4 Correlate
Let the Errors of  RIdea4Q8 and RIdea1Q5 Correlate
Let the Errors of  SEff2Q41 and IMot4Q16 Correlate
Let the Errors of  SEff4Q43 and Evid3Q11 Correlate
Let the Errors of  SAp4Q20 and RIdea2Q6 Correlate
```

R.1 Confirmatory Factor Analysis of the Survey (cont'd)

Let the Errors of SAp5Q21 and SAp3Q19 Correlate
Let the Errors of SSEff2Q41 and Evid3Q11 Correlate
Let the Errors of SAp5Q21 and SAp4Q20 Correlate
Let the Errors of SEff2Q41 and Evid3Q11 Correlate
Let the Errors of PSSt1Q44 and SEff2Q41 Correlate
Let the Errors of SEff4Q43 and SAp4Q20 Correlate
Let the Errors of PSSt1Q44 and IMot2Q14 Correlate
Let the Errors of DAp3Q3 and DAp1Q1 Correlate
Let the Errors of PSSt8Q51 and DAp1Q1 Correlate
Let the Errors of Evid1Q9 and RIdea4Q8 Correlate
Let the Errors of Evid4Q12 and Evid2Q10 Correlate
Let the Errors of AMot2Q38 and DAp3Q3 Correlate
Let the Errors of Evid2Q10 and Evid1Q9 Correlate
Let the Errors of Evid4Q12 and Evid3Q11 Correlate
Let the Errors of Evid3Q11 and Evid2Q10 Correlate
Let the Errors of EMot1Q29 and IMot1Q13 Correlate
Let the Errors of Evid4Q12 and Evid1Q9 Correlate
Let the Errors of SEff1Q40 and Evid3Q11 Correlate
Let the Errors of AMot2Q38 and Evid3Q11 Correlate
Let the Errors of PSSt8Q51 and DOSt4Q36 Correlate
Let the Errors of AMot2Q38 and EMot1Q29 Correlate

Number of Decimals = 3
Path Diagram
Method of Estimation: Maximum Likelihood
Admissibility Check =Off
Iterations = 5000
Print Residuals
End of Problem

APPENDIX S

SIMPLIX SYNTAX FOR SURVEY-TEST MODEL

S.1 Structural Equation Modeling of the Survey -Test Model
Observed Variables
LInf1R1 LInf2R2 LInf3R3 MEx1R4 MEx2R5 ExTb1R6 CpSkl1R7 CpSkl2R8 EC1R9i EC2R9ii EC3R9iii EC4R9iv EC5R9v EC6R9vi LInf4R10 ECp1R11 ECp2R12 ECp3R13 ExTb2R14 ESInf1R15 ECp4R16 ECp5R17 ECp6R18 ECp7R19 VTrth1R2 ExTb3R21 DAp1Q1 DAp2Q2 DAp3Q3 DAp4Q4 RIdea1Q5 RIdea2Q6 RIdea3Q7 RIdea4Q8 Evid1Q9 Evid2Q10 Evid3Q11 Evid4Q12 IMot1Q13 IMot2Q14 IMot3Q15 IMot4Q16 SAp1Q17 SAp2Q18 SAp3Q19 SAp4Q20 SAp5Q21 SAp6Q22 SBnd1Q23 SBnd2Q24 SBnd3Q25 FFail1Q26 FFail2Q27 FFail3Q28 EMot1Q29 EMot2Q30 EMot3Q31 EMot4Q32 DOSt1Q33 DOSt2Q34 DOSt3Q35 DOSt4Q36 AMot1Q37 AMot2Q38 AMot3Q39 SEff1Q40 SEff2Q41 SEff3Q42 SEff4Q43 PSSt1Q44 PSSt2Q45 PSSt3Q46 PSSt4Q47 PSSt5Q48 PSSt6Q49 PSSt7Q50 PSSt8Q51
Covariance Matrix From File SURVEY-TESTonly.COV
Sample Size 431

Latent Variables: MEANORT MOT SURAPP DISORSTD MSEFFIC EXINFLOG EXPEXTCMP

Relationships:

DAp1Q1 DAp2Q2 DAp3Q3 DAp4Q4 RIdea1Q5 RIdea2Q6 RIdea3Q7 RIdea4Q8 Evid1Q9 Evid2Q10 Evid3Q11 Evid4Q12 SEff3Q42 = MEANORT
SEff1Q40 SEff2Q41 SEff3Q42 SEff4Q43 PSSt1Q44 PSSt2Q45 PSSt8Q51 = MSEFFIC
IMot1Q13 IMot2Q14 IMot4Q16 EMot1Q29 AMot2Q38 SEff2Q41 SEff1Q40 = MOT
DOSt1Q33 DOSt2Q34 DOSt3Q35 DOSt4Q36 = DISORSTD
SAp2Q18 SAp3Q19 SAp4Q20 SAp5Q21 SAp6Q22 DOSt1Q33 = SURAPP
ExTb2R14 ECp4R16 CpSkl1R7 ECp2R12 ECp6R18 ECp7R19 ExTb3R21 ECp1R11 = EXPEXTCMP
LInf2R2 LInf1R1 MEx1R4 ECp3R13 LInf3R3 EC6R9vi EC3R9iii EC5R9v EC4R9iv ECp5R17 = EXINFLOG
EXINFLOG = MEANORT MOT SURAPP DISORSTD MSEFFIC
EXPEXTCMP = MEANORT MOT SURAPP DISORSTD MSEFFIC
EXPEXTCM = EXINFLOG

Let the Errors of EC5R9v and EC4R9iv Correlate

S.1 Structural Equation Modeling of the Survey -Test Model (cont'd)
Let the Errors of LInf2R2 and LInf1R1 Correlate
Let the Errors of EC5R9v and EC4R9iv Correlate
Let the Errors of EC6R9vi and EC3R9iii Correlate
Let the Errors of ECp4R16 and ExTb2R14 Correlate
Let the Errors of SEff2Q41 and SEff1Q40 Correlate
Let the Errors of SEff3Q42 and SEff2Q41 Correlate
Let the Errors of SEff3Q42 and SEff1Q40 Correlate
Let the Errors of RIdea1Q5 and DAp3Q3 Correlate
Let the Errors of RIdea2Q6 and DAp4Q4 Correlate
Let the Errors of RIdea2Q6 and RIdea1Q5 Correlate
Let the Errors of Evid2Q10 and Evid1Q9 Correlate
Let the Errors of Evid3Q11 and Evid2Q10 Correlate
Let the Errors of PSSt1Q44 and SEff2Q41 Correlate
Let the Errors of SEff2Q41 and IMot4Q16 Correlate
Let the Errors of SEff4Q43 and Evid3Q11 Correlate
Let the Errors of Evid4Q12 and Evid3Q11 Correlate
Let the Errors of RIdea4Q8 and RIdea1Q5 Correlate
Let the Errors of Evid1Q9 and RIdea4Q8 Correlate
Let the Errors of Evid4Q12 and Evid2Q10 Correlate
Let the Errors of SEff4Q43 and SAp4Q20 Correlate
Let the Errors of PSSt1Q44 and IMot2Q14 Correlate
Let the Errors of SSEff2Q41 and Evid3Q11 Correlate
Let the Errors of PSSt8Q51 and DAp1Q1 Correlate
Let the Errors of Evid4Q12 and Evid1Q9 Correlate
Let the Errors of PSSt8Q51 and DOSt4Q36 Correlate
Let the Errors of SEff2Q41 and Evid3Q11 Correlate
Let the Errors of SEff1Q40 and Evid3Q11 Correlate
Let the Errors of AMot2Q38 and DAp3Q3 Correlate
Let the Errors of AMot2Q38 and Evid3Q11 Correlate
Let the Errors of SAp3Q19 and SAp2Q18 Correlate
Let the Errors of DOSt2Q34 and DOSt1Q33 Correlate
Let the Errors of SAp4Q20 and SAp3Q19 Correlate
Let the Errors of SAp4Q20 and SAp2Q18 Correlate
Let the Errors of SAp5Q21 and SAp4Q20 Correlate
Let the Errors of SAp4Q20 and RIdea2Q6 Correlate
Let the Errors of SAp5Q21 and SAp3Q19 Correlate
Number of Decimals = 3
Path Diagram
Method of Estimation: Maximum Likelihood
Admissibility Check =Off
Iterations = 5000
Print Residuals
End of Problem

APPENDIX T

SIMPLIX SYNTAX FOR THE SURVEY-TESTt MODEL

T.1 SEM for SURVEY-TESTt Model
Observed Variables
DAp1Q1 DAp2Q2 DAp3Q3 DAp4Q4 RIdea1Q5 RIdea2Q6 RIdea3Q7
RIdea4Q8 Evid1Q9 Evid2Q10 Evid3Q11 Evid4Q12 IMot1Q13 IMot2Q14
IMot3Q15 IMot4Q16 SAp1Q17 SAp2Q18 SAp3Q19 SAp4Q20 SAp5Q21
SAp6Q22 SBnd1Q23 SBnd2Q24 SBnd3Q25 FFail1Q26 FFail2Q27 FFail3Q28
EMot1Q29 EMot2Q30 EMot3Q31 EMot4Q32 DOSt1Q33 DOSt2Q34
DOSt3Q35 DOSt4Q36 AMot1Q37 AMot2Q38 AMot3Q39 SEff1Q40 SEff2Q41
SEff3Q42 SEff4Q43 PSSt1Q44 PSSt2Q45 PSSt3Q46 PSSt4Q47 PSSt5Q48
PSSt6Q49 PSSt7Q50 PSSt8Q51 EXPETCMt EXINLOGt
Covariance Matrix From File TESTt-SURVEY.COV
Sample Size 431
Latent Variables: MEANORT MOT SURAPP DISORSD MSEFFIC
EXPETCM EXINLOG
Relationships:
DAp1Q1 DAp2Q2 DAp3Q3 DAp4Q4 RIdea1Q5 RIdea2Q6 RIdea3Q7
RIdea4Q8 Evid1Q9 Evid2Q10 Evid3Q11 Evid4Q12 SEff3Q42 = MEANORT
SEff1Q40 SEff2Q41 SEff3Q42 SEff4Q43 PSSt1Q44 PSSt2Q45 PSSt8Q51
= MSEFFIC
IMot1Q13 IMot2Q14 IMot4Q16 EMot1Q29 AMot2Q38 SEff2Q41
SEff1Q40 = MOT
DOSt1Q33 DOSt2Q34 DOSt3Q35 DOSt4Q36 = DISORSD
SAp2Q18 SAp3Q19 SAp4Q20 SAp5Q21 SAp6Q22 DOSt1Q33 = SURAPP

EXPETCMt = EXPETCM
EXINLOGt = EXINLOG
EXINLOG = MEANORT MOT SURAPP DISORSD MSEFFIC
EXPETCM = MEANORT MOT SURAPP DISORSD MSEFFIC
EXPETCM = EXINLOG

Set the Error Variance of EXPETCMt to 0.343
Set the Error Variance of EXINLOGt to 0.349
Let the Errors of SAp3Q19 and SAp2Q18 Correlate
Let the Errors of SEff3Q42 and SEff2Q41 Correlate
Let the Errors of DOSt2Q34 and DOSt1Q33 Correlate
Let the Errors of SEff2Q41 and SEff1Q40 Correlate
Let the Errors of SAp4Q20 and SAp3Q19 Correlate
Let the Errors of SEff3Q42 and SEff1Q40 Correlate
Let the Errors of SAp4Q20 and SAp2Q18 Correlate
Let the Errors of RIdea1Q5 and DAp3Q3 Correlate

T.1 SEM for SURVEY-TESTt Model (cont'd)

Let the Errors of RIdea2Q6 and RIdea1Q5 Correlate
Let the Errors of RIdea2Q6 and DAp4Q4 Correlate
Let the Errors of RIdea4Q8 and RIdea1Q5 Correlate
Let the Errors of SEff2Q41 and IMot4Q16 Correlate
Let the Errors of SEff4Q43 and Evid3Q11 Correlate
Let the Errors of SAp4Q20 and RIdea2Q6 Correlate
Let the Errors of SAp5Q21 and SAp3Q19 Correlate
Let the Errors of SSEff2Q41 and Evid3Q11 Correlate
Let the Errors of SAp5Q21 and SAp4Q20 Correlate
Let the Errors of SEff2Q41 and Evid3Q11 Correlate
Let the Errors of PSSt1Q44 and SEff2Q41 Correlate
Let the Errors of SEff4Q43 and SAp4Q20 Correlate
Let the Errors of PSSt1Q44 and IMot2Q14 Correlate
Let the Errors of DAp3Q3 and DAp1Q1 Correlate
Let the Errors of PSSt8Q51 and DAp1Q1 Correlate
Let the Errors of Evid1Q9 and RIdea4Q8 Correlate
Let the Errors of Evid4Q12 and Evid2Q10 Correlate
Let the Errors of AMot2Q38 and DAp3Q3 Correlate
Let the Errors of Evid2Q10 and Evid1Q9 Correlate
Let the Errors of Evid4Q12 and Evid3Q11 Correlate
Let the Errors of Evid3Q11 and Evid2Q10 Correlate
Let the Errors of EMot1Q29 and IMot1Q13 Correlate
Let the Errors of Evid4Q12 and Evid1Q9 Correlate
Let the Errors of SEff1Q40 and Evid3Q11 Correlate
Let the Errors of AMot2Q38 and Evid3Q11 Correlate
Let the Errors of PSSt8Q51 and DOSt4Q36 Correlate
Let the Errors of AMot2Q38 and EMot1Q29 Correlate

Number of Decimals = 3
Path Diagram
Method of Estimation: Maximum Likelihood
Admissibility Check =Off
Iterations = 5000
Print Residuals
End of Problem

APPENDIX U

SIMPLIX SYNTAX FOR SURVEYi-TEST SEM MODEL

```
Structural Equation Modeling of the Surveyi-Test Model
Observed Variables
LInf1R1 LInf2R2 LInf3R3 MEx1R4 MEx2R5 ExTb1R6 CpSkl1R7 CpSkl2R8
EC1R9i EC2R9ii EC3R9iii EC4R9iv EC5R9v EC6R9vi LInf4R10 ECp1R11
ECp2R12 ECp3R13 ExTb2R14 ESInf1R15 ECp4R16 ECp5R17 ECp6R18
ECp7R19 VTrth1R2 ExTb3R21
MEANORTi MSEFFICi MOTi DISORSDi SURAPPi
Covariance Matrix From File TEST-SURVEYi.COV
Sample Size 431
Latent Variables:   EXINFLOG EXPEXTCMP
Relationships:
ExTb2R14 ECp4R16 CpSkl1R7 ECp2R12 ECp6R18 ECp7R19 ExTb3R21
ECp1R11  = EXPEXTCMP
LInf2R2 LInf1R1 MEx1R4 ECp3R13 LInf3R3 EC6R9vi EC3R9iii EC5R9v
EC4R9iv ECp5R17 = EXINFLOG
EXINFLOG = MEANORTi  MOTi SURAPPi DISORSDi MSEFFICi
EXPEXTCMP = MEANORTi MOTi SURAPPi DISORSDi MSEFFICi
EXINFLOG =  EXPEXTCMP
Set the Error Variance of MEANORTi to 0.131
Set the Error Variance of MSEFFICi to 0.238
Set the Error Variance of MOTi to 0.255
Set the Error Variance of DISORSDi to 0.263
Set the Error Variance of SURAPPi to 0.279
Let the Errors of  LInf2R2 and LInf1R1 correlate
Let the Errors of  EC5R9v and  EC4R9iv correlate
Let the Errors of   EC6R9vi and  EC3R9iii correlate
Let the Errors of   ECp4R16 and ExTb2R14 correlate
Number of Decimals = 3
Path Diagram
Method of Estimation: Maximum Likelihood
Admissibility Check =Off
Iterations = 5000
Print Residuals
End of Problem
```

APPENDIX V

SIMPLIX SYNTAX OF SURVEYi-TEST FOR ANKARA

Observed Variables
LInf1R1 LInf2R2 LInf3R3 MEx1R4 MEx2R5 ExTb1R6 CpSkl1R7 CpSkl2R8 EC1R9i EC2R9ii EC3R9iii EC4R9iv EC5R9v EC6R9vi LInf4R10 ECp1R11 ECp2R12 ECp3R13 ExTb2R14 ESInf1R15 ECp4R16 ECp5R17 ECp6R18 ECp7R19 VTrth1R2 ExTb3R21
MEANORTi MSEFFICi MOTi DISORSDi SURAPPi
Covariance Matrix From File surveyi-testank.COV
Sample Size 231
Latent Variables: EXINFLOG EXPEXTCMP
Relationships:
ExTb2R14 ECp4R16 CpSkl1R7 ECp2R12 ECp6R18 ECp7R19 ExTb3R21 ECp1R11 = EXPEXTCMP
LInf2R2 LInf1R1 MEx1R4 ECp3R13 LInf3R3 EC6R9vi EC3R9iii EC5R9v EC4R9iv ECp5R17 = EXINFLOG
EXINFLOG = EXPEXTCMP MEANORTi MOTi SURAPPi DISORSDi MSEFFICi
EXPEXTCMP = MEANORTi MOTi SURAPPi DISORSDi MSEFFICi
Set the Error Variance of MEANORTi to 0.131
Set the Error Variance of MSEFFICi to 0.238
Set the Error Variance of MOTi to 0.255
Set the Error Variance of DISORSDi to 0.263
Set the Error Variance of SURAPPi to 0.279
Let the Errors of LInf2R2 and LInf1R1 correlate
Let the Errors of EC5R9v and EC4R9iv correlate
Let the Errors of EC6R9vi and EC3R9iii correlate
Let the Errors of ECp4R16 and ExTb2R14 correlate
Number of Decimals = 3
Path Diagram
Method of Estimation: Maximum Likelihood
Admissibility Check =Off
Iterations = 5000
Print Residuals
LISREL Output: RS MI SC EF WP
End of Problem

APPENDIX W

SIMPLIX SURVEYi-TEST MODEL FOR NORTH. CYPRUS

Observed Variables
LInf1R1 LInf2R2 LInf3R3 MEx1R4 MEx2R5 ExTb1R6 CpSkl1R7 CpSkl2R8 EC1R9i EC2R9ii EC3R9iii EC4R9iv EC5R9v EC6R9vi LInf4R10 ECp1R11 ECp2R12 ECp3R13 ExTb2R14 ESInf1R15 ECp4R16 ECp5R17 ECp6R18 ECp7R19 VTrth1R2 ExTb3R21
MEANORTi MSEFFICi MOTi DISORSDi SURAPPi
Covariance Matrix From File surveyi-testNC.COV
Sample Size 200
Latent Variables: EXINFLOG EXPEXTCMP
Relationships:
ExTb2R14 ECp4R16 CpSkl1R7 ECp2R12 ECp6R18 ECp7R19 ExTb3R21 ECp1R11 = EXPEXTCMP
LInf2R2 LInf1R1 MEx1R4 ECp3R13 LInf3R3 EC6R9vi EC3R9iii EC5R9v EC4R9iv ECp5R17 = EXINFLOG
EXINFLOG = EXPEXTCMP MEANORTi MOTi SURAPPi DISORSDi MSEFFICi
EXPEXTCMP = MEANORTi MOTi SURAPPi DISORSDi MSEFFICi
Set the Error Variance of MEANORTi to 0.131
Set the Error Variance of MSEFFICi to 0.238
Set the Error Variance of MOTi to 0.255
Set the Error Variance of DISORSDi to 0.263
Set the Error Variance of SURAPPi to 0.279
Let the Errors of LInf2R2 and LInf1R1 correlate
Let the Errors of EC5R9v and EC4R9iv correlate
Let the Errors of   EC6R9vi and EC3R9iii correlate
Let the Errors of   ECp4R16 and ExTb2R14 correlate
Number of Decimals = 3
Path Diagram
Method of Estimation: Maximum Likelihood
Admissibility Check =Off
Iterations = 5000
Print Residuals
End of Problem

APPENDIX X

SUMMARY STATISTICS

X.1 SUMMARY STATISTICS OF FITTED, STANDARDIZED RESIDUALS, STEAM-LEAF AND Q PLOTS OF RESIDUALS FOR CFA OF TEST

Summary Statistics for Fitted Residuals
Smallest Fitted Residual = -0.101
Median Fitted Residual = 0.000
Largest Fitted Residual = 0.126

Stemleaf Plot

```
-10|1
 - 9|0
 - 8|95
 - 7|8200
 - 6|2200
 - 5|8764410
 - 4|75553320
 - 3|999753220
 - 2|9986443200
 - 1|8764433331100
 - 0|988877664441000000000000000000000000000
   0|3335777778889
   1|00011122245668
   2|000134567789
   3|1145578
   4|4566779
   5|068
   6|35
   7|23566
   8|0113577
   9|01
  10|
  11|
  12|06
```

Summary Statistics for Standardized Residuals
Smallest Standardized Residual = -3.176
Median Standardized Residual = 0.000
Largest Standardized Residual = 2.926

Stemleaf Plot

```
- 3|2
 - 2|5
 - 2|421000
 - 1|887776555
 - 1|4432222210000
 - 0|9999877777666655
 - 0|44444443333332222221111100000000000000000000000000
   0|111222222222222233333344444
   0|555666677788899999
   1|011112233
   1|5578888889
   2|01122234
   2|679
```

X.1 SUMMARY STATISTICS OF FITTED, STANDARDIZED RESIDUALS, STEAM-LEAF AND Q PLOTS OF RESIDUALS FOR CFA OF TEST (cont'd)

Largest Negative Standardized Residuals
Residual for ECp7R19 and ECp2R12 -3.176
Largest Positive Standardized Residuals
Residual for ECp2R12 and ECp1R11 2.609
Residual for ExTb2R14 and EC5R9v 2.727
Residual for ECp4R16 and EC5R9v 2.926

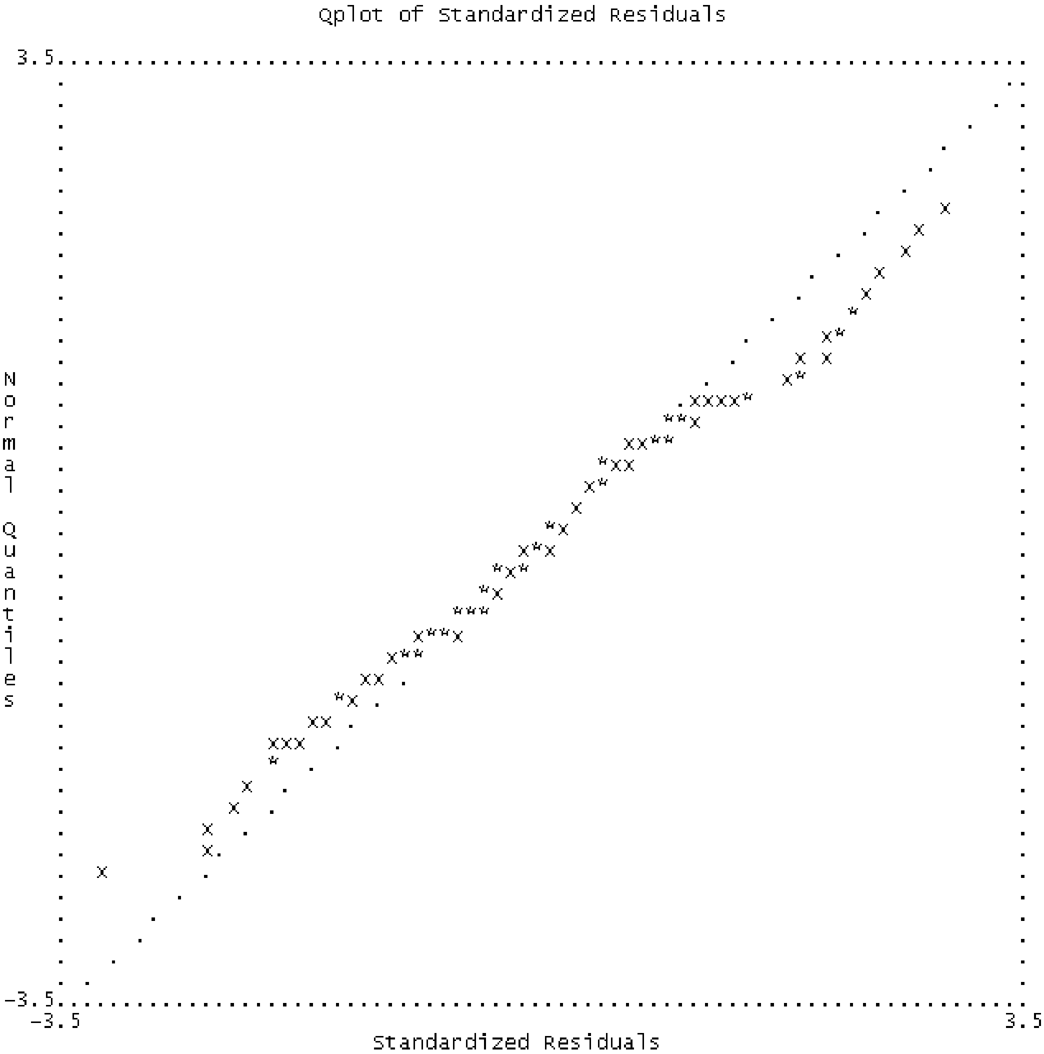


Figure 49 Q-plot of Standardized Residuals of the Test Model

X.2 SUMMARY STATISTICS OF CFA OF THE SURVEY

Summary Statistics for Fitted Residuals
Smallest Fitted Residual =   -0.216
Median Fitted Residual =   0.004
Largest Fitted Residual =   0.176

Stemleaf Plot

```
 -20|6
 -18|
 -16|
 -14|843
 -12|969950
 -10|87197766540
 - 8|98766531877543200
 - 6|98877554321097666655443330
 - 4|9998887665444432222210998887776655533332110
 - 2|9998888777766655554444443333321110099987766555555443333211000
 - 0|99988877766665555544322200009998888887766666555444444444443333333222111+20
   0|1111111122222333344444444555556666667777888888999900001111111111222233333+24
   2|000122223333333445566777777888899999900000011112233344444566666777788889999
   4|000000000111122334445556677788890011222233344555566778899 9
   6|00011115666788899011112234556777788 9
   8|0122333001348
  10|0112900259
  12|04551235789
  14|89
  16|36
```

Summary Statistics for Standardized Residuals
Smallest Standardized Residual =   -4.932
Median Standardized Residual =   0.172
Largest Standardized Residual =   4.083

Stemleaf Plot

```
 - 4|9
 - 4|
 - 3|9886
 - 3|32221
 - 2|9888888666666555
 - 2|443333222111111111110000000
 - 1|9999999988887776666666655555
 - 1|4444444444443333333333322222222222221111100000000000
 - 0|99999999999988888888888887777777666666666666666665555555555
 - 0|44444444444444444444333333322222222222111111111111111000000000000000000000+11
   0|1111111111112222222222222222222333333333333444444444444444
   0|5555555555555666666666666666677777777777777888888888888888888888899999999999999
   1|00000000000000000011111111111112222222222223333333333333333344444444
   1|5555555555666666666777777777777888888888888888889999999
   2|00000001111111112222334444
   2|555556677788999
   3|00222333
   3|567
   4|01
```

X.2 SUMMARY STATISTICS OF CFA OF THE SURVEY (cont'd)

Largest Negative Standardized Residuals
Residual for SEff1Q40 and DOSt2Q34 -4.932
Residual for SEff1Q40 and DOSt4Q36 -3.921
Residual for Evid4Q12 and DAp3Q3 -3.804
Largest Positive Standardized Residuals
Residual for DOSt1Q33 and SAp6Q22 4.083
Residual for PSSt8Q51 and Evid2Q10 4.013
Residual for SEff3Q42 and EMot1Q29 3.672

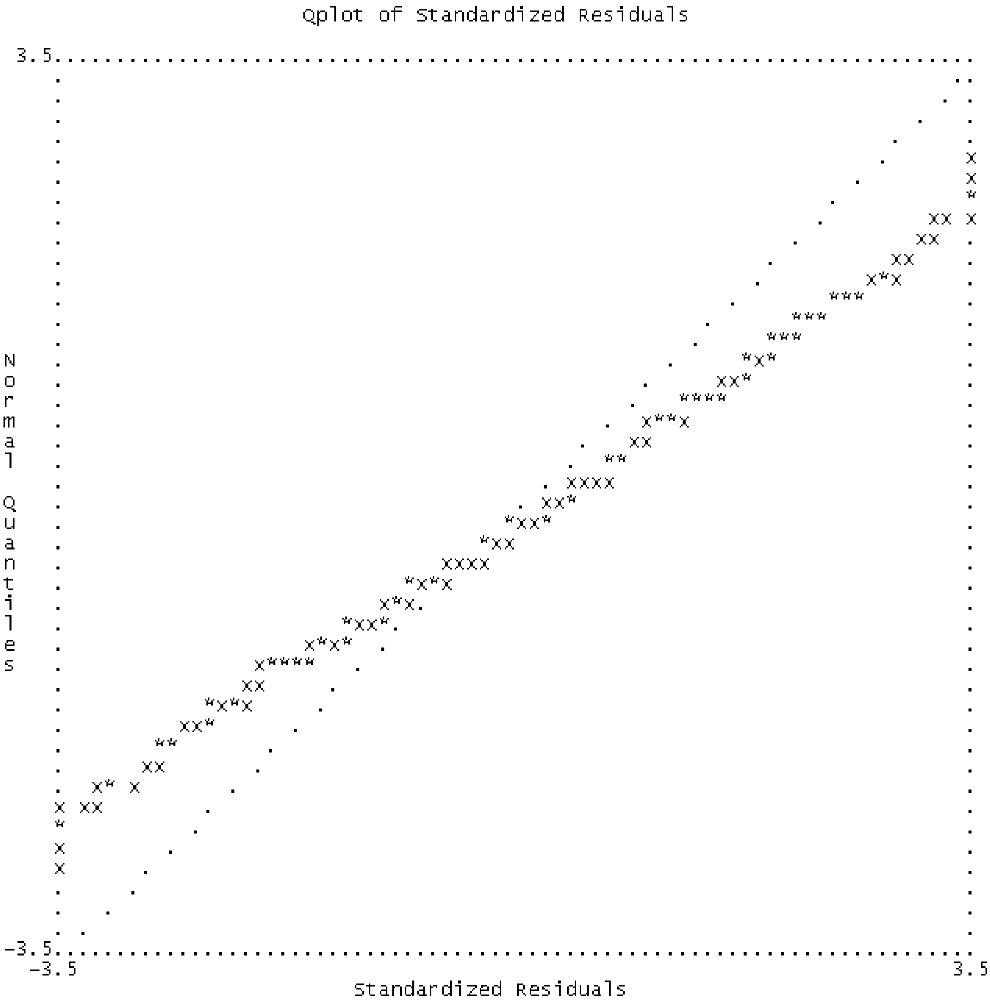


Figure 50 Q Plot of the Survey in CFA

X3. SUMMARY STATISTICS OF FITTED, STANDARDIZED AND STEAM-LEAF, Q PLOTS OF RESIDUALS FOR STRUCTURAL EQUATION MODELING OF SURVEY-TEST MODEL

```
Smallest Fitted Residual =   -0.260
Median Fitted Residual =    0.001
Largest Fitted Residual =    0.168
Stemleaf Plot
 -26|0
 -24|
 -22|
 -20|
 -18|52
 -16|755
 -14|6
 -12|255311
 -10|974109876321
 - 8|7766443109885544310
 - 6|88776655432299886665332110
 - 4|88888888777665555544222110009999988877666655555555544444333222221100
 - 2|99998888877777776666666655544443333322222222111111000000999999888888777777+78
 - 0|99999999999998888888888888888777777777777766666666666655555555555555554444444+91
   0|11111111111111111111111111111111222222222222222222222223333333333333333333+96
   2|0000000000000111111111112222222222233333333333334444444444455555555555556666+19
   4|00000000111111122222233334444555555567788889999999900000111112223333334555+09
   6|01122333444556790011112444444455567889
   8|001333466913444566
  10|1126892679
  12|091237
  14|058
  16|68
Summary Statistics for Standardized Residuals
Smallest Standardized Residual =   -4.786
   Median Standardized Residual =    0.059
  Largest Standardized Residual =    4.000
 Stemleaf Plot
 - 4|8
 - 4|10
 - 3|9766
 - 3|33211100
 - 2|99888877766655555555
 - 2|4443333333322222222222221111110000000000
 - 1|999999999999999988888888888888888777777776666666666666555555555555555555+06
 - 1|44444444444444444444433333333333333333333333333322222222222222222221111111+48
 - 0|9999999999999999999999999999999999888888888888888888888888888887777777777777+82
 - 0|44444444444444444444444444444444444443333333333333333333333333333333333333+64
   0|11111111111111111111111111111111111111112222222222222222222222222222222222222+93
   0|55555555555555555555555555555555555566666666666666666666666666666777777777777+83
   1|0000000000000000000000000000000000111111111111111111122222222222222222222+63
   1|555555555555555555555555555666666666666666666777777777777777777777777888888888+27
   2|000000000000000000000001111111111111111112222222222222222223333333344444444
   2|555555556666666777777777888899
   3|01123444
   3|67
   4|0
```

X3. SUMMARY STATISTICS OF SURVEY-TEST MODEL(cont'd)
Largest Negative Standardized Residuals
Residual for SEff1Q40 and DOSt2Q34 -4.786
Residual for EMot1Q29 and ECp2R12 -4.081
Residual for Evid4Q12 and DAp3Q3 -4.001
Residual for SEff1Q40 and DOSt4Q36 -3.737
Largest Positive Standardized Residuals
Residual for PSSt8Q51 and Evid2Q10 4.000
Residual for IMot4Q16 and Evid4Q12 3.652

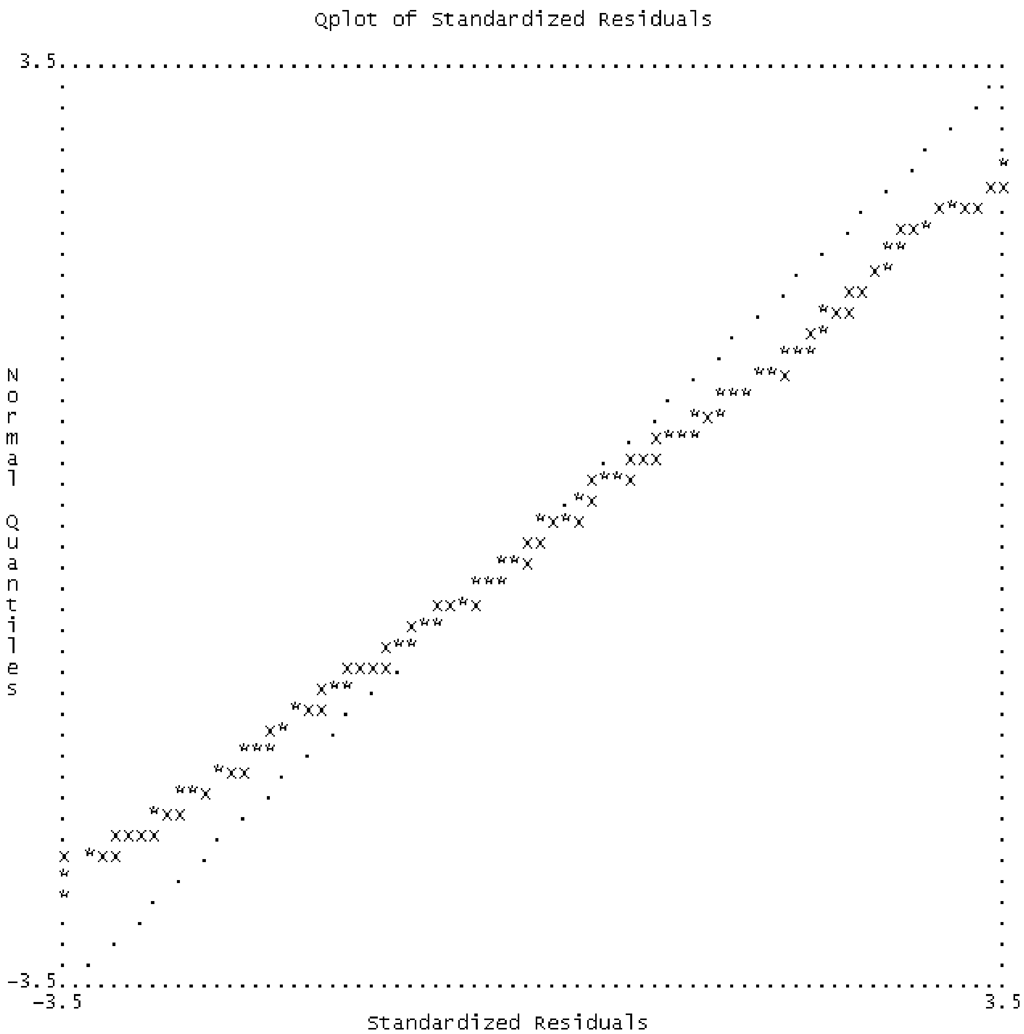


Figure 51 Q-plot of Standardized Residuals for SEM

X4. SUMMARY STATISTICS OF FITTED, STANDARDIZED AND STEAM-LEAF, Q PLOTS OF RESIDUALS FOR STRUCTURAL EQUATION MODELING OF SURVEY-TESTt MODEL

Summary Statistics for Fitted Residuals
Smallest Fitted Residual = -0.311
Median Fitted Residual = 0.002
Largest Fitted Residual = 0.362
Stemleaf Plot

```
- 3|11
- 2|6
- 2|2
- 1|9888876665
- 1|4332222221111111000000000
- 0|999999999988888888888777777777777777666666666666666666555555555555555555+04
- 0|44444444444444444444444444444444333333333333333333333333333333333222222+44
  0|1111111111111111111111111111111111111111111111111111222222222222222222222+90
  0|55555555555555555555555555555555666666666666666666666777777777777777777+28
  1|000000001111122233333444
  1|56677788
  2|24
  2|89
  3|
  3|6
```

Summary Statistics for Standardized Residuals
Smallest Standardized Residual = -4.816
Median Standardized Residual = 0.078
Largest Standardized Residual = 4.004
Stemleaf Plot

```
- 4|8
- 4|
- 3|988765
- 3|33311
- 2|999888877666655555
- 2|4433322221111111111000000000
- 1|999999999888888777766666666655555555
- 1|4444444444433333333333322222222221111100000000000000
- 0|999999999888888888888777777777777777777777666666666655555555555555
- 0|444444444444444333333333333333333222222222222222211111111111000000000000+23
  0|11111111111111111111222222222222222333333333333344444444444444444
  0|555555555666666666667777777777777777777788888888888888889999999999999999999
  1|000000000000000000011111112222222222222223333333333333333344444444
  1|555555555666666666666677777777777788888888888899999999999999999
  2|00000111111122222333333444
  2|556666777888999
  3|002222334
  3|567
  4|0
```

Largest Negative Standardized Residuals
Residual for SEff1Q40 and DOSt2Q34 -4.816
Residual for SEff1Q40 and DOSt1Q33 -3.885
Residual for Evid4Q12 and DAp3Q3 -3.804
Largest Positive Standardized Residuals
Residual for PSSt8Q51 and Evid2Q10 4.004
Residual for Evid2Q10 and EXPETCMt 3.713
Residual for SEff3Q42 and EMot1Q29 3.619

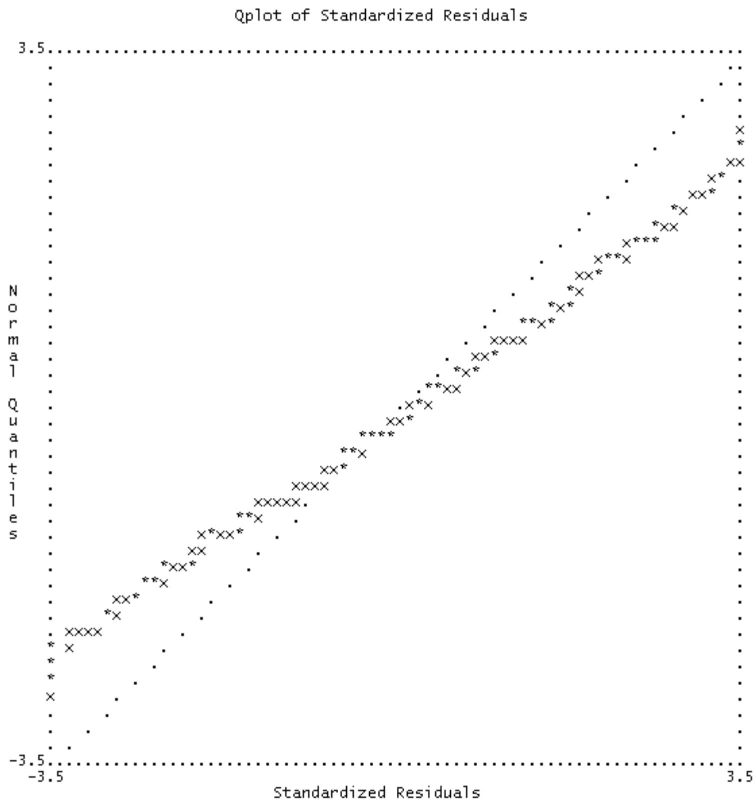


Figure 52 Q-plot of Standardized Residuals for SEM

X5. SUMMARY STATISTICS OF SURVEYi-TEST MODEL

```
Summary Statistics for Fitted Residuals
 Smallest Fitted Residual =   -0.038
   Median Fitted Residual =    0.000
  Largest Fitted Residual =    0.052
 Stemleaf Plot
 - 3|85
 - 3|441
 - 2|9865
 - 2|43321
 - 1|87776665555555
 - 1|44443211111000000
 - 0|99999999888888877777766665555
 - 0|44444433333322222222222221111111100000000000000000000000000000000000+11
   0|1111111111122222233333333444444
   0|5555555556666666677777777778888999999
   1|0000000011111122234444
   1|5556778999
   2|00000000233
   2|56
   3|04
   3|6
   4|
   4|6
   5|2
Summary Statistics for Standardized Residuals
 Smallest Standardized Residual =   -3.185
 Median Standardized Residual =    0.000
 Largest Standardized Residual =    2.932
 Stemleaf Plot
 - 3|2
 - 2|5
 - 2|422221
 - 1|999988876665555
 - 1|4444433222221111100000
 - 0|99999999888887777777766666665555
 - 0|44444444433333333333222222222111110000000000000000000000000000000000000+10
   0|1111111222222222222222223333334444444444
   0|5555555555566666666777777777888888999
   1|000000111223333334444444
   1|56788899
   2|000111111123
   2|57789
 Largest Negative Standardized Residuals
 Residual for  ECp7R19 and  ECp2R12  -3.185
 Largest Positive Standardized Residuals
 Residual for  ECp2R12 and  ECp1R11   2.710
 Residual for ExTb2R14 and   EC5R9v   2.678
 Residual for  ECp4R16 and   EC5R9v   2.932
 Residual for MEANORTi and  EC4R9iv   2.819
```

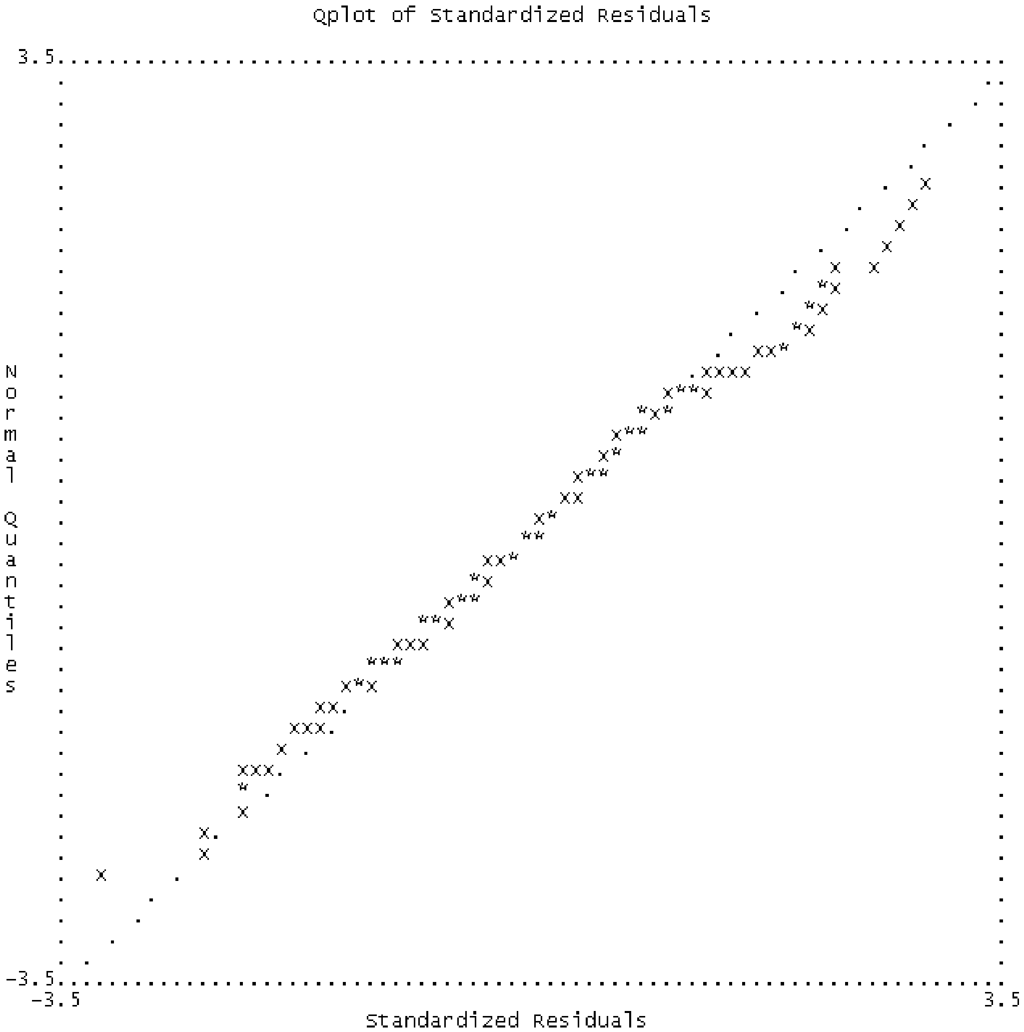


Figure 53 Q-plot of Standardized Residuals for Surveyi-Test Model

X6. SUMMARY STATISTICS OF FITTED, STANDARDIZED AND STEAM-LEAF, Q PLOTS OF RESIDUALS FOR STRUCTURAL EQUATION MODELING OF SURVEYi-TEST MODEL FOR ANKARA SAMPLE

Summary Statistics for Fitted Residuals

Smallest Fitted Residual = -0.043

Median Fitted Residual = 0.000

Largest Fitted Residual = 0.072

Stemleaf Plot

```
 - 4|3
 - 3|610
 - 2|87766654432222110
 - 1|98777665555444433333322222221111111000000
 - 0|9999888877777766666555554444443333333222222222222111110000000000000000000+24
   0|111111111122222333333334444455555556666777777777888888888899999
   1|0011122333334445556778888888999
   2|02233344445556999
   3|11257788
   4|2
   5|
   6|
   7|2
```

Summary Statistics for Standardized Residuals

Smallest Standardized Residual = -2.422

Median Standardized Residual = 0.000

Largest Standardized Residual = 3.433

Stemleaf Plot

```
 - 2|4432111
 - 1|9887776666655
 - 1|4444443333222222222111110000
 - 0|99998877777766666666666555555
 - 0|444444444433333333322222222211111100000000000000000000000000000000000000+09
   0|111111122222223333333333344444444
   0|55555555666666666667777788899999
   1|000000011111122233333333444444
   1|556667777788999
   2|0022
   2|69
   3|24
```

Largest Positive Standardized Residuals

Residual for ECp6R18 and CpSkl1R7 3.233

Residual for ECp7R19 and ECp4R16 3.433

Residual for ExTb3R21 and ECp5R17 2.946

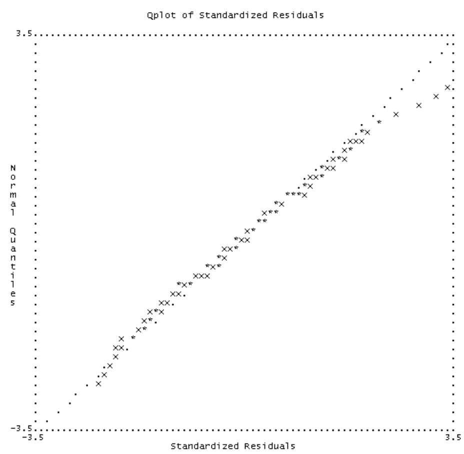


Figure 54 Q-plot of Standardized Residuals of Surveyi-Test model for Ankara

X7. SUMMARY STATISTICS OF SURVEYi-TEST MODEL FOR NORTHERN CYPRUS

Summary Statistics for Fitted Residuals

Smallest Fitted Residual = -0.078

Median Fitted Residual = 0.000

Largest Fitted Residual = 0.068

Stemleaf Plot

```
 - 7|8
 - 6|7
 - 5|3
 - 4|75320
 - 3|98754200
 - 2|88753321111111000
 - 1|9998888777666555553332221111000000
 - 0|99999888777776666665555555444433333332222222211111110000000000000000000+21
   0|11111111122222222222333333444444555555556666777788999
   1|001112223334455558899999
   2|00011222223334556677777
   3|0003459
   4|23368
   5|2
   6|58
```

Summary Statistics for Standardized Residuals

Smallest Standardized Residual = -2.926

Median Standardized Residual = 0.000

Largest Standardized Residual = 3.347

Stemleaf Plot

```
 - 2|98
 - 2|444110000
 - 1|999887655555
 - 1|444444333332111000000
 - 0|99999988888888877777666666666666555555555
 - 0|4444444333333333333222222222111111000000000000000000000000000000000000000+05
   0|11111111111222222222223333333444444
   0|555566666777777888888888889999
   1|0000000111111122233344
   1|55555666677889
   2|000011112224
   2|9
   3|3
```

Largest Negative Standardized Residuals

Residual for ECp7R19 and ECp2R12 -2.818

Residual for DISORSDi and ECp4R16 -2.926

Largest Positive Standardized Residuals

Residual for ECp4R16 and EC5R9v 3.347

Residual for ECp5R17 and EC6R9vi 2.932

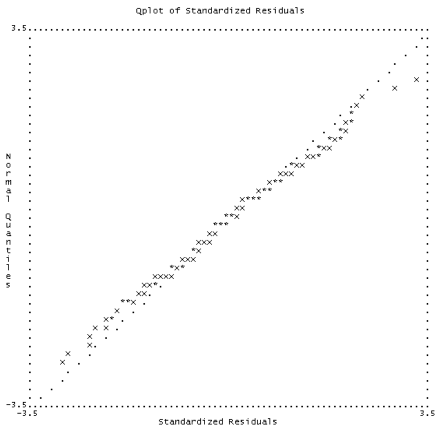


Figure 55 Q-plot of Std. Residuals of surveyi-test model for North. Cyprus

CURRICULUM VITAE

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WORK EXPERIENCE

Year	Place	Enrollment
2001- Present	METU, Informatics Institute	Specialist
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FOREIGN LANGUAGES

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PUBLICATIONS

Başaran, S., Sarı, M. (2009) an Exploration of The Relationship Between Factors Affecting Students' Views about Proof And their Performance in Proof. *Paper presented at the 33rd Conference of the International Group for the Psychology of Mathematics Education (PME 33) 2009 Thessaloniki, Greece, July 19-24, 2009*.

Sarı, M., **Başaran, S.** (2009) A Structural Equation Modeling Study: Modeling The Relationship between Factors Affecting Students' Views about Proof and their Performance in Proof. *Paper presented at the 23rd European Conference on Operational Research (EURO XXIII) 2009, Bonn, Germany, July 5-8, 2009.*

HOBBIES

Cycling, Running, Argentine Tango