THE RELATION OF STEM IDENTITY TO STEM STEREOTYPICAL BELIEFS

by

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Dedicated to my beloved father, Hikmet Kaya

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ABSTRACT

THE RELATION OF STEM IDENTITY TO STEM STEREOTYPICAL BELIEFS

This study aimed to investigate the status of middle school students in four dimensions of identity framework-overall identity, recognition, performance-competence, and interest- and also in three dimensions of stereotypical beliefs framework-feminine, masculine, and socioeconomic status- across four STEM disciplines. Additionally, it aimed to explore how recognition, performance-competence, and interest and stereotypical beliefs -related dimensions predicted the students' overall identity for each STEM disciplines. The study involved 604 students from three schools. Two main data sources were utilized: the STEM Disciplinary Identities scale (STEMDIds) with 68 items and the STEM Disciplinary Stereotypical Beliefs Scale (STEMDSBs) containing 48 items. Descriptive statistics results indicated that the students' status concerning identity and stereotypical beliefs dimensions exhibit different patterns across the four STEM disciplines, with differences observed based on gender and grade level. Results from three-step hierarchical multiple regression analysis further revealed that the variance in STEM disciplinary identities was accounted for by independent variables (gender, grade level, gender and socioeconomic status related stereotypical beliefs, and recognition, performance-competence and interest in the disciplines of STEM) at different levels, and these identities were statistically significantly predicted by these variables to varying extents across four STEM disciplines. This research provides implications for further studies, including investigating relationships between variables using Structural Equation Modeling, conducting cross-cultural comparative studies, and exploring issues pertaining to identity and stereotypical beliefs influenced by the social environment.

ÖZET

STEM KİMLİĞİNİN STEM STEREOTİPİK İNANIŞLAR İLE İLİŞKİSİ

Bu çalışmanın amacı, ortaokul öğrencilerinin dört STEM disiplini için kimlik çerçevesinin dört boyutundaki- genel kimlik, tanınma, performans-yetkinlik ve ilgi- ve ayrıca stereotipik (kalıp yargı) inanışların çerçevesinin üç boyutundaki- kadınsı, erkeksi ve sosyoekonomik statü- durumlarını araştırmaktır. Ayrıca, tanınma, performans-yetkinlik ve ilgi ile stereotipik inanışlara ilişkin boyutların öğrencilerin bu disiplinlerin her biri için genel kimliklerini nasıl öngördüğünü araştırmayı da amaçlamıştır. Çalışmaya üç okuldan 604 öğrenci katılmıştır. İki ana veri kaynağı kullanılmıştır: 68 maddeden oluşan STEM Disipliner Kimlikleri Ölçeği (STEMDIds) ve 48 maddeden oluşan STEM Disipliner Stereotipleri Ölçeği (STEMDSBs). Tanımlayıcı istatistik sonuçları, öğrencilerin kimlik ve kalıp yargı boyutlarına ilişkin durumlarının dört STEM disiplini arasında farklı örüntüler sergilediğini, cinsiyet ve sınıf düzeyine göre de farklılıklar gözlemlendiğini göstermiştir. Üç aşamalı hiyerarşik çoklu regresyon analizinden elde edilen sonuçlar ise STEM disiplin kimliklerindeki varyansın bağımsız değişkenler (cinsiyet, sınıf düzeyi, cinsiyet ve sosyoekonomik statü ile ilgili stereotipik inanışlar ve STEM disiplinlerine yönelik tanınma, performans-yeterlilik ve ilgi) tarafından farklı düzeylerde açıklandığını ve bu kimliklerin dört STEM disiplini genelinde bu değişkenler tarafından istatistiksel olarak anlamlı ölçüde yordandığını ortaya koymuştur. Bu çalışma, ileriye dönük araştırmalar için Yapısal Eşitlik Modellemesi kullanılarak değişkenler arasındaki ilişkilerin incelenmesi, kültürler arası karşılaştırmalı çalışmaların yapılması ve sosyal çevreden etkilenen kimlik ve stereotipik inanışlarla ilgili konuların araştırılması gibi çeşitli öneriler (doğurgular) sunmaktadır.

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LIST OF ACRONYMS/ABBREVIATIONS

STEM	Science, Technology, Engineering, Mathematics
STEMDIds	STEM Disciplinary Identities
STEMDSBs	STEM Disciplinary Stereotypical Beliefs

1. INTRODUCTION

STEM identity denotes the extent to which an individual considers STEM domains (such as science and engineering) as fundamental to their self-concept (Chemers *et al.*, 2011). The concept of STEM identity has an important role in students' success in educational environments, in determining their career goals and in explaining their retention in STEM fields (Singer *et al.*, 2020; Stewart, 2022). It is also an important social justice issue as students who develop a STEM identity are more likely to secure STEM opportunities that benefit economically and socially (Cohen *et al.*, 2021). The rising prominence of STEM in modern times brings to light concerns about who faces challenges in forming a strong STEM identity and how certain individuals experience marginalization within STEM fields.

Despite the growing number of individuals pursuing careers in STEM fields, women and certain social groups remain underrepresented in these domains (Rodriguez *et al.*, 2023). STEM stereotypical beliefs, characterized as generalized beliefs about individuals in STEM fields, lead minority groups like women to be exposed to discrimination and marginalization (Luo *et al.*, 2021; Starr, 2018). Various stereotypical beliefs related to STEM, such as those based on gender or socioeconomic status (SES), impact the motivation for active participation in STEM subjects and STEM identity of minority individuals (Starr and Leaper, 2023). Thus, particularly individuals from minority social groups often struggle to identify with STEM fields and their motivation to remain engaged in STEM decreases over time (Rice and Barth, 2016). In short, the relevant literature emphasizes that identifying and addressing STEM stereotypical beliefs is crucial.

Balanced identity theory suggests that people generally have a tendency to strive for coherence and consistency in their self-concepts, stereotypical beliefs they hold, and their sense of belonging to specific social groups (Cvencek *et al.*, 2012). In accordance with this theory, if a girl internalizes the stereotype that science and mathematics are

domains where boys excel, she may struggle to identify with these fields (Greenwald *et al.*, 2002). Starr and Simpkins (2021) also found a significant relationship between students' gender stereotypical beliefs and their intersectional identities in science and mathematics. Another study revealed that women's stereotypical beliefs about STEM fields contributed to explaining 15% of their STEM identity (Starr, 2018). Additionally, exposure to gender- and income-based stereotypical beliefs in STEM can lead students to lose interest in STEM fields, potentially resulting in their inability to pursue STEM careers over time (Hughes and Roberts, 2019). In summary, the literature indicates that there is a relationship between STEM stereotypical beliefs and STEM identity, highlighting the importance of further investigation in this area.

The studies concerning this issue reveal that students' enthusiasm for STEM, a significant predictor of their persistence in STEM fields, tends to diminish notably during their middle school years (Archer *et al.*, 2012; Tai *et al.*, 2006). Besides that, in the middle school and adolescent years, it is reported by girls that they encounter academic sexual discrimination within STEM fields and are subjected to sexist remarks regarding their abilities in these areas (Leaper and Brown, 2008). This scenario underscores the importance of researching and closely monitoring how the stereotypical beliefs about STEM prevalent during these developmental stages influence the formation of students' STEM identities.

Absolutely, within the realm of STEM, individuals often embrace multiple and occasionally conflicting specific discipline identities, such as science or mathematics identity (Stewart, 2022).

In this regard, while certain studies explore STEM identities in a comprehensive manner (e.g., STEM identity (Dou and Cian, 2022), others focus on individual identities within STEM fields (e.g., mathematics identity (Cribbs *et al.*, 2015) and engineering identity (Rodriguez *et al.*, 2018)), separately.

Indeed, the approach to studying STEM identity-whether holistically or through specific discipline identities-varies based on the objectives of the research and the available resources and opportunities. In studies involving students who do not receive integrated STEM education, such as the one in question, it may be more reasonable and logical to examine STEM identity based on four distinct areas rather than holistically. This approach can potentially yield more reliable results by allowing for a more nuanced understanding of students' perceptions and experiences within specific STEM domains.

In conclusion, this study underscores the importance of researching, supporting, and enhancing strong STEM identities, recognizing their significant influence on individuals' engagement in STEM fields. It also advocates for investigating the impact of stereotypical beliefs about STEM on these identities and promoting inclusivity within the field. Given that existing literature indicates the formation of STEM-related identities and stereotypes typically begins during middle school, it was deemed crucial to focus on this age group in the study. Additionally, since disciplinary distinctions regarding identity and stereotypes become more apparent at higher education levels, it was deemed valuable to explore whether such differentiation begins within the four STEM disciplines during middle school education.

1.1. The Purpose of the Study

The current study aims to (a) investigate and determine the middle school students' STEM stereotypical beliefs and STEM disciplinary identity status by lensing four disciplines of STEM separately, (b) and how the disciplinary identity is predicted by the components of the disciplinary stereotypical beliefs (feminine, masculine, socioeconomic status) and the components of the disciplinary identity framework (recognition, performance-competence, and interest) in each STEM discipline.

1.2. Significance of the Study

Despite the growing number of students pursuing STEM majors, the involvement and continuity of women and minorities in STEM fields are on the decline (Fouad and Santana, 2017; Marginson *et al.*, 2013). In other words, women's and minorities' lack of representation in STEM persists (Botella *et al.* 2019; Sánchez-Tapia and Alam, 2020). If, for instance, the ongoing underrepresentation of women persists, the world shaped by STEM will be designed by and most likely for men, and the potential of young women will not be tapped (UNICEF, 2020).

A student's commitment and perseverance in STEM fields are shaped by their sense of identity, and those who possess a strong STEM identity are more likely to select and pursue careers related to STEM (Carlone and Johnson, 2007; Martin-Hansen, 2018). Between the ages of 10-14, students commonly experience a decline in their interest in STEM, which serves as a significant marker for the development of permanence and identity within STEM fields (Tai *et al.*, 2006). Meanwhile, during early adolescence, which encompasses this age range, individuals' educational and career aspirations start to solidify (Eccles, 2007). The existing literature on identities within STEM fields primarily targets university-level samples (Dou and Cian, 2022; Kelly *et al.*, 2020; Singer *et al.*, 2020), with subsequent attention given to high school students (Cheng *et al.*, 2018; Rafanan *et al.*, 2020). However, as research on identity progresses, there is growing evidence suggesting that identity formation begins during early developmental stages (Gülen and Dönmez, 2021). Therefore, it is crucial to assess and support middle school students' current STEM identities during this specific life stage, ensuring they receive the necessary interventions.

Plenty of studies have highlighted the significant influence of stereotypes, socioeconomic background, gender, family support, and ethnicity on individuals' identity formation, their commitment to STEM, as well as their motivation and interest in STEM disciplines (Bian *et al.*, 2017; Grimalt-Álvaro *et al.*, 2022; Hughes *et al.*, 2013; Master and Meltzoff, 2016). Hence, firstly, it is essential to explore and characterize

STEM stereotypical beliefs across diverse social and demographic dimensions that could impact STEM identity formation. Secondly, it is essential to investigate and uncover the connection between STEM stereotypical beliefs and STEM identity, as indicated by relevant literature. Studies have discussed the correlation between STEM stereotypical beliefs and STEM identity, often by considering factors such as self-efficacy or interest in STEM (Luo *et al.*, 2021). Additionally, STEM identity has been investigated as a potential mediator between stereotypical beliefs and motivation in STEM (Starr, 2018). As can be seen, there are limited number of studies that comprehensively investigate to what extent and how students' STEM identities are affected by their stereotypical beliefs.

Research on STEM stereotypes or stereotypical beliefs has predominantly taken a qualitative approach (Fralick *et al.*, 2009; Meador, 2018), with quantitative studies being limited in comparison (Luo *et al.*, 2021). Besides, while existing studies typically focus on STEM stereotypes related to gender and traits (Luo *et al.*, 2021; Starr, 2018), there is a dearth of research examining stereotypes based on socioeconomic status (Turner *et al.*, 2004). Furthermore, stereotypes related to STEM have frequently been studied in a comprehensive manner (Luo *et al.*, 2021) or through dual and triple combinations of STEM disciplines (Musso *et al.*, 2022). To fulfill the objectives of this research, it is crucial to quantitatively measure students' STEM stereotypes related to gender characteristics and socioeconomic status on a large scale, separately across the four STEM disciplines. In this regard, analyzing individuals' stereotypes using the STEM Disciplinary Stereotypes Scale (Aydin *et al.*, 2023), which comprehensively evaluates STEM stereotypical beliefs in terms of feminine, masculine, and socioeconomic dimensions, can yield significant findings relevant to the research objectives.

Similar to the research on STEM stereotypical beliefs, STEM identity has been examined holistically (Dou and Cian, 2022) or on a specific disciplinary basis (Sandrone, 2022). For the students who lack exposure to comprehensive STEM education in Turkish educationa system, analyzing STEM identity across the four separate disciplines provides a more realistic approach.

There are few measurement tools available that specifically assess identities and related dimensions within STEM disciplines. Within the scope of this study, in order to assess disciplinary identity, the Physics Identity Scale developed by Ulu and Yerdelen-Damar (2022) was adapted to the fields of science, technology, engineering, and mathematics to measure the identities based on STEM disciplines. Each adapted scale assesses four dimensions of identity: identity, recognition, performance-competence, and interest. The present study's results supported the scale's construct validity in each STEM discipline for middle school students.

Overall, the literature highlights that stereotypical beliefs regarding STEM present a barrier to the formation and cultivation of STEM identity among middle school students. The relationship between STEM stereotypes and identity has primarily been explored through qualitative studies or quantitative scales containing only a few items (Dunlap and Barth, 2023; Starr, 2018), lacking comprehensive quantitative measurements. In addition, STEM stereotypical beliefs and identity have typically been investigated holistically, encompassing all four STEM disciplines. In such cases, researchers often asked participants to respond to scales based on their interest in a specific STEM field or they examined stereotypical beliefs and identities within one or two disciplines (usually mathematics and/or science) under the STEM. Consequently, while most studies in the literature aim to investigate STEM stereotypical beliefs and identity with a unified approach, they have done so within a restricted framework.

In that sense, STEM-related stereotypical beliefs need to be addressed in order to develop, protect and maintain individuals' STEM identities. The insights provided by this study enable teachers, researchers, and policymakers to determine the extent of the identity of each STEM discipline needs to be supported and understand the threats posed by STEM stereotypical beliefs. Thereby, they can strategize and implement necessary improvements to support STEM identity development effectively.

1.3. Research Questions (RQ)

This study focuses on three main research questions, each of which will be explored through four sub-questions. The questions and the visual representation of them (see Figure 1.1) stated as follows:

- RQ 1. What is the status of middle school students' STEM disciplinary identities?

  RQ 1.1. What is the status of middle school students' science identity?

  RQ 1.2. What is the status of middle school students' technology identity?

  RQ 1.3. What is the status of middle school students' engineering identity?

  RQ 1.4. What is the status of middle school students' mathematics identity?
- RQ 2. What is the status of middle school students' STEM disciplinary stereotypical beliefs?

  RQ 2.1. What is the status of middle school students' science stereotypical beliefs?

  RQ 2.2. What is the status of middle school students' technology stereotypical beliefs?

  RQ 2.3. What is the status of middle school students' engineering stereotypical beliefs?

  RQ 2.4. What is the status of middle school students' mathematics stereotypical beliefs?
- RQ 3. How is middle school students' STEM disciplinary identity predicted by STEM disciplinary stereotypical beliefs?

  RQ 3.1. How is middle school students' science identity predicted by science stereotypical beliefs?

  RQ 3.2. How is middle school students' technology identity predicted by technology stereotypical beliefs?

  RQ 3.3. How is middle school students' engineering identity predicted by engineering stereotypical beliefs?

  RQ 3.4. How is middle school students' mathematics identity predicted by mathematics stereotypical beliefs?

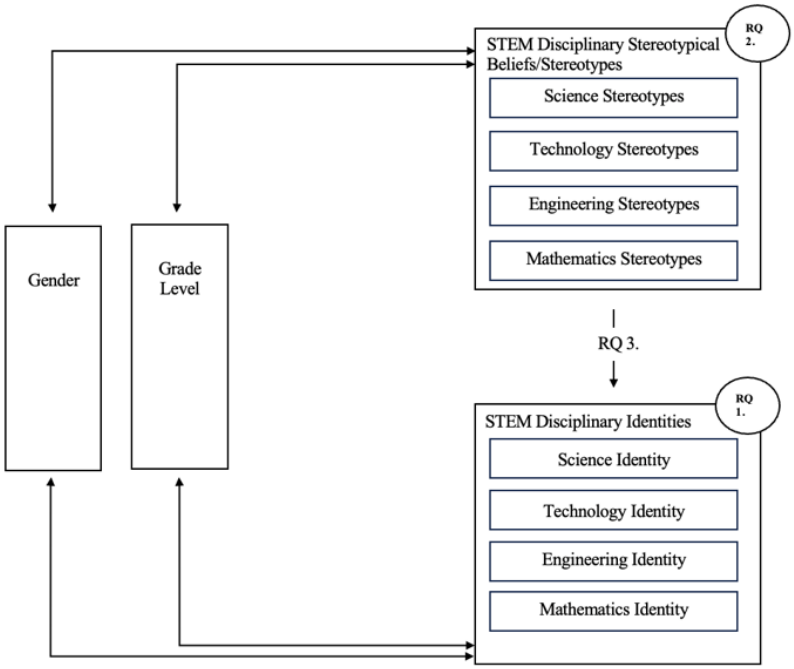

Figure 1.1. Visual representation of research questions.

2. REVIEW OF THE LITERATURE

The rising demand and significance of STEM professionals and education have prompted essential inquiries within the STEM community and among researchers regarding the identity formation within these fields, as well as the stereotypical beliefs influencing this process. In this regard, this chapter offers referenced explanations across five primary sections.

The first section has four subsections focusing on the necessity and importance of developing a STEM identity, the description and conceptual structure of STEM identity, the developmental process and dimensions of the STEM identity model on which the study is based, and the literature on this issue respectively. In the second section, the insights are given into STEM related stereotypical beliefs, their characteristics, and effects, relevance of studying middle school and teenage students' stereotyping in STEM fields, gender-based STEM stereotypical beliefs and their role, and the existence and impact of STEM stereotypical beliefs regarding socioeconomic status. The subsequent section mentions about the constructional relation between STEM identity and STEM stereotypical beliefs, alongside the necessity and significance of investigating both. The next section provides details about official STEM education in Türkiye with which the research group is affiliated. The last section serves as a summary of the preceding four sections including the theoretical background of STEM identity, the defining attributes of STEM stereotypical beliefs, and the contextual suggestions from relevant literature to analyze these concepts.

2.1. Stem Identity

2.1.1. The Importance of Developing STEM Identity

Recent scientific developments are rapidly shaping the global economy. Thus, STEM is becoming more popular among students of all levels since its fields provide

many occupations and economic growth (Andrée and Hansson, 2020; Bacovic *et al.*, 2022). By the 21st century, the need for individuals with STEM competencies and skills, that is, individuals who think scientifically, question, criticize, be productive, solve problems and work interdisciplinary has increased (Akaygun and Aslan-Tutak, 2016). Therefore, it is important for students to choose careers in STEM fields in order to contribute to society.

Some psychological factors such as identity, interest, belief of competency and value of perception affect students' academic and career preferences and their permanence (Boaler, 2016). Studies have pointed out that a student's sense of identity is effective in their continued interest and persistence in STEM disciplines (Aschbacher *et al.*, 2010; Brickhouse *et al.*, 2000). For instance, it has been concluded that students with a stronger physics identity are more likely to choose careers associated fields with physics (Hazari *et al.*, 2010). At this juncture, STEM identity is an important factor that affects individuals' success, motivation, interest in STEM fields, and their commitment to pursuing career goals within these domains (Syed *et al.*, 2019). For the reasons mentioned, individuals' STEM identities need to be strengthened in meeting the needs of STEM fields, achieving success, and ensuring the continuity of individuals' participation in STEM (Bell *et al.*, 2019).

2.1.2. Disciplinary Identities Related to STEM

As a social being, each of us has a comprehensive identity that cannot be put on a single card since it includes our characteristics, qualities, and the conditions that form our personality, all the specialties of us. It addresses the questions of who we are, how we exist in communities and how we are seen by society.

Identity, which consists of MIIC values held personally (i.e., a person's perception of his/her competence) and socially (i.e., gender, socio-economic status), is a complex construct. Therefore, it can be defined in various ways. Holland *et al.* (1998) offered a broad definition of identity. He suggested that our identity is our meaning-making

process of determining who we are through internal dialogue and sociocultural participation. Moreover, Lave and Wenger (1991) stated that people's understanding of identity is formed depending on their experiences. It has been also noted that each of us has an identity specific to a particular context, formed by our performance there as well as by the personal and social agreements we reach with members of the context (Gee, 2000; Gee *et al.*, 2001).

Based on the definitions of identity in the literature (Holland *et al.*, 1998; Lave and Wenger, 1991), it can be argued that identity as a construct can change with the fluctuations of the components that form and affect it, and therefore it is an ongoing process. In this process, several attempts like probing, dealing with, supporting, and improving the components that affect people being a person of a certain field will most likely help them create a strong identity. Thus, this will ensure that the workplace attracts people who can be active in it with commitment and enthusiasm.

By the nature of identity, STEM identity is a concept that boundaries cannot be clearly defined in many cases and is difficult to operationalize in research (Carlone and Johnson, 2007). Current literature shows that due to the complex structure of identity construct, quite simple definitions that can be valid in many cases have been developed for the concept being talked about. One and the most prevalent is offered by adapting the definition of science identity that Carlone and Johnson (2007) proposed. Through this definition, STEM identity can be defined as the recognition of one as a STEM person by oneself and meaningful others. According to another similar definition, STEM identity is a reflection of how one is positioned and recognized by oneself and others in the STEM community (Rodriguez *et al.*, 2019). In the interviews conducted with thirteen researchers who are active in the field of STEM, the concept was defined as a sense of self constructed by individually and socially in parallel with the previous ones (Bell *et al.*, 2018). Overall, a commitment to the discourses and practices of the STEM world enables people to create a sense of self or internalize the STEM identity by establishing a relationship with this world and its people, events, places and systems (Kane, 2012).

2.1.3. STEM Identity Model

In the current research, the grounded model of science identity developed by Carlone and Johnson (2007) was used to study STEM identity. As Lewis (2003), and Tan and Barton (2008) pointed out, the model attempts to explain nature of identity by acknowledging that it is socially constructed. This, considering that a social process is effective in identity formation, is one of its salient features. In addition, it recognizes that individuals' science identities emerge situationally and also have continuity across context and time.

The initial framework of the model informed by the findings, which is highly detailed in the recognition dimension in the original version, includes three main interrelated dimensions: (1) competence, (2) performance and (3) recognition. These three dimensions predict another dimension, the overall identity. While performance and competence constructs refer to the person's belief in them, recognition refers to the person's perception of this construct (Godwin *et al.*, 2016). If the dimensions proposed by Carlone and Johnson (2007) are redefined and applied within the STEM domain in accordance with the current research objectives, competence can be defined as a person's meaningful understanding of STEM content and their knowledge in STEM. Additionally, being competent in STEM involves not only demonstrating meaningful cognition and understanding but also being motivated to interpret the world through the lens of STEM. The second dimension performance is his or her ability to become involved in STEM practices and to realize competence in these practices for others. Lastly, recognition states being seen as a STEM person by oneself and others. A study conducted in the field of science identity showed that people who are known as a science person by those around them have higher science identity scores than those who are not known (Puente *et al.*, 2021). As Erikson (1994) states in his theoretical model, the perception of how people are recognized by the members of their community is an important part of developing a strong identity.

The developers of the science identity model have emphasized that a person has not succeeded in becoming a science person and enacting his identity in this field unless he makes his competence in relevant practices visible to those around him with his performance and this performance is accepted as creditable by them. These two are both requirements for developing a strong STEM identity (Tonso, 2006). In summary, the existence of STEM identity can be mentioned when the person's competence and performance related to STEM are deemed meaningful by herself and her environment.

The model developed by Carlone and Johnson (2007) is quite flexible. Thus, the model developed for science identity could be adapted and used in various related disciplines, for instance, physics identity (Hazari *et al.*, 2010) and computing identity (Mahadeo *et al.*, 2020). In their research examining how students' physics identities are affected by their classroom experiences and career goals, Hazari and her colleagues (2010) added a new component to Carlone and Johnson's model (2007), interest. Although Carlone and Johnson (2007) acknowledged the importance of the interest dimension, it was not added to the model because it was assumed that their study participants already had interest. The interest dimension, which is thought to be of critical importance in influencing a person's decision about who and what she wants to be, was added to the model in the research in which physics identity was studied. If the definitions of the dimensions proposed by Hazari *et al.* (2010) in the new version of the model are adapted for STEM, competence is defined as "the belief in the ability to understand STEM-related contents", while performance is defined as "the belief in the ability to perform the required tasks of STEM". The third dimension, recognition, corresponds to "being recognized by others as a good STEM student". However, it has been also pointed out that how a person sees himself and his choices are significantly influenced by how others see him such as parents' perceptions and expectations of their children. The later dimension interest can be defined as "the desire or curiosity to understand and think about STEM". Although Hazari *et al.* (2010) aligned the model in their research with the framework of the science identity model, factor analysis pointed out that the performance and competence dimensions should be combined as a single dimension, performance-competence.

Based on this framework, the best fit structure between the latent variables was assessed through the tested models and the path model of identity was established (Cheng *et al.*, 2018; Cribbs *et al.*, 2015; Godwin *et al.*, 2016). Former studies have shown that the interest and recognition dimension mediate the performance-competence dimension towards identity. Accordingly, it was determined that the performance-competence is not a direct predictor of identity (Cribbs *et al.*, 2015; Dou and Cian, 2022).

Briefly, in this study, STEM identity is grounded in the model developed by Carlone and Johnson (2007) to delineate science identity, a framework that has been both utilized and refined by subsequent researchers over time. This model is well-suited for studying the identity related to STEM's respective fields. It also acknowledges that aspects of social identity, including gender biases and ethnicity, play a significant role in shaping and influencing the identities formed within STEM (Stewart, 2022). This facilitates the examination of the correlation between STEM identity and STEM stereotypical beliefs.

2.1.4. Research on STEM Identity

Research on STEM identity enables the visualization of how students perceive themselves regarding STEM fields with what is effective in identity development, and thus allows educators and individuals to develop their STEM identities over time by determining and subsequently actualizing effective strategies.

National efforts aim to recruit students to STEM fields and countries are trying to carry out various reforms in STEM education so that they can achieve qualified success in STEM fields, and this will be effective in maintaining their economic and technological leadership. (National Academies of Sciences, Engineering and Medicine, 2018; Güler, 2017). Studies in the literature reveal and advocate that educators should not take STEM-related initiatives without making sense of students' STEM identities (Collins, 2013, 2015, 2017; Collins *et al.*, 2017; Collins, 2018). STEM identity plays a

strong role in a person's success in educational settings, achievement of career goals, and professional trajectory (Perez *et al.*, 2014; Simpson and Bouhafa, 2020). Rodriguez and her collages (2019) argue that STEM identity gives insight about the acculturation process of individuals in communities of specific STEM practices, and how students approach or move away from the norms, culture, and practices of these communities. Developing a STEM identity for students means that they develop a way of participating in a disciplinary community, and as the results of one study point out, a strong identity that is developed suggests that the student is more likely to pursue a career in a relevant STEM field (Hazari *et al.*, 2010; Lave 1998).

STEM fields have been recognized as among the least diverse sectors in the workforce, with underrepresentation of certain demographic groups such as women, racial and ethnic minorities, and individuals from lower socioeconomic backgrounds (Kennedy *et al.*, 2021; Kricorian *et al.*, 2020). In this regard, having a strong STEM identity enables students to select and actively pursue professions within STEM fields. Some scholars have proposed that a student's STEM identity is influenced by how they perceive and understand their social identities, including factors like socioeconomic status and gender (Charleston *et al.*, 2014; Ortiz *et al.*, 2019).

Studies indicate that individuals' identification with STEM fields, which significantly influences the career paths they pursue later in life, develops during their early years (Tai *et al.*, 2006; Eren and Dökme, 2024). In addition, there is less strong information about people's STEM tendencies in their early ages compared to their later lives and that students show a reluctance towards STEM content in their secondary school ages (Kim *et al.*, 2018). Moreover, Archer *et al.* (2010) highlighted a notable decline in students' motivation and interest in pursuing STEM careers by the age of 14. Research corroborates these assertions as well by demonstrating that middle school students often exhibit low levels of identification with STEM fields (Carlone *et al.*, 2014; Çolakoğlu *et al.*, 2023). For these reasons, examining STEM identity in students' middle school and early adolescence ages is crucial.

Since STEM involves different disciplines, STEM identities can also refer to more than one specific disciplinary identity (e.g., engineering or mathematics identity), sometimes overlapping and sometimes competing (Simpson and Bouhafa, 2020; Stewart, 2022). STEM identity, similarly, integrates multiple disciplines, so that individuals who identify strongly with mathematics are also inclined to perceive themselves as having aptitude in engineering or science (Stewart, 2022). While developing the science identity model, women who described themselves as science person but whose careers were spent in different scientific disciplines such as chemistry or molecular biology were studied (Carlone and Johnson, 2007). In the study conducted by Carlone and Johnson (2007), the participants responded to the items regarding science identity by taking into consideration their identities related to the discipline in which they work. This attitude of the participants indicates that it may be more reasonable and logical to examine STEM identity on a discipline-based basis. Besides, in a study exploring individuals' identities across four STEM disciplines, it was found that factors such as interest, curiosity, competence, and intelligence played significant roles in shaping their identities (Gülen and Dönmez, 2021). As a result, people exhibited distinct identities for each of these disciplines. Furtermore, in countries, where integrated STEM education is not prevalent, it may be more reliable to assess STEM identity by examining its four domains individually rather than as a whole.

2.2. Stem Stereotypical Beliefs

2.2.1. Stereotypical Beliefs Relating to Science, Technology, Engineering and Mathematics

Biases refer to a collection of beliefs, attitudes, and actions directed towards or against individuals due to their perceived group affiliation or identification (Dovidio *et al.*, 2010). A common aspect of biases is stereotypes / stereotypical beliefs. Stereotypical beliefs are general beliefs that link certain qualities and traits with the majority or all members of a particular social group, often assuming uniformity within that group (Kuchynka *et al.*, 2022).

Typically, these generalized beliefs about a specific group of individuals tend to be negative (Matsumoto, 2009).

STEM stereotypical beliefs involve broadly recognized, simplified, and generalized notions concerning both the attributes of STEM subjects and the individuals who demonstrate excellence, work in, or have an affinity for the fields of STEM (Kessels, 2015; Luo *et al.*, 2021). It is observed in the literature that, beliefs about STEM are frequently stereotyped on the basis of several aspects like general characteristics, gender, ethnicity, race, socioeconomic status, and (dis)ability. Individuals in STEM are occasionally depicted as displaying social awkwardness and lacking physical attractiveness, experiencing lacking success in romantic pursuits, yet being inherently intelligent, genius, technology and computer obsessed prodigies (Cheryan *et al.*, 2013; Starr, 2018; Storage *et al.*, 2016). Some research has been conducted in accordance with this manner. For instance, in a study aiming to explore the influence of the genius stereotype along with gender stereotypes on STEM motivation and identity, genius was described with the adjective "nerdy", that is, as someone who has only one goal in life, is successful in scientific or technical pursuits, but is socially inadequate (Starr, 2018). Besides these, STEM fields are perceived as more suitable for men even by girls (Archer *et al.*, 2018; Kessels, 2015). The underlying reason for the former is that STEM subjects are often viewed as unfeminine, with the belief that men are more capable and interested in these fields (Le *et al.*, 2023; Martinot *et al.*, 2012). It was also revealed from the research that students often perceive the disciplines encompassing STEM as predominantly represented by individuals who are white and middle-class (Barton, 1997; Hughes *et al.*, 2013).

The stereotypical beliefs mentioned can lead to a variety of consequences. Luo and her colleagues (2021) indicated that students' stereotypical beliefs about STEM careers were found to have a negative impact on their self-efficacy in STEM activities and their expectations regarding career outcomes in STEM similar to some other studies (Archer *et al.*, 2014; DeWitt *et al.*, 2013; Nassar-McMillan *et al.*, 2011). It was discovered that there is an association also between stereotypes and decreased perfor-

mance in STEM tests (Logel *et al.*, 2009). Stereotypes possess considerable capacity to detrimentally impact the education, recruitment, advancement, and retention of women in STEM fields, thereby resulting in a substantial loss of talent and human potential (Jackson *et al.*, 2014; UNICEF, 2020). Biased norms contribute to individuals harboring low expectations and self-confidence regarding their STEM abilities. This particularly affects girls' and women's beliefs and attitudes towards STEM, discouraging them from pursuing careers in these fields (UNICEF, 2020). It is regrettable that there exists a vicious cycle for girls and women in this context. Stereotypes diminish their involvement in both social and STEM domains, and likely because of their underrepresentation, girls and women tend to adopt stereotypical descriptors more often than men (Cassidy *et al.*, 2018; Cyr *et al.*, 2021; Ehrlinger *et al.*, 2018).

To sum up, it becomes challenging for girls, students of color, and those from low socioeconomic backgrounds to envision themselves as capable of succeeding and fully engaging in STEM fields, as they struggle to overcome these stereotypical perceptions (Hughes *et al.*, 2013). Furthermore, according to educators and researchers, these circumstances result in a declining interest in STEM careers among students from lower to upper grades (Metcalf, 2010). For all these reasons, students' stereotypes regarding STEM are recognized as an issue requiring attention and resolution (van Tuijl and van der Molen, 2016).

2.2.2. Stereotyping of STEM-Related Beliefs During Life Periods

Many studies reviewed have shown that regardless of the time frame, children, adolescents, and adults consistently exhibit stereotypes such as a stronger association between STEM fields and males compared to females (Kessels, 2015). However, the literature specifically highlights the middle school years, or early adolescence, for particular scrutiny and emphasis. Stereotypical beliefs related to STEM start to arise in childhood and typically intensify during the transition from childhood to early adolescence (Cvencek *et al.*, 2011; Miller *et al.*, 2018). Based on their research findings, Hughes and Roberts (2019) stated that at this stage, factors such as race, gender, and

income become influential, as students begin to feel the impact of stereotypical beliefs. Another study discovered that middle school students possess restricted understanding regarding the roles of STEM professionals and the academic prerequisites associated with those fields (Blotnicky *et al.*, 2018). This could be interpreted as amplifying their inclination to hold biased beliefs. During the middle school years, students' interest in STEM, which plays a crucial role in predicting their long-term commitment to STEM fields, starts to diminish (Archer *et al.*, 2012). Alongside this, their involvement in related activities decreases, and their motivation to excel is adversely affected (Kang *et al.*, 2019; Lauermann *et al.*, 2017). In addition, during this stage, their engagement in STEM subjects declines, and gender disparities widen due to the stereotypes (Heddy and Sinatra, 2017). Because of all these reasons, it is crucial to explore and address the stereotypes among middle school students and to initiate early interventions that can be much more effective than interventions introduced later.

2.2.3. Gender Related STEM Stereotypical Beliefs

Despite possessing genuine interests, talents, and expertise, females continue to be inadequately represented in STEM fields (van der Vleuten *et al.*, 2018). One of the core issues behind the underrepresentation of girls in STEM lies in the perception that they are unsuitable for STEM education and careers, compounded by gender stereotype threat, which discourages girls from pursuing paths in these fields. (Dost, 2024; Musso *et al.*, 2022). Gender stereotypical beliefs associate traits like brilliance, high intelligence, competence, and performance in STEM disciplines more with masculinity than femininity (Hand *et al.*, 2017; Leslie *et al.*, 2015; Shapiro and Williams, 2012). Such expressions and beliefs often dissuade women and girls from pursuing STEM courses and careers by insinuating that they lack the ability or intelligence required for success in these fields (Wang and Degol, 2017). Therefore, these beliefs and their effects on girls contribute to the amplification of gender inequality (Mau and Li, 2018).

Children's gender stereotypical beliefs indeed surface early, and they often gain considerable strength from childhood through early adolescence compared to other

characteristics, such as race (Cai *et al.*, 2021; Liben *et al.*, 2002). Even though many individuals in this life stage hold flexible views on gender, they still tend to acknowledge the existence of masculine and feminine careers, often attributing greater importance to masculine careers over feminine ones (McGuire *et al.*, 2020).

Gender-related stereotypical beliefs lead to various disruptions in STEM education, workplaces, and society at large. Principally, the stereotypes impact the representation of girls and women in STEM fields by diminishing and interrupting their STEM engagement, motivation, career desire and self-efficacy (Leaper and Starr, 2019; McGuire *et al.*, 2020; Musso *et al.*, 2022; Reuben *et al.*, 2014; Schuster and Martiny, 2017). Sexist statements about who can succeed in STEM afterward threaten women's career choices and can cause women who pursue STEM careers to eventually abandon their chosen field (Cundiff *et al.*, 2013). They also lead girls to categorize STEM fields as either "women's fields" or "men's fields" (Mendick, 2013). This further limits women to representation and preference in certain specific areas only. Balanced identity theory sheds light on the influence of gender norms on career choices, particularly in STEM fields as well. By internalizing these norms, girls may develop a perception that STEM fields are not aligned with their identity or interests, leading them to avoid pursuing such careers (Cheryan *et al.*, 2017). Gender stereotypical beliefs have also broad-reaching impacts on various aspects of society, including social interactions, relationships, education, and the workplace, manifesting in both physical and psychological consequences (Carvalho Silva *et al.*, 2024). Studies have indicated that women may experience decreased confidence levels when they internalize prevailing negative stereotypes about themselves in STEM fields (Hand *et al.*, 2017; Stout *et al.*, 2013). As Kuchynka and her colleagues suggest (2022), gender stereotypes in STEM can be seen as a dual-sided coin, dampening girls' and women's interest and performance while bolstering boys' and men's. Therefore, it is crucial to investigate how these stereotypes impact both girls' and boys' STEM-related thoughts (such as identity) and actions (such as performance and persistence).

2.2.4. Socioeconomic Status (SES) Related STEM Stereotypical Beliefs

The education and workforce of STEM fields exhibit substantial inequalities and a lack of representation (Riegle-Crumb *et al.*, 2019). In this context, researchers primarily focusing on gender and race/ethnicity as key dimensions of this disparity, while giving less attention to family facilities, wealth, socio-economic status and social class (McGuire *et al.*, 2024). However, these factors also exert an influence for individuals to engage with science, technology, engineering and mathematics, as much as the others. Beside this, stereotypical beliefs shaped by socioeconomic status interact with gender-based stereotypical beliefs. Girls from lower socioeconomic backgrounds have limited access to STEM learning opportunities and exposure to STEM skills. As a result, they may be more susceptible to conforming to culturally transmitted gender stereotypes regarding STEM (Master and Meltzoff, 2020). Similarly, girls from disadvantaged backgrounds are less inclined to address the unequal allocation of STEM resources, suggesting that STEM stereotypes influence matters related to fairness and justice (Sims *et al.*, 2023). Despite being as impactful as other prejudiced beliefs, the failure to give this issue its due place in the literature has started to influence the latest trends in research. Researchers have directed their attention towards investigating socioeconomic status based stereotypes, which are believed to have the capacity to impact STEM identity, using indirect evidence like home support and parental education (Dou and Cian, 2020; Myint and Robnett, 2024).

2.3. Stem Stereotypical Beliefs and Stem Identity

STEM (Science, Technology, Engineering, and Mathematics) identity refers to an individual's sense of belonging, competence, and recognition within the STEM domain. Research often investigates how one's perception of themselves as a "STEM person" influences their engagement, persistence, and success in STEM-related pursuits (Grimalt-Álvaro *et al.*, 2022; Smith *et al.*, 2015). The concept of STEM identity is indeed crucial in researching ethnic and gender disparities within these fields.

Understanding ethnic and gender disparities in STEM involves exploring various factors, including societal expectations, stereotypes, access to resources and opportunities, cultural influences, and educational experiences (Andersen and Ward, 2014). By examining STEM identity within different demographic groups, researchers can gain insights into the barriers and challenges faced by underrepresented populations (Flowers and Banda, 2016; Myint and Robnett, 2024).

Stereotype threat theory proposes that stereotypes result in decreased identification with a particular domain (Inzlicht and Schmader, 2012). In the same vein, when a field becomes strongly associated with a particular gender, it can create barriers for individuals of the other gender to identify with or feel connected to that field (Nosek *et al.*, 2002). Previous research findings have supported this by demonstrating that stereotypes in STEM decrease the identification of girls and women with these fields, consequently impacting their career interests, self-efficacy and motivation to participate in STEM-related domains (Cundiff *et al.*, 2013; Eddy and Brownell, 2016; Starr, 2018). Expectation-value theory operates on a similar principle as well. It suggests that identity, as an individual factor, and stereotypical beliefs, as environmental factors, interact with each other, influencing a student's motivation to pursue a specific field (Eccles and Wigfield, 2002). In other respects, social identity theory emphasizes the significance of social identities in shaping individuals' perceptions of themselves and others within social groups (Hogg, 2016). Social identities delineate who belongs to a particular group and articulate the characteristics, norms, attitudes, and behaviors associated with that group. Understanding the content of social identities within STEM disciplines is essential for comprehending how individuals develop their sense of belonging and identity within these fields. It also sheds light on the role of stereotypes and cultural norms in shaping attitudes towards STEM careers and disciplines, particularly among underrepresented groups (Kim *et al.*, 2018). Once for all, STEM identity is shaped by the cultural and historical context surrounding STEM fields (Aschbacher *et al.*, 2010). Stereotypes about STEM can discourage students from developing a positive self-concept and identifying with STEM fields, potentially leading them to opt out of pursuing activities or careers in STEM (Starr, 2019).

The middle school years and adolescence represent crucial stages for investigating the interplay between stereotypical beliefs and identity formation. During adolescence, when individuals are actively exploring and shaping their identities, stereotypes can significantly influence their self-concept and sense of identity (Erikson, 1968; Lauermann *et al.*, 2017). Empirical studies support these assertions as well. It has been observed that especially female students in STEM fields are likely to have low experiences in terms of identification and prototyping with STEM due to normed beliefs in middle school and high school years (Kim *et al.*, 2018). By recognizing and challenging stereotypical beliefs and promoting inclusive representations of STEM identities, efforts can be made to foster greater diversity and equity within these fields.

2.4. Stem Education in Türkiye

The information presented in previous chapters and discipline-specific studies in the literature, played a crucial role in guiding this study to explore identity and stereotypical beliefs, particularly within the domains of science, technology, engineering, and mathematics. Since in present study the research group comprises middle school students the choice between conducting a unified or discipline-specific analysis of students' STEM identities and stereotypical beliefs was further informed by an examination of the STEM education in Türkiye.

Turkish Industry and Business Association (TÜSİAD), by publishing a report, stated that there is a difference in the field contributions of employees in STEM fields and non-STEM fields (TÜSİAD, 2014). For this reason, it was emphasized that the number of students to be educated in STEM fields should be increased and planning should be made to develop students' STEM skills at all levels of education (Çavaş, 2020). In that regard, the central authorized and responsible institution of the education system that can realize educational breakthroughs and reforms in the Republic of Turkey is the Ministry of National Education. The education program of all public and general private schools is subject to the curriculum determined by this government department.

STEM is an educational approach that aims to transform theoretical knowledge into practice, products, and innovative inventions, and enables students to see the knowledge and skills they have learned in the fields of science, technology, engineering and mathematics as a part of a whole (Republic of Türkiye Ministry of National Education, 2016). In order for countries to adapt to the developing world, interest in STEM fields and the quality of human resources in these fields need to be increased, and it is anticipated that integrated STEM education will play an important role in this (Akgunduz *et al.*, 2015).

There is no direct action plan or program determined by the ministry for STEM education in Türkiye. When the curriculum is examined, it is seen that while the interaction of science and technology is given particular importance, the integration of engineering and STEM is not directly included (Kertil and Gurel, 2016). Similarly, while Turkish education programs include courses in the disciplines of science, technology and mathematics and their learning goals and practices, there are no direct courses and learning goals related to the field of engineering (Yıldırım and Altun, 2015). On the other hand, various facilities are served to support STEM education. Within the scope of the FATİH Project, schools were provided with interactive boards and access to the Education Information Network (EBA) platform through the STEM education approach, which aims to provide students with skills such as questioning, researching, product development and invention. In addition to this, The Scientific and Technological Research Council of Türkiye (TÜBİTAK) organizes different project calls and events to support STEM approach and education.

2.5. Summary of the Literature Review

The opening section highlights the increasing demand for individuals who are both interested in and prepared for careers in STEM fields. In this context, it has been revealed that research touches on the importance of developing and cultivating a STEM identity (Aschbacher *et al.*, 2010; Bell *et al.*, 2019). From Lave and Wenger (1991) to Gee (2000), researchers proposed different definitions and characteristics for

the general structure of identity. These efforts have pointed out that defining identity and determining its boundaries is difficult. Therefore, broadly valid basic definitions have been attributed to STEM identity. Specifically, STEM identity is characterized as the manner in which an individual is acknowledged by themselves and their significant community within the STEM domain (Carlone and Johnson, 2007; Rodriguez *et al.*, 2019).

Carlone and Johnson (2007) formulated a model that defines science identity, taking into account the socially constructed nature of identity formation. This model consists of three fundamental dimensions: competence, performance, and recognition. According to the model, for an individual to be considered as having a strong science identity, they need to be perceived as competent, performing well, and recognized positively by themselves and those around them (Aghekyan, 2019). This model, serving as a framework for science identity, is applicable for use in other STEM-related disciplines. Building upon it, research has investigated physics identity (Hazari *et al.*, 2010), STEM identity (Dou and Cian, 2022), engineering identity (Rodriguez *et al.*, 2018), mathematics identity (Cribbs *et al.*, 2015), and computing identity (Mahadeo *et al.*, 2020).

Hazari and her colleagues (2010) have considered the interest dimension as a necessary component to complement the model while studying physics identity, and it has been added accordingly. In addition, factor analysis indicated that the performance and competence dimensions behave as a unified dimension. As a result, this model has been revised to form a framework incorporating the dimensions of interest, performance-competence, and recognition. Afterward, research utilizing the model has revealed that the performance-competence dimension does not directly predict identity but is mediated by interest and recognition (Cheng *et al.*, 2018; Cribbs *et al.*, 2015; Dou and Cian, 2022). Therefore, another modification resulted in the path structure of the model.

STEM identity holds significant sway in various domains, spanning educational settings to professional realms. Certain social minorities face underrepresentation in these fields, particularly in business sectors, often stemming from their struggle to identify with STEM domains (Kennedy et al, 2021). Social identities serve as one of the primary reasons behind this phenomenon (Ortiz *et al.*, 2019). Additionally, decreased motivation and interest, particularly during secondary school ages and adolescence, contribute to this trend (Archer *et al.*, 2010). Therefore, it is crucial to investigate the STEM identities of middle school students. In that sense, STEM identity is suitable for discipline-based examination as it integrates multiple identities belonging to the disciplines it is related to.

The second section begins by examining the general characteristics of stereotypical beliefs and delves into STEM stereotypical beliefs. These stereotypical beliefs often revolve around factors like ethnicity, gender, and socioeconomic status. Common stereotypical beliefs include portraying STEM fields as inherently intelligent, excessively focused on technology, or more suitable for men (Cheryan *et al.*, 2013; Martinot *et al.*, 2012). These biased beliefs impact self-confidence in STEM activities, career aspirations, and performance in STEM subjects (Logel *et al.*, 2009; Luo *et al.*, 2021). This situation particularly hampers the involvement of girls and women in STEM, resulting in a loss of potential talent.

Explanatory studies indicate that the middle school years or early adolescence are particularly important for examining STEM stereotypical beliefs. During this period, it has been observed that students' interest in and motivation towards STEM decrease. It has been hypothesized that stereotypes or stereotypical beliefs are effective during this period. Factors such as gender, income, or limited knowledge about STEM fields experienced by individuals during this period are influential in the formation of stereotypes (Blotnicky *et al.*, 2018; Hughes and Roberts, 2019).

The analysis of literature revealed that stereotypical beliefs in STEM were predominantly shaped by gender and socioeconomic factors. Gender stereotypical beliefs

attribute traits like intelligence and talent in STEM to masculinity (Leslie *et al.*, 2015). It is noteworthy that gender-based stereotypical beliefs become significantly stronger in early adolescence, a period characterized by self-discovery. This makes it crucial to address these stereotypical beliefs during this developmental stage.

If these stereotypical beliefs are left unaddressed, it is unavoidable to encounter adverse effects across various domains, spanning from STEM education to business environments. For instance, women may experience reduced confidence and may refrain from pursuing careers in STEM fields (Cheryan *et al.*, 2017; Hand *et al.*, 2017). Further stereotypical beliefs that require scrutiny and intervention to counteract inequitable practices in STEM and promote diversity in STEM fields are those associated with socioeconomic status. It is believed that being wealthy or coming from a privileged social class background affects being active in STEM. These stereotypical beliefs which has attracted the attention of researchers recently also increase their scope by interacting with gender stereotypes. Since this construct is difficult to measure directly, it is examined through different components such as family education or home support.

The following section focuses on the central problem of the research and the way of dealing with it. For example, there are inequalities and under-representations in stem due to gender. In line with studies, it is stated that in order to understand this situation, factors such as stereotypes and opportunities should be focused on and STEM identity should be examined (Andersen and Ward, 2014; Myint and Robnett, 2024). Stereotypical beliefs and identity perception are also phenomena that interact with each other. From stereotype threat theory (Hogg, 2016; Inzlicht and Schmader, 2012) to social identity theory, it is stated that STEM stereotypes can hinder identification with STEM. Erikson (1968) emphasizes that these stereotypical beliefs affect identity, especially during adolescence. All this information reveals the necessity of examining adolescents' STEM stereotypical beliefs, STEMidentities, and the relationship between the two.

The last section provides information about the STEM education that the students participating in the research are subject to. The present study focuses on middle school students studying in the official education system in Türkiye. An examination of the existing literature indicated a lack of research on both aspects in Türkiye, where scholars have explored STEM identity and stereotypical beliefs from both holistic and interdisciplinary perspectives. In that sense, the analytical approach was determined by examining the landscape of STEM education within Türkiye's official educational framework. This examination emphasizes an important observation that the formal education system lacks a comprehensive approach to STEM education. Besides, unlike the other three disciplines, engineering lacks designated learning goals and courses within the curriculum (Yıldırım and Altun, 2015). Given the absence of a comprehensive STEM education, it was deemed appropriate to separately investigate students' perceptions of STEM identity and stereotypical beliefs within each of the four STEM disciplines.

In conclusion, the research findings, statements, and perspectives outlined above all indicate the importance of examining both middle school students' STEM identity and stereotypical beliefs because they offer valuable insights into their experiences, perceptions, and challenges within STEM education and career desires. It can inform efforts to foster a more inclusive and supportive STEM environment for all students, regardless of background or identity.

3. METHODOLOGY

The present chapter of the research outlines the utilized methodology. It covers the research design, sampling method, participants demographics, conceptual and operational definitions of the key terms, concepts and study variables, scales for data collection, data gathering procedure, adherence to research ethics, considerations of internal validity, and the approach to data analysis. Each of these components is presented in the following sections with appropriate headings.

3.1. Research Design and Methodology

The present research adopts a quantitative approach in order to describe middle school students' STEM discipline identities and STEM stereotypical beliefs. Moreover, it aims to examine the relation between STEM disciplinary identity and stereotypical beliefs related variables by collecting and analyzing numerical data. The type of research design followed to investigate the study's research questions is a cross-sectional survey. Consistent with this, data were gathered from selected participants at a single time point as described by Gay *et al.* (2012). To be able to describe and interpret the relations among STEM identity and stereotypical beliefs variables, correlational research method was also implemented (Creswell, 2017).

3.2. Sampling and Participants

3.2.1. Population and Sample of the Study

In the light of the literature, the current study aimed to involve all grades of middle school students that are at the 5th, 6th, 7th, and 8th grades. At these grades, students at these grades are typically aged between 10 to 14 years. The accessible population comprises middle school students who are enrolled in public middle schools in Istanbul and are following the official curriculum. To ensure a representative sample

from the middle school population, the decision was made to collaborate with schools that implement the official Turkish middle school curriculum (MEB, 2018a), regardless of their type. The convenient sampling method was employed for participant selection. This approach was chosen due to its practicality, involving individuals readily accessible within the existing environment or willing to participate (Fink, 1995; Sedgwick, 2013). As a result, data was gathered from three middle schools of diverse types, including a public middle school, an official imam-hatip middle school, and a science and social sciences project school located in İstanbul. All schools were following national curriculum of Türkiye (MEB, 2018a).

3.2.1.1. Sample Size. The sample size is essential for the reliability and validity of statistical analysis results. The sample size of the current study was determined by considering the common requirements of the analyses, which are confirmatory factor analysis (CFA) employed for STEM discipline identity scale and regression analysis. In this regard, three key suggestions were taken into consideration when determining the optimal sample size. In sections 4.1 and 4.3.1.1.1, the methodology explains how the sample size was determined in accordance with these suggestions. With 604 students participating in this research, it is evident that the obtained sample size exceeds the minimum requirements for both Confirmatory Factor Analysis (CFA) and correlational studies. Therefore, it can be confidently asserted that the obtained sample size is sufficient to conduct the planned analyses effectively.

Since the present research focuses on exploring STEM stereotypical beliefs and discipline identities across students of diverse genders and grade levels, particular attention was given to ensuring a balanced representation of participants from each grade level and gender which enhances the representativeness and comprehensiveness of the study's findings. Thus, out of the 604 participants, 50.3 percent (304 students) were female, while 49.7 percent (300 students) were male. Each grade level was also adequately represented, with 25 percent (151 individuals) from the 5th grade, 24.7 percent (149 individuals) from the 6th grade, 25 percent (151 individuals) from the 7th grade, and 25.4 percent (153 individuals) from the 8th grade.

Table 3.1 displays the numerical count and the corresponding percentage for gender and grade levels, providing a comprehensive overview of the distribution across gender and grade levels among the participants.

Table 3.1. Distribution of Participants by Grade Level and Gender (N=604).

Variable						
Grade Level	**Gender**					
	Female		**Male**			**Total**
	N	**% within Gender**	**N**	**% within Gender**	**N**	**%**
Grade 5	75	24.7	76	25.3	151	25.0
Grade 6	75	24.7	74	24.7	149	24.7
Grade 7	76	25.0	75	25.0	151	25.0
Grade 8	78	25.7	75	25.0	153	25.3
Total	304	100.0	300	100.0	604	100.0

Table 3.1 demonstrates that there is an equitable distribution of students across grade levels and genders.

3.3. Definition of Key Terms, Concepts and Variables

Conceptual descriptions entail the theoretical understanding or explanation of a term or concept, providing a foundation for comprehension within the study's context (Gay *et al.*, 2012). Operational definitions, on the other hand, offer specific and measurable descriptions of how these concepts or variables are observed and quantified in the study, ensuring clarity and consistency in data collection and analysis (Gay *et al.*, 2012).

The conceptual descriptions and operational definitions of the key terms and variables pertinent to the current study are expressed as follows:

3.3.1. Conceptual Definitions

Concepts related to identities and stereotypical beliefs of STEM disciplines are presented in two sections (3.3.1.1 and 3.3.1.2).

3.3.1.1. Conceptual Definitions Related to STEM Disciplinary Identities.

- STEM Identity: A person's recognition by self and others as being able to be a legitimate participant in STEM or be a STEM person through interest or capabilities (Carlone and Johnson, 2007; Hughes *et al.*, 2013).
- Recognition in STEM domain: Recognition by oneself and others as a proficient STEM student (Dou and Cian, 2022; Hazari *et al.*, 2010).
- Performance-competence in STEM domain: Belief in one's capability to complete essential tasks within the STEM domain and to grasp and comprehend the content pertaining to STEM subjects (Dou and Cian, 2022; Hazari *et al.*, 2010).
- Interest in STEM domain: Desire or curiosity in exploring and understanding concepts and principles within STEM domains (Dou and Cian, 2022; Hazari *et al.*, 2010).

Since this research examines the identities and dimensions of STEM disciplines individually, the definitions provided above have been adjusted accordingly to describe each discipline's identity and dimensions concepts.

- Science/Technology/Engineering/Mathematics Identity: the recognition by oneself and others as a legitimate participant in each STEM domain namely science, technology, engineering, and mathematics, or one's ability to be a person in each domain of STEM through one's interest or abilities.

- Recognition in each domain of STEM (Science, Technology, Engineering, Mathematics): Recognition by oneself and others as a proficient student in each domain of STEM namely science, technology, engineering, and mathematics.
- Performance-competence in each domain of STEM: Belief in one's ability to accomplish essential tasks within each STEM fields and to understand and comprehend related content.
- Interest in each STEM domain: The inclination or curiosity to actively engage in thinking about and comprehending various topics and principles within the fields of STEM.

3.3.1.2. Conceptual Definitions Related to STEM Disciplinary Stereotypical Beliefs.

- STEM stereotypes: Overgeneralized beliefs, often negative, about people in STEM fields (Luo *et al.*, 2021; Matsumoto, 2009; VandenBos, 2015).
- Socioeconomic status (SES) STEM stereotypes: Generalized beliefs about the combination of social and economic factors as income and amount of education affecting people in STEM fields (Aydin *et al.*, 2023).
- Gender related STEM stereotypes: Generalized beliefs about who is considered capable, expected, and typically proficient in science, technology, engineering, and mathematics (STEM) (McGuire *et al.*, 2020).

Since this study investigates stereotypical beliefs related to STEM disciplines individually, the definitions presented above have been modified to articulate stereotypical beliefs concepts for each discipline accordingly.

- Socioeconomic status (ses) related STEM domains stereotypical beliefs: Generalized beliefs concerning how social and economic factors, such as income and level of education, impact individuals within the fields of STEM.
- Gender related STEM domains stereotypical beliefs: Generalized beliefs regarding individuals who are perceived as capable, anticipated, and typically proficient in the STEM fields.

In this study, gender related stereotypical beliefs were examined individually within the context of femininity and masculinity. Hereby, two new concepts are described based on the general definition:

- Feminine stereotypical beliefs: Generalized beliefs that women are perceived as proficient, expected, and generally capable in the STEM fields.
- Masculine stereotypical beliefs: Generalized beliefs that men are perceived as proficient, expected, and generally capable in the STEM fields.

3.3.2. Operational Definitions

The operational definition of each construct involved calculating the total score by summing the scores of all items measuring the construct and subsequently dividing the sum by the number of items.

3.3.2.1. Operational Definitions Related to STEM Disciplinary Identities.

- STEM Identity: One third of the total score derived from responses given to identity dimension of STEM Disciplinary Identities Scale, utilizing a seven-point Likert scale ranging from 1 (it doesn't reflect me at all) to 7 (it reflects me exactly).
- Recognition in STEM: One fourth of the total score derived from responses given to recognition dimension of STEM Disciplinary Identities Scale, utilizing a seven-point Likert scale ranging from 1 (it doesn't reflect me at all) to 7 (it reflects me exactly).
- Performance-competence in STEM: One sixth of the total score derived from responses given performance-competence dimension of STEM Disciplinary Identities Scale, utilizing a seven-point Likert scale ranging from 1 (it doesn't reflect me at all) to 7 (it reflects me exactly).
- Interest in STEM: One fourth of the total score derived from responses given to interest dimension of STEM Disciplinary Identities Scale, utilizing a seven-

point Likert scale ranging from 1 (it doesn't reflect me at all) to 7 (it reflects me exactly).

3.3.2.2. Operational Definitions Related to STEM Disciplinary Stereotypical Beliefs.

- Socioeconomic status (SES) stereotypical beliefs: One sixth of the total score derived from responses given to SES dimension of STEM Disciplinary Stereotypes Scale, utilizing a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).
- Feminine stereotypical beliefs: One third of the total score derived from responses given to feminine dimension of STEM Disciplinary Stereotypes Scale, utilizing a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).
- Masculine stereotypical beliefs: One third of the total score derived from responses given to masculine dimension of STEM Disciplinary Stereotypes Scale, utilizing a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

3.4. Data Collection Instruments

Three data collection tools were used to gather quantitative data addressing the interest of this study.

3.4.1. Demographic Information Form

To be able to better understand some background characteristics of participants the demographic information form was used (see Appendix A). The form comprises 2 main parts. The initial part prompts participants to indicate their gender by selecting one of two options (i.e., male or female). In the subsequent part, participants are asked to specify their grade level in middle school (5th, 6th, 7th, or 8th).

3.4.2. STEM Disciplinary Identities (STEMDIds) Scale

To measure identity and related constructs for each STEM discipline, the Physics Identity scale developed by Cheng *et al.* (2018) and adapted to Turkish by Ulu and Yerdelen-Damar (2022) was utilized. Cheng *et al.* (2018) constructed the original scale for measuring physics identity by incorporating specific items derived from Hazari *et al.*'s (2010) study. Thereafter, the scale was adapted to Turkish and subsequently validated to probe high school students' perceptions of their physics identities and the underlying constructs shaping their identities (Ulu and Yerdelen-Damar, 2022).

The validity of the adapted scale was assessed through CFA, revealing that the results of multiple fit indices fell within the acceptable range. The reliability analysis also yielded satisfactory results. Cronbach's alpha for the overall scale was calculated to be 0.97, with MIIC values ranging from .89 to .97 for its individual dimensions. These findings confirm that the Turkish Physics Identity scale produces valid and reliable results.

This scale comprises four items for interest, six for performance-competence, four for recognition, one for measuring overall physics identity, resulting in a total of 15 items. Each item is rated on an eleven-point Likert scale (0=Not at all to 10=Very much so). Turkish version of the scale was further adapted to measure identity in the four disciplines of STEM, with necessary adjustments made according to the researcher's directions who adapted the original version of the scale.

Since the Physics Identity scale measures identity with a single item, its predictive validity was examined using two adapted items related to self-perception from the STEM Identity scale developed by Hughes and Roberts (2019). Table 3.2 illustrates the dimensions along with one example item for each dimension.

Table 3.2. The dimensions of STEM Disciplinary Identity subscales with one example item for each dimension.

Scale	**STEM Disciplinary Identities**	
Subscale	**Dimension**	**Example Item**
Science Identity	Identity	I see myself as a science person.
	Recognition	My teachers see me as a science person.
	Performance-competence	I am confident that I can understand science.
	Interest	I am interested in learning more about science.
Technology Identity	Identity	I would feel a loss if I were forced to give up doing technology.
	Recognition	My family sees me a tech person.
	Performance-competence	I can do well on questions in technology.
	Interest	Topics in technology excites my curiosity.
Engineering Identity	Identity	Engineering is an important part of my student identity.
	Recognition	My friends or classmates see me an engineering person.
	Performance-competence	I understand concepts I have studied in engineering.
	Interest	I enjoy learning about engineering.
Mathematics Identity	Identity	I see myself as a math person.
	Recognition	Others ask for my advice/input in mathematics.
	Performance-competence	Learning mathematics is comfortable for me.
	Interest	Mathematics is fun for me.

This scale was employed to determine middle school students' identity regarding each discipline of STEM through four dimensions (identity, interest, recognition, performance-competence). The scale contains 17 items for each STEM discipline, 68 items in total (see Appendix B). The items were distributed throughout the scales alongside other items relevant to their respective dimension.

The distribution of the items based on disciplines and dimensions is shown in the Table 3.3.

Table 3.3. Arrangement of identity items according to dimensions and disciplinary scales.

Scale		**STEM Disciplinary Identities**			
		Item Distribution			
Subscale		**Science Identity**	**Technology Identity**	**Engineering Identity**	**Mathematics Identity**
Dimension	**N of Items**				
Identity	3	1, 2, 3	18, 19, 20	35, 36, 37	52, 53, 54
Recognition	4	4, 5, 6, 7	21, 22, 23, 24	38, 39, 40, 41	55, 56, 57, 58
Performance-competence	6	8, 9, 10, 11, 12, 13	25, 26, 27, 28, 29, 30	42, 43, 44, 45, 46, 47	59, 60, 61, 62, 63, 64
Interest	4	14, 15, 16, 17	31, 32, 33, 34	48, 49, 50, 51	65, 66, 67, 68

For each item, participants are expected to rate on a seven-point Likert scale (1=it doesn't reflect me at all to 7=it reflects me exactly). The participants' total scores are calculated individually for each subscale's respective dimensions. The minimum total score achievable for each dimension of four subscales is 1 with a maximum of 7. A high score on the identity dimensions indicates that both the individual and those around him or her perceive that person as inclined towards the related STEM discipline. In other words, higher scores indicate that the individual identifies him/herself as having a strong identity in a STEM discipline.

3.4.3. STEM Disciplinary Stereotypical Beliefs (STEMDSBs) Scale

Aydin *et al.* (2023) developed and validated the STEM Disciplinary Stereotypes Scale (see Appendix C) to assess trait, gender, and socioeconomic status (SES) specific

stereotypical beliefs within each STEM domain. It was noted that stereotypes about STEM have often been explored qualitatively (Fralick *et al.*, 2009; Meador, 2018), with fewer quantitative studies conducted (Garriott *et al.*, 2017; Luo *et al.*, 2021).

Therefore, they aimed to conduct a large-scale assessment. The items were initially constructed based on findings from qualitative literature and empirical studies about STEM education, with the final version of the items refined through pilot studies, observations, and feedback from the field.

In consideration of the literature, the original scale investigates stereotypical beliefs across four disciplines: science, technology, engineering, and mathematics, utilizing four subscales. The items are further categorized into three main dimensions: general beliefs, gender (feminine and masculine), and socioeconomic status for each discipline.

The scale comprises a total of 64 items, with 16 items allocated to each subscale. Each item is rated on a four-point Likert scale, ranging from 1 (Strongly Disagree) to 4 (Strongly Agree).

Confirmatory and exploratory analyses yielded significant results regarding the validity of the subscales. Additionally, the reliability of each subscale was supported by Cronbach's alpha MIIC values (.84 for the Science Stereotypes subscale, .87 for the Technology Stereotypes subscale, .88 for the Engineering Stereotypes subscale, and .86 for the Mathematics Stereotypes subscale).

Based on the purpose of the study, gender and SES dimensions of the scale were only used in the current study. Thus, the scale employed in this study comprises four subscales specific to the four disciplines of STEM, with three dimensions for each subscale. Table 3.4 provides the dimensions along with one example item for each dimension.

Table 3.4. Descriptives statistics of participants.

Scale	**STEM Disciplinary Stereotypical Beliefs**	
Subscale	**Dimension**	**Example Item**
Science	Feminine	A person working in science-related fields is more likely to be a female.
	Masculine	A person working in science-related fields is more likely to be a male.
	Socioeconomic status	The likelihood of having a science-related job is greater for people whose families are middle- and high-income.
Technology	Feminine	Females are generally more talented in technology-related fields.
	Masculine	Males are generally more talented in technology-related fields.
	Socioeconomic status	Technology-related fields generally work better for people whose families are middle- and high-income.
	Feminine	The working conditions of engineering-related jobs are often more suitable for females.
Engineering	Masculine	The working conditions of engineering-related jobs are often more suitable for males.
	Socioeconomic status	The likelihood of having an engineering-related job is greater for people whose families are well-educated.
	Feminine	A person working in mathematics-related fields is more likely to be a female.
Mathematics	Masculine	A person working in mathematics-related fields is more likely to be a male.
	Socioeconomic status	Mathematics-related fields are generally preferred by people whose families are well-educated.

At the beginning of each subscale, examples of professions and projects associated with the relevant discipline are provided so that students can have an idea about the activities and implementations within that discipline. There are 12 items in each subscale and 48 items in total. Among these, 6 of the 12 items measure stereotypical beliefs re-

lated to the gender participation (3 items for feminine stereotypical beliefs and 3 items for masculine stereotypical beliefs), while the remaining 6 items assess stereotypical beliefs related to socioeconomic status. The items were interspersed throughout the subscales alongside other items relevant to their respective dimension. The distribution of the items based on disciplines and dimensions is shown in the Table 3.5.

Table 3.5. Arrangement of stereotype/ stereotypical beliefs items according to dimensions and disciplinary scales.

Scale		**STEM Disciplinary Stereotypical Beliefs**			
		Item Distribution			
Subscale		**Science**	**Technology**	**Engineering**	**Mathematics**
Dimension	**N of Items**				
Gender					
Feminine	3	1, 3, 5	13, 15, 17	25, 27, 29	37, 39, 41
Masculine	3	2, 4, 6	14, 16, 18	26, 28, 30	38, 40, 42
Socioeconomic Status	6	7, 8, 9, 10, 11, 12	19, 20, 21, 22, 23, 24	31, 32, 33, 34, 35, 36	43, 44, 45, 46, 47, 48

For each item, participants rate on a seven-point Likert scale (1=strongly disagree to 7=strongly agree). The minimum total score to be obtained on each feminine and masculine subdimension and SES dimension of the subscales is 1, with a maximum score of 7. Higher scores point out having the stereotypical beliefs associated with the relevant dimension of the STEM discipline.

3.5. Procedure

The literature was carefully reviewed to identify the subject and research questions of this thesis. In line with the established purpose, it was decided to utilize a set of measurement tools comprising: demographic form, STEM Disciplinary Identity scale and STEM Disciplinary Stereotypical Beliefs scale.

Initially, the Turkish version of the Physics Identity scale (Ulu and Yerdelen-Damar, 2022) was adapted for implementation across four STEM disciplines. This adaptation process commenced with the acquisition of permission from the researchers who adapted and validated the scale. Adapting the forecited scale for this study involves modifying the contextual situation of the items, the target audience, response options, and the number of items. As the items originally measure within the context of physics, their contextual framework was altered from physics discipline to science/technology/engineering/mathematics discipline. Then, to be able to adequately appeal to middle school students, the items were also structured with consideration given to their education level. For instance, instead of the phrase "I can do well on exams in engineering", a revised statement "I can be successful in questions that require engineering knowledge" was formulated. Another change was made to the response structure. The 11-point Likert scale has been revised to a 7-point scale. This adjustment tends to provide an adequate number of distinctions without necessitating an excessive number of response options. Furthermore, two additional items from Self-perception sub-scale of STEM Identity (Hughes and Roberts, 2019) scale were reconstructed and incorporated into the identity dimension. This adjustment was made because relying on single-item measures can restrict the precision of the assessment. By incorporating additional items, the measurement becomes more robust and can offer a more accurate reflection of individuals' perceptions within the STEM identity framework. All these adaptations were implemented in accordance with the suggestions provided by one of the researchers who validated the Physics Identity scale in Turkish. Ultimately, this expert assessed the scale alongside another expert, evaluating its language and meaning, and confirmed its suitability for use in the research. By following this whole process, the scale's content validity was ensured.

Secondly, for the purpose of this study, gender and SES participation dimensions of the STEM Disciplinary Stereotypes scale (Aydin *et al.*, 2023) were used in this study.

Thirdly, the choice of demographic variables was informed by existing literature. Recognizing the significant impact of gender on STEM identities and stereotypical

beliefs, it was deemed crucial to include it in the investigation. In addition, it was planned to explore differences among the middle school students based on their grade levels.

With the intent of investigating the relation between gender, grade level, STEM stereotypical beliefs, and identity-related factors with middle school students' STEM identity, the demographic form, STEM Identity, and STEM Stereotypical Beliefs scales were administered simultaneously.

Prior to collecting the data for adaptation and statistical analyses, the necessary research permissions were acquired. This thesis study was found appropriate by Science and Engineering Fields Human Research Ethics Committee (FMINAREK) of Boğaziçi University (see Appendix D) and Ministry of National Education (see Appendix E) in terms of participants' physiological and psychological health and safety, current legal provisions, human rights and doctrines of ethics and law. Then, permission for the research was sought by contacting the administrative unit of the selected schools selected with convenient sampling. Additionally, permission was obtained from teachers of eligible classes to conduct the study within their classrooms. Before data collection commenced, a consent form (see Appendix F) was sent to the parents of the students, requesting permission for their children's participation in the research. Students whose parental consent was secured were then asked to provide verbal consent. Once all permissions were obtained, data were collected from participants in a single session, with approximately 40 minutes of class time allocated for administering the measurement tools. Data were collected anonymously based on the principle of volunteering. This data is securely stored within a locked file on the computer of the researcher.

3.6. Internal Validity

The present study systematically addressed potential threats to internal validity to guarantee its methodological rigor. This approach aimed to establish a precise structure, thereby ensuring that any observed differences in the dependent variable

were directly linked to the independent variables under investigation and that the study's results accurately reflect the characteristics of the studied group (Gay *et al.*, 2012).

In this study, the focus was on addressing "subject characteristics", "loss of subjects", "location", "instrumentation" as well as "testing", all of which were among the threats described in detail by Fraenkel *et al.* (2012). In terms of the first threat, control was made for the variables gender and class level (as indicators of age and education level) to ensure that differences in the characteristics of study participants did not lead to undesirable variations in the variables being examined. The threat of loss of participants was also mitigated since the scales were administered simultaneously and data were collected from all students at once. To address the third threat, careful consideration was given to maintaining consistency in the classroom environments where the scales were administered. This was done to prevent any potential influence of the setting on participants' responses. For another threat, instrumentation, three significant criteria were carefully considered. To mitigate instrument decay, both the number and content of items were standardized for each identity scale and stereotype scale. By preventing students from reading different items for each STEM discipline and therefore getting tired, items of the same type were scored on the basis of these disciplines. Due to the researcher mostly conducting the data collection process with minimal interaction, the potential influence of the data collector characteristics on the research was also minimized. Furthermore, the process was standardized by allocating a fixed time for the application process and ensuring consistent explanations about the study were provided before each application. Thus, the formation of biases originating from the data collector was prevented as much as possible. As this was a correlational study, there was a possibility that students' awareness of the relationship between the variables being investigated could influence their responses. Therefore, for the last concern testing, explanations or implications that could potentially lead students to infer that the research aimed to establish a relationship were deliberately avoided.

3.7. Data Analysis

Once the instruments are completed by the participants, the resulting data was individually organized, tabulated and entered into a spreadsheet on the computer. In this spreadsheet, the names of each variable were placed in columns and each student's record was listed horizontally according to student number. Codes were determined for the categorical variables (e.g. gender, grade level) of the study and range scores were determined for the continuous variables (e.g. science identity score, technology recognition score, feminine stereotypes score in mathematics).

Before conducting the analysis, missing data were addressed to ensure the accuracy of statistical analysis, as their presence could compromise precision. Upon examination, it was found that the percentage of missing data ranged from .2 to .7 per item. It was decided to address the missing MIIC values by imputation strategy so that all participants would be included in the analysis. Initially, the data was split into two sub-files based on gender with the split file command in Statistical Package for Social Sciences (SPSS). After that, the missing MIIC values were substituted with the mean of the respective item. Explanations concerning the analyses carried out in this study are provided in sections 3.7.1, 3.7.2, and 3.7.3, respectively.

3.7.1. Analyzing the Factor Structure of the Adapted STEM Disciplinary Identities Scale

CFA using Mplus 8.8 (Muthén and Muthén, 1998-2017) was employed to evaluate the construct validity of participants' responses to the dimensions within each subscale of the STEM Disciplinary Identities scale. In other words, four CFAs were conducted to test whether the proposed four-dimensional framework of each subscale of STEM Disciplinary Identities scale aligned with the collected data.

3.7.2. Reliability Analyses

Cronbach's alpha and mean interitem correlation (MIIC) were utilized to estimate the reliability of both STEM Disciplinary Identity scale and STEM Disciplinary Stereotypical Beliefs scale. The analyses were conducted in two phases using SPSS 29 (Statistical Package for Social Sciences). To be able to examine overall consistency of the measurement, Cronbach's alpha coefficient was initially computed for each subscale and dimensions of these scales. It is important to acknowledge that Cronbach's alpha coefficient can be sensitive to the scale's short length. In that sense, the dimensions associated with identity and stereotypical beliefs in this study are constructed as mini scales with a restricted number of items. Therefore, it is advisable to calculate MIIC as an alternative measure. MIIC provides a reliability estimate independent of the scale's length, thus offering a more robust assessment for shorter scales (Briggs and Cheek, 1986). Thus, in the second phase, MIIC value was computed for all dimensions to gauge the internal consistency among the items.

3.7.3. Descriptive and Inferential Statistics

In this research, quantitative analysis was conducted since only quantitative data was collected. The data was analyzed with descriptive and inferential statistical methods using SPSS 29. These statistical methods enable to describe, synthesize, analyze, and interpret the data. While descriptive statistics was used to describe, summarize, and present the scores in a meaningful way, inferential statistics enable to make inferences and interpretation about how similar is the results of the sample that if they were taken from the entire population (Gay, *et al.*, 2012; Privitera, 2023). Descriptive and inferential statistics were performed for the four disciplines of STEM separately.

3.7.3.1. Descriptive Statistics. Descriptive analyses were conducted for the first and second questions of the study. The first question aimed to explore middle school students' identities concerning STEM disciplines and their profiles in identity-related dimensions. Initially, the mean MIIC values of students' identities, recognition, performance-

competence, and interest dimensions were examined. Secondly, the analysis explored how these mean MIIC values differed based on students' gender. Finally, the mean MIIC values of these dimensions were examined according to grade levels. These analyses, conducted in three phases, were also performed for the dimensions of STEM stereotypical beliefs investigated in the second question of the research. Thus, the mean MIIC values of students regarding the dimensions of feminine, masculine, and SES stereotypical beliefs were examined both overall and according to gender and grade level, respectively. The reasoning behind prioritizing mean MIIC values in these analyses is multifaceted. Firstly, focusing on mean MIIC values simplifies the interpretation of data, especially when dealing with relatively large sample sizes like in this study (Gay *et al.*, 2012). Secondly, averaging offers a typical or highly reflective representation of the data (Gay *et al.*, 2012). Moreover, it encompasses information from every data point within the dataset (Gay *et al.*, 2012).

3.7.3.2. Inferential Statistics. The study conducted interpretive statistics specifically for the third research question, which focuses on exploring how stereotypical beliefs held by middle school students predict their identity across four STEM disciplines. To investigate this relationship, four separate hierarchical multiple regression analysis were employed. Hierarchical regression involves adding independent variables to the model in a predetermined sequence based on theoretical reasoning (Pallant, 2016). These variables are introduced in steps, with each new addition evaluated for its contribution to predicting the dependent variable, while considering the influence of previously included variables. The preliminary analyses described in section 4.3.1.1 were carried out to check whether the assumptions underlying hierarchical multiple regression analysis were met. This was crucial to maintain the integrity of the results and ensure their accurate interpretation, as such violations could potentially influence both the outcomes and the interpretation of the results obtained from the analysis (Pallant, 2016). Prior to conducting the analyses, dummy variables were generated for the categorical variables of gender and grade levels. This step ensured that these variables could be incorporated into the regression model for analysis. The group characterized by the lower mean value was designated as 0 and identified as the reference group. In this

regard, the reference group for the gender variable was established as girls, and for grade levels, being an 8th grade student was designated as the reference group. Consequently, one dummy variable was created to represent gender, while three separate dummy variables were generated to represent being a student at different grade levels. This approach facilitates the analysis and interpretation of the regression results.

The hierarchical multiple regression analysis employed in this study consisted of three sequential steps. Independent variables were systematically incorporated into the analysis in predetermined order. In the initial block (step or model), the demographic variables, gender and grade level, were entered into the analysis, with the aim of statistically controlling these variables. In block 2 of the analysis, the four dummy variables representing gender and grade levels were entered along with stereotypical beliefs dimensions, including feminine, masculine, and SES stereotypical beliefs variables. The dimensions of identity, recognition, performance-competence, and interest were combined with the variables from the second block and entered into block 3 of the analysis.

4. RESULTS

This chapter contains the results of all analyzes performed within the scope of the research. Initially, CFA of the adapted identity scale and the reliability analyses results of the research instruments were discussed. Following this, descriptive analyses were presented for the first and second research questions. Finally, inferential statistics, specifically hierarchical multiple regression results, were provided for the third research question.

4.1. Confirmatory Factor Analysis Results for the Measurement Model of STEM Disciplinary Identities Scale

Concerning the initial stage of the analyses, the sample size should ideally be a minimum of 200 for CFA as an essential component of Structural Equation Modeling (SEM) (Barrett, 2007).

The factor structure of the model related to STEM Disciplinary Identities scale was evaluated by conducting CFA via Mplus 8.8 (Muthén and Muthén, 1998-2017). This was to reveal how well the proposed factor structure, comprising recognition, performance-competence, interest, and identity constructs, matched the observed data. In that sense, multiple fit indices, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) were calculated to assess the fitness of the factor structure to the data.

The literature offers the rules of thumb to consider model fit. While CFI $\geq$ 0.95, TLI $\geq$ 0.95, RMSEA $\leq$ 0.05 and SRMR $\leq$ 0.05 indicate a good fit, CFI $\geq$ 0.90, TLI $\geq$ 0.90, RMSEA $\leq$ 0.08 and SRMR $\leq$ 0.10 indicate an acceptable fit (Hu and Bentler, 1999; Marsh *et al.*, 2004). Furthermore, the models were not assessed using Chi-square due to its sensitivity to sample sizes surpassing 250 (Bentler and

Bonett, 1980). Chi-square tests commonly yield statistically significant results with large samples (Schumacker and Lomax, 2016).

Table 4.1 displays the MIIC values of multiple fit indices for the subscales of STEM Disciplinary Identities Scale. According to the rule of thumb for multiple fit indices, TLI, CFI, and SRMR demonstrated a good fit for each STEM discipline, while the RMSEA MIIC values remained within an acceptable range.

Table 4.1. Fit indices for the measurement model of each subscale within STEM disciplinary identities scale.

Subscale	**TLI**	**CFI**	**RMSEA (90% CI)**	**SRMR**
Science Identity	0.957	0.964	0.058 (0.051-0.065)	0.032
Technology Identity	0.958	0.965	0.063 (0.056-0.070)	0.031
Engineering Identity	0.969	0.974	0.055 (0.048-0.062)	0.025
Mathematics Identity	0.960	0.967	0.070 (0.064-0.077)	0.024

Note: TLI: Tucker Lewis index,

CFI: Comparative fit index,

RMSEA: Root Mean Square Error of Approximation,

SRMR: Standardized Root Mean Square Residual;

CI: Confidence Interval

The standardized factor loadings for the Science Identity Scale's items, as displayed in Table 4.2, ranged from 0.74 to 0.78 for Factor 1; 0.71 to 0.78 for Factor 2; 0.68 to 0.82 for Factor 3; and 74 to 0.82 for Factor 4. Item 13 demonstrates a good factor loading, surpassing the cut-off 0.63, whereas the other items exhibit excellent factor loadings, exceeding the cut-off 0.71. (Comrey and Lee, 1992; Tabachnick and Fidell, 2013). The correlations between items and factors were all statistically significant ($p < 0.05$).

Table 4.2. Factor loading results of science identity scale.

Factor	**Indicator**	**Factor Loading**	**SE**	**p value**
1.Identity	Item 1	0.78*	0.02	0.000
	Item 2	0.74*	0.02	0.000
	Item 3	0.76*	0.02	0.000
2.Recognition	Item 4	0.78*	0.02	0.000
	Item 5	0.76*	0.02	0.000
	Item 6	0.78*	0.02	0.000
	Item 7	0.71*	0.02	0.000
3.Performance-competence	Item 8	0.78*	0.02	0.000
	Item 9	0.82*	0.01	0.000
	Item 10	0.81*	0.02	0.000
	Item 11	0.79*	0.02	0.000
	Item 12	0.76*	0.02	0.000
	Item 13	0.68*	0.02	0.000
4.Interest	Item 14	0.74*	0.02	0.000
	Item 15	0.80*	0.02	0.000
	Item 16	0.82*	0.02	0.000
	Item 17	0.81*	0.02	0.000
*$p< 0.05$				

The standardized factor loadings for the Technology Scale's items, as displayed in Table 4.3, ranged from 0.78 to 0.84 for Factor 1; 0.73 to 0.79 for Factor 2; 0.73 to 0.82 for Factor 3; and 78 to 0.88 for Factor 4. The factor loading value of every item is excellent as it is above the cut-off value of 0.71 (Comrey and Lee, 1992; Tabachnick and Fidell, 2013). All the correlations between items and factors were found to be statistically significant ($p< 0.05$).

Table 4.3. Factor loading results of technology identity scale.

Factor	**Indicator**	**Factor Loading**	**SE**	**p value**
1.Identity	Item 18	0.78*	0.02	0.000
	Item 19	0.84*	0.02	0.000
	Item 20	0.81*	0.02	0.000
2.Recognition	Item 21	0.78*	0.02	0.000
	Item 22	0.79*	0.02	0.000
	Item 23	0.79*	0.02	0.000
	Item 24	0.73*	0.02	0.000
3.Performance-competence	Item 25	0.82*	0.01	0.000
	Item 26	0.73*	0.02	0.000
	Item 27	0.80*	0.02	0.000
	Item 28	0.82*	0.02	0.000
	Item 29	0.82*	0.02	0.000
	Item 30	0.75*	0.02	0.000
4.Interest	Item 31	0.88*	0.01	0.000
	Item 32	0.86*	0.01	0.000
	Item 33	0.88*	0.01	0.000
	Item 34	0.78*	0.02	0.000
*$p< 0.05$				

The standardized factor loadings for the Engineering Scale's items, as displayed in Table 4.4, ranged from 0.77 to 0.91 for Factor 1; 0.78 to 0.85 for Factor 2; 0.76 to 0.85 for Factor 3; and 81 to 0.86 for Factor 4. Every item's factor loading is excellent, exceeding the threshold of 0.71 (Comrey and Lee, 1992; Tabachnick and Fidell, 2013). All correlations between items and factors were statistically significant ($p< 0.05$).

Table 4.4. Factor loading results of engineering identity scale.

Factor	**Indicator**	**Factor Loading**	**SE**	**p value**
1.Identity	Item 35	0.77*	0.02	0.000
	Item 36	0.91*	0.01	0.000
	Item 37	0.84*	0.01	0.000
2.Recognition	Item 38	0.85*	0.01	0.000
	Item 39	0.84*	0.01	0.000
	Item 40	0.81*	0.02	0.000
	Item 41	0.78*	0.02	0.000
3.Performance-competence	Item 42	0.79*	0.02	0.000
	Item 43	0.83*	0.01	0.000
	Item 44	0.85*	0.01	0.000
	Item 45	0.78*	0.02	0.000
	Item 46	0.83*	0.01	0.000
	Item 47	0.76*	0.02	0.000
4.Interest	Item 48	0.84*	0.01	0.000
	Item 49	0.85*	0.01	0.000
	Item 50	0.86*	0.01	0.000
	Item 51	0.81*	0.02	0.000
*$p< 0.05$				

The standardized factor loadings for the Mathematics Scale's items, as displayed in Table 4.5, ranged from 0.83 to 0.86 for Factor 1; 0.80 to 0.88 for Factor 2; 0.79 to 0.88 for Factor 3; and 86 to 0.89 for Factor 4. All of the items' factor loadings are excellent, surpassing the threshold of 0.71 (Comrey and Lee, 1992; Tabachnick and Fidell, 2013). The correlations between items and factors were all statistically significant ($p< 0.05$).

Table 4.5. Factor loading results of mathematics identity scale.

Factor	**Indicator**	**Factor Loading**	**SE**	**p value**
1.Identity	Item 52	0.83*	0.01	0.000
	Item 53	0.86*	0.01	0.000
	Item 54	0.86*	0.01	0.000
2.Recognition	Item 55	0.88*	0.01	0.000
	Item 56	0.86*	0.01	0.000
	Item 57	0.87*	0.01	0.000
	Item 58	0.80*	0.02	0.000
3.Performance-competence	Item 59	0.84*	0.01	0.000
	Item 60	0.88*	0.01	0.000
	Item 61	0.87*	0.01	0.000
	Item 62	0.84*	0.01	0.000
	Item 63	0.81*	0.01	0.000
	Item 64	0.79*	0.02	0.000
4.Interest	Item 65	0.86*	0.01	0.000
	Item 66	0.88*	0.01	0.000
	Item 67	0.89*	0.01	0.000
	Item 68	0.86*	0.01	0.000
*$p< 0.05$				

Figure 4.1, Figure 4.2, Figure 4.3 and Figure 4.4 present the factor structure of the adapted subscales respectively. Each subscale exhibits a four-dimensional structure similar to that of the original scale.

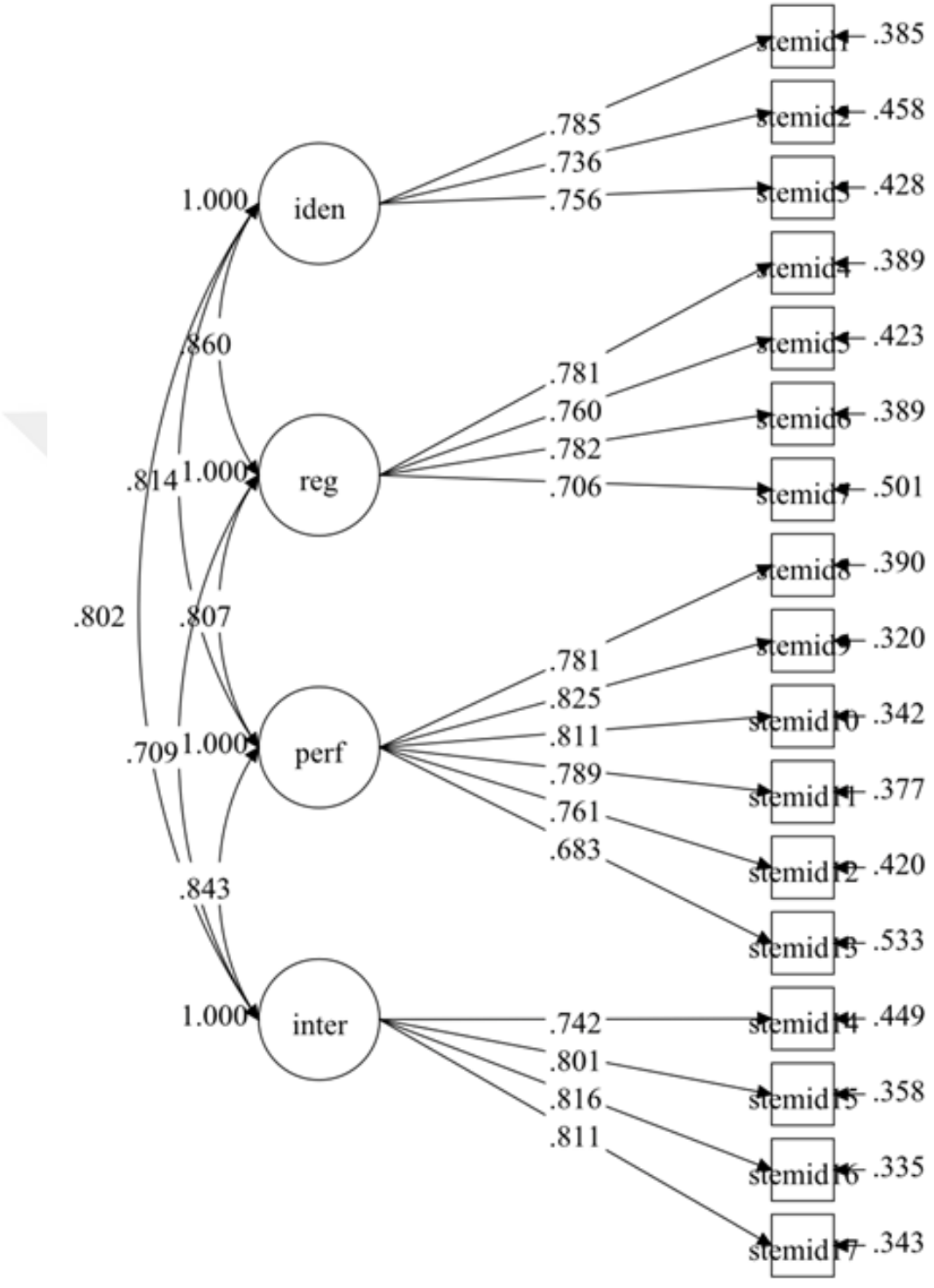

Figure 4.1. Factor structure of science identity scale. iden: identity, reg: recognition, per: performance-competence, inter: interesty.

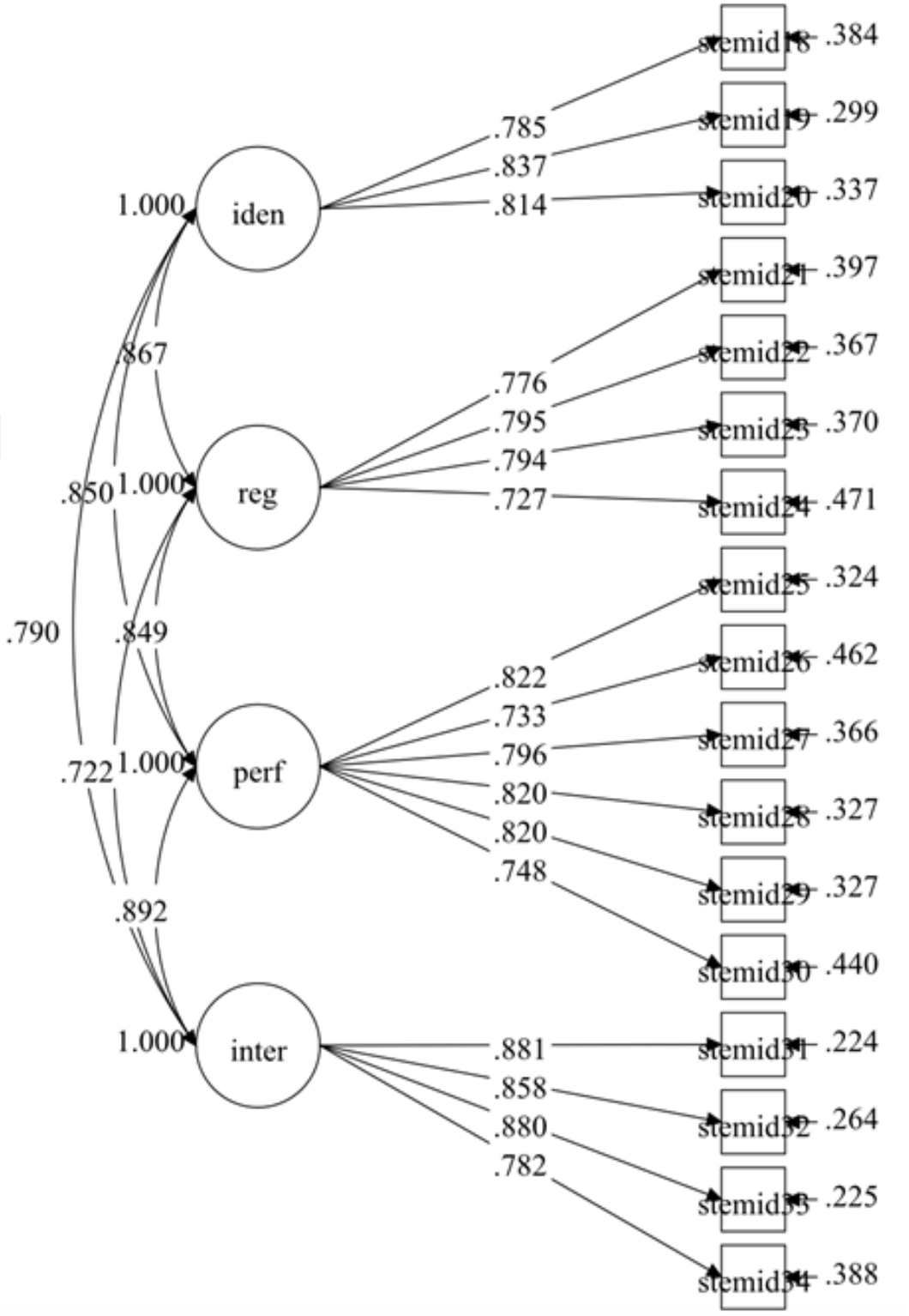

Figure 4.2. Factor structure of technology identity scale. iden: identity, reg: recognition, per: performance-competence, inter: interest.

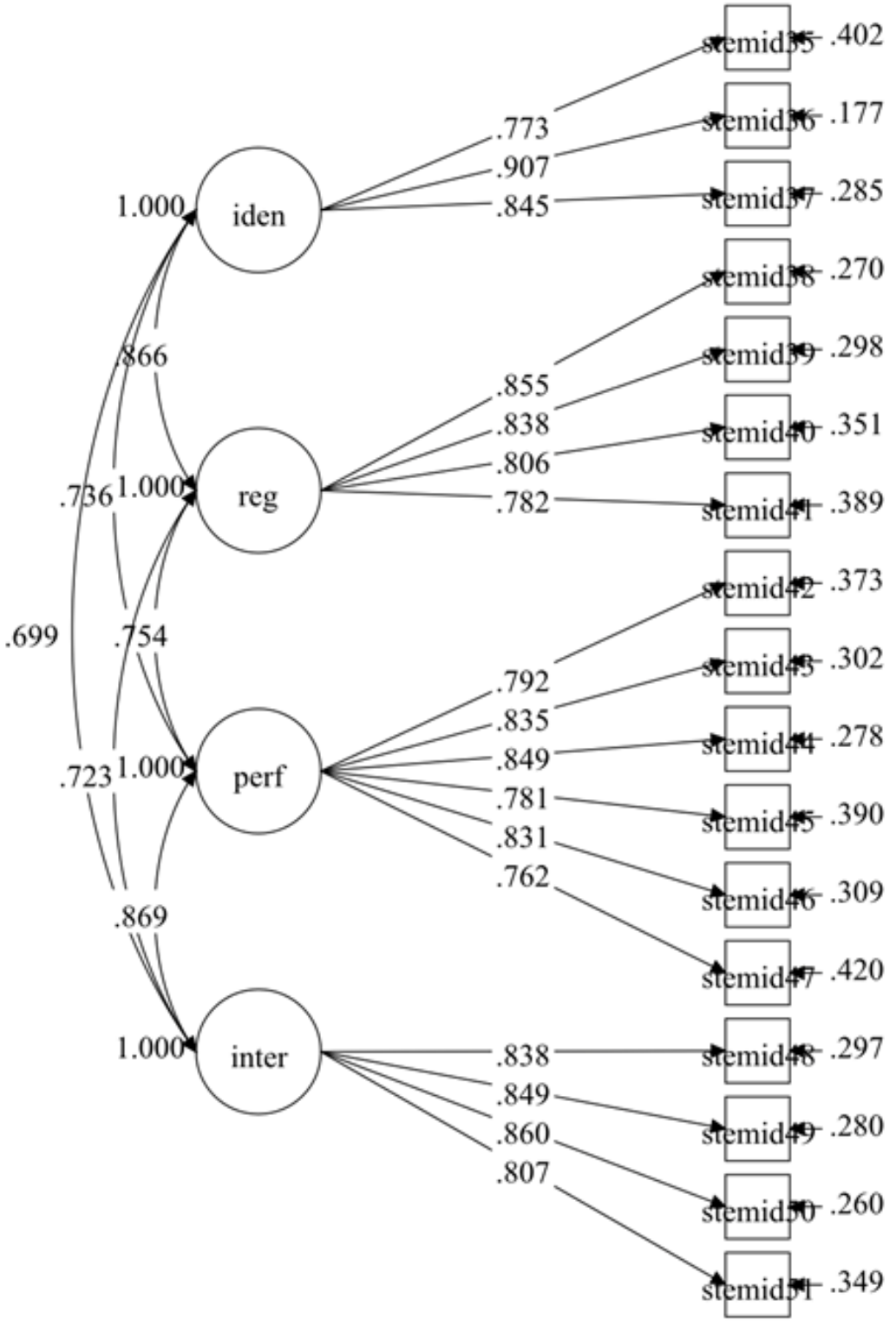

Figure 4.3. Factor structure of engineering identity scale. iden: identity, reg: recognition, per: performance-competence, inter: interest.

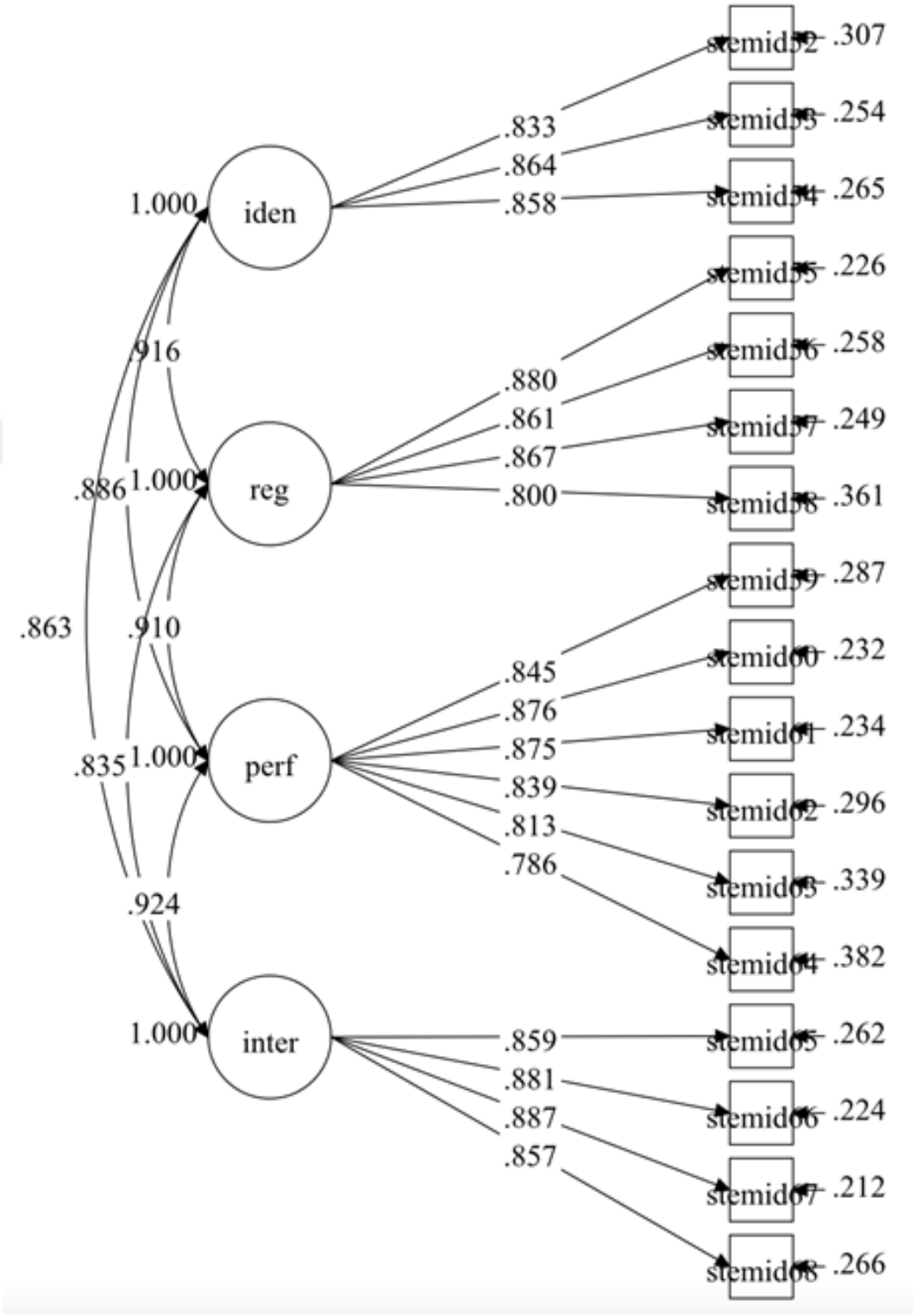

Figure 4.4. Factor structure of mathematics identity scale. iden: identity, reg: recognition, per: performance-competence, inter: interest.

4.2. Reliability Analysis Results

For internal consistency, it is considered that Cronbach's Alpha lower than 0.70 is unacceptable; between 0.70 and 0.79 is fair; between 0.80-0.89 is good; 0.90 and above is excellent (Cicchetti, 1994). Additionally, a minimum MIIC magnitude of 0.20 was suggested to ensure reliable results (Briggs and Cheek, 1986).

Table 4.6 reports the Cronbach's Alpha coefficient as a reliability value for both subscales of STEM Disciplinary Identities and their dimensions. The Cronbach's alpha coefficient for the first subscale, Science Identity, and its dimensions ranges from 0.81 to 0.95. The entire scale and performance-competence dimension demonstrate excellent internal consistency with coefficients 0.95 and 0.90 respectively. This value of 0.81 for identity dimension, 0.84 for recognition and 0.88 for interest indicates that they have good internal consistency. For the second subscale, Technology Identity, and its four dimensions, Cronbach's alpha coefficient ranges from 0.85 to 0.96. The overall scale, performance-competence and interest have excellent internal consistency, with a reported Cronbach's alpha coefficient of 0.96, 0.91 and 0.91, respectively. On the other hand, the identity dimension with a reliability coefficient of 0.85 and recognition with 0.86 display a good internal consistency. The Cronbach's alpha coefficient for the third subscale, Engineer Identity, and its dimensions falls within the range of 0.87 to 0.96. The internal consistency of the overall scale, performance, and interest dimensions is excellent, with coefficients of 0.96, 0.92, and 0.90, respectively. Interest and recognition exhibit good internal consistency, with coefficients of 0.87 and 0.89, respectively. The Cronbach's alpha coefficient for the Mathematics Identity subscale and its dimensions ranged from 0.89 to 0.91. While only the identity dimension, with a reported Cronbach's alpha coefficient of 0.89, demonstrates good internal consistency, the entire scale, along with recognition, performance-competence, and interest, exhibit excellent internal consistency, with reliability MIIC values of 0.97, 0.91, 0.93, and 0.93, respectively.

Table 4.6 also indicates that the MIIC MIIC values for all dimensions within the subscales exceeded the threshold of 0.20. This finding suggests that the reliability level of each dimension was satisfactory.

Table 4.6. Reliability statistics for STEM disciplinary identity.

Scale	**STEM Disciplinary Identities**			
Subscale	**Dimension**	**Cronbach's Alpha**	**MIIC**	**N of Items**
Science Identity		0.95		17
	Identity	0.81	0.58	3
	Recognition	0.84	0.57	4
	Performance-competence	0.90	0.65	6
	Interest	0.88	0.60	4
Technology Identity		0.96		17
	Identity	0.85	0.66	3
	Recognition	0.86	0.60	4
	Performance-competence	0.91	0.62	6
	Interest	0.91	0.72	4
Engineering Identity		0.96		17
	Identity	0.87	0.70	3
	Recognition	0.89	0.67	4
	Performance-competence	0.92	0.65	6
	Interest	0.90	0.70	4
Mathematics Identity		0.97		17
	Identity	0.89	0.72	3
	Recognition	0.91	0.72	4
	Performance-competence	0.93	0.70	6
	Interest	0.93	0.76	4

Table 4.7 presents the Cronbach's Alpha coefficient as a reliability value for both subscales of STEM Disciplinary Stereotypical Beliefs and their respective dimensions.

The Cronbach's alpha coefficient for each subscale and their dimensions ranges as follows: 0.82 to 0.84; 0.84 to 0.86; 0.82 to 0.89; and 0.84 to 0.89, respectively. These MIIC values suggest that each subscale and their dimensions exhibit good internal consistency. As also seen in Table 4.7, the reliability level of all dimensions is satisfactory, with MIIC MIIC values exceeding the critical value of 0.20.

Table 4.7. Reliability statistics for STEM disciplinary stereotypical beliefs.

Scale	**STEM Disciplinary Stereotypical Beliefs**			
Subscale	**Dimension**	**Cronbach's Alpha**	**MIIC**	**N of Items**
Science Stereotypes		0.84		12
	Gender			
	Feminine	0.82	0.60	3
	Masculine	0.82	0.60	3
	Socioeconomic Status	0.84	0.47	6
Technology Stereotypes		0.85		12
	Gender			
	Feminine	0.84	0.63	3
	Masculine	0.86	0.67	3
	Socioeconomic Status	0.86	0.51	6
Engineering Stereotypes		0.84		12
	Gender			
	Feminine	0.82	0.61	3
	Masculine	0.87	0.68	3
	Socioeconomic Status	0.89	0.57	6

Table 4.7 Reliability statistics for STEM disciplinary stereotypical beliefs. (cont.)

Scale	**STEM Disciplinary Stereotypical Beliefs**			
Subscale	**Dimension**	**Cronbach's Alpha**	**MIIC**	**N of Items**
Mathematics Stereotypes		0.85		12
	Gender			
	Feminine	0.87	0.69	3
	Masculine	0.84	0.64	3
	Socioeconomic Status	0.89	0.56	6

4.3. Descriptive Statistics Results Related to Research Question 1 and Research Question 2

4.3.1. Descriptive Statistics Results Related to STEM Disciplinary Identities

The primary research question aimed to explore the profile of middle school students regarding STEM disciplinary identities on the basis of relevant dimensions. To achieve this objective, the profile of students was examined through descriptive analysis in general, as well as specifically based on gender and grade level.

Table 4.8, Table 4.11, Table 4.14 and Table 4.17 displays the minimum and maximum scores achievable for the dimensions of identity, alongside the average value, denoted as mean (M), and the standard deviation value (SD), indicating the degree of deviation of the group's scores from this mean.

Table 4.9, Table 4.12, Table 4.15 and Table 4.18 presents the total number of observations, mean and standard deviation MIIC values separately by gender for the dimensions of identity, recognition, performance-competence, and interest within the context of disciplinary Identity.

Table 4.10, Table 4.13, Table 4.16, Table 4.19, provides the total number of individuals, means and standard deviations for each of the disciplinary identity dimensions, categorized by grade level.

According to Table 4.8, the mean scores for only interest and performance - competence dimensions of science identity are higher than the midpoint. The mean MIIC values of the science identity's dimensions, from highest to lowest, are interest (M=4.15, SD=1.78), performance-competence (M=4.14, SD=1.62), identity (M=3.74, SD=1.69), and recognition (M=3.71, SD=1.62).

Table 4.8. Descriptive statistics for science identity.

Scale	**Science Identity**			
Dimension	**Minimum**	**Maximum**	**Mean**	**SD**
Identity	1.00	7.00	3.74	481.69
Recognition	1.00	7.00	3.71	1.62
Performance-competence	1.00	7.00	4.14	1.62
Interest	1.00	7.00	4.15	1.78

As indicated in Table 4.9, the mean value for performance-competence and interest dimensions of science identity is above the midpoint for both male and female students. Except for the recognition dimension, the higher mean MIIC values in all dimensions belong to female. While the highest mean value was obtained by female in the performance-competence dimension (M=4.22, SD=1.62), the lowest mean value (M=3.71, SD=1.62) was again obtained by female in the recognition dimension.

Table 4.9. Descriptive statistics of science identity by gender.

Scale	**Science Identity**			
Gender	**Dimension**	**N**	**M**	**SD**
Female	Identity	303	3.77	1.72
Male		299	3.71	1.67

Table 4.9 Descriptive statistics of science identity by gender. (cont.)

Scale	**Science Identity**			
Gender	**Dimension**	**N**	**M**	**SD**
Female	Recognition	303	3.70	1.62
Male		298	3.71	1.63
Female	Performance-competence	303	4.22	1.62
Male		297	4.05	1.61
Female	Interest	301	4.20	1.84
Male		300	4.09	1.71

Table 4.10 reveals that among different grade levels, 5th grade students attained the highest mean scores across all dimensions of science identity. Specifically, 5th grade students achieved the highest mean score in the interest dimension (M=4.90, SD=1.72), whereas 6th grade students obtained the lowest mean score in the identity dimension (M=3.28, SD=1.59).

Table 4.10. Descriptive statistics of science identity by grade level.

Scale	**Science Identity**			
Grade Level	**Dimension**	**N**	**M**	**SD**
5th Grade	Identity	150	4.64	1.52
6th Grade		149	3.28	1.59
7th Grade		150	3.57	1.65
8th Grade		153	3.47	1.68
5th Grade	Recognition	150	4.30	1.44
6th Grade		149	3.38	1.63
7th Grade		149	3.73	1.58
8th Grade		153	3.41	1.68
5th Grade	Performance-competence	150	4.75	1.44
6th Grade		149	3.83	1.61
7th Grade		149	4.08	1.58
8th Grade		152	3.89	1.66

Table 4.10 Descriptive statistics of science identity by grade level. (cont.)

Scale	**Science Identity**			
Grade Level	**Dimension**	**N**	**M**	**SD**
5th Grade	Interest	149	4.90	1.72
6th Grade		148	3.71	1.66
7th Grade		151	4.24	1.78
8th Grade		153	3.73	1.69

Based on the data presented in Table 4.11, the mean scores for all four dimensions of technology identity exceed the midpoint. Performance-competence in technology exhibits the highest mean score (M=4.42, SD=1.67), while the sense of recognition in technology records the lowest (M=4.12, SD=1.69).

Table 4.11. Descriptive statistics for technology identity.

Scale	**Technology Identity**			
Dimension	**Minimum**	**Maximum**	**Mean**	**SD**
Identity	1.00	7.00	4.36	1.81
Recognition	1.00	7.00	4.12	1.69
Performance-competence	1.00	7.00	4.42	1.67
Interest	1.00	7.00	4.41	1.83

According to the data provided in Table 4.12, except for the mean value of female's recognition dimension, the mean MIIC values for technology identity dimensions are above the midpoint for both male and female students. With the exception of the interest dimension, male students generally exhibit higher mean MIIC values across all dimensions. The performance-competence dimension records the highest mean value among males (M=4.50, SD=1.71), while the recognition dimension demonstrates the lowest mean value among females (M=3.91, SD=1.62).

Table 4.12. Descriptive statistics of technology identity by gender.

Scale	**Technology Identity**			
Gender	**Dimension**	**N**	**M**	**SD**
Female	Identity	303	4.24	1.81
Male		300	4.48	1.81
Female	Recognition	303	3.91	1.62
Male		296	4.32	1.73
Female	Performance-competence	298	4.35	1.63
Male		297	4.50	1.71
Female	Interest	302	4.42	1.85
Male		298	4.41	1.80

According to Table 4.13, it is evident that among various grade levels, 7th grade students achieved the highest mean scores across all dimensions of technology identity. Particularly, 7th grade students attained the highest mean score in the interest dimension (M=4.64, SD=1.79), while 6th grade students recorded the lowest mean score in the recognition dimension (M=3.85, SD=1.81).

Table 4.13. Descriptive statistics of technology identity by grade level.

Scale	**Technology Identity**			
Grade Level	**Dimension**	**N**	**M**	**SD**
5th Grade	Identity	150	4.50	1.73
6th Grade		149	3.99	1.87
7th Grade		151	4.60	1.85
8th Grade		153	4.35	1.77
5th Grade	Recognition	147	3.97	1.56
6th Grade		149	3.85	1.81
7th Grade		150	4.45	1.64
8th Grade		153	4.20	1.69
5th Grade	Performance-competence	146	4.49	1.64
6th Grade		149	4.09	1.75
7th Grade		149	4.61	1.66
8th Grade		151	4.50	1.61
5th Grade	Interest	151	4.46	1.89
6th Grade		148	4.12	1.85
7th Grade		149	4.64	1.79
8th Grade		152	4.43	1.75

The data from Table 4.14 indicates that none of the engineering identity dimensions surpassed the midpoint. Recognition in engineering shows the highest mean score (M=3.78, SD=1.48), while the identity related to engineering has the lowest (M=2.94, SD=1.77).

Table 4.14. Descriptive statistics for engineering identity.

Scale	**Engineering Identity**			
Dimension	**Minimum**	**Maximum**	**Mean**	**SD**
Identity	1.00	7.00	2.94	1.77
Recognition	1.00	7.00	3.78	1.48
Performance-competence	1.00	7.00	3.04	1.64
Interest	1.00	7.00	3.10	1.76

Based on the findings in Table 4.15, it is observed that neither girls nor boys were found to exceed the midpoint value in any dimension of engineering identity. Male students generally exhibit higher mean MIIC values across all dimensions. Specifically, the recognition dimension records the highest mean value among males (M=3.88, SD=1.38), whereas among females, it demonstrates the lowest mean value (M=2.70, SD=1.66).

Table 4.15. Descriptive statistics of engineering identity by gender.

Scale	**Engineering Identity**			
Gender	**Dimension**	**N**	**M**	**SD**
Female	Identity	304	2.70	1.66
Male		300	3.19	1.83
Female	Recognition	304	3.68	1.56
Male		300	3.88	1.38
Female	Performance-competence	303	2.88	1.58
Male		296	3.20	1.68
Female	Interest	302	2.96	1.74
Male		295	3.25	1.77

According to Table 4.16, only the recognition dimension for 5th graders has the mean value above the midpoint. The highest mean MIIC values for identity and recognition dimensions belong to 5th graders, while for performance-competence and interest dimensions, they belong to 7th graders. Specifically, 5th grade students attained the highest mean score in the recognition dimension (M=4.18, SD=1.25), while 8th and 6th grade students recorded the lowest mean score in the identity (M=2.83, SD=1.72) and performance-competence dimension (M=2.83, SD=1.72), respectively.

Table 4.16. Descriptive statistics of engineering identity by grade level.

Scale	**Engineering Identity**			
Grade Level	**Dimension**	**N**	**M**	**SD**
5th Grade	Identity	151	3.16	1.80
6th Grade		149	2.88	1.59
7th Grade		151	2.91	1.93
8th Grade		153	2.83	1.72
5th Grade	Recognition	151	4.18	1.25
6th Grade		149	3.86	1.46
7th Grade		151	3.52	1.53
8th Grade		153	3.56	1.56
5th Grade	Performance-competence	148	3.10	1.58
6th Grade		149	2.83	1.56
7th Grade		150	3.23	1.82
8th Grade		152	2.99	1.58
5th Grade	Interest	150	3.20	1.80
6th Grade		145	2.97	1.73
7th Grade		150	3.34	1.79
8th Grade		152	2.90	1.71

Based on the information outlined in Table 4.17, it appears that none of the mathematics identity dimensions exceeded the midpoint. Specifically, performance-competence in mathematics demonstrates the highest mean score (M=3.62, SD=1.78), while the identity related to mathematics has the lowest (M=3.44, SD=1.91).

Table 4.17. Descriptive statistics for mathematics identity.

Scale	**Mathematics Identity**			
Dimension	**Minimum**	**Maximum**	**Mean**	**SD**
Identity	1.00	7.00	3.44	1.91
Recognition	1.00	7.00	3.47	1.83
Performance-competence	1.00	7.00	3.62	1.78
Interest	1.00	7.00	3.49	1.91

According to the results presented in Table 4.18, it is evident that the mean MIIC values for all dimensions of mathematics identity did not exceed the midpoint for both female and male students. Female students generally display higher mean MIIC values across all dimensions. The highest mean value is observed among female students in the performance-competence dimension (M=3.76, SD=1.79), while the lowest mean value is recorded among male students in the interest dimension (M=3.30, SD=1.84).

Table 4.18. Descriptive statistics of mathematics identity by gender.

Scale	**Mathematics Identity**			
Gender	**Dimension**	**N**	**M**	**SD**
Female	Identity	304	3.56	1.96
Male		300	3.32	1.86
Female	Recognition	301	3.55	1.86
Male		299	3.40	1.80
Female	Performance-competence	300	3.76	1.79
Male		300	3.46	1.77
Female	Interest	303	3.67	1.95
Male		300	3.30	1.84

Table 4.19, presenting descriptive statistics of mathematics identity dimensions by grade level, highlights that only 5th graders exhibit a mean value above the midpoint in interest dimension, whereas the students from all grade levels showed mean MIIC values below the midpoint in all dimensions. Besides, while 6th graders achieve higher mean MIIC values in the performance-competence and interest dimensions, 7th graders

attain in the performance-competence dimension. The interest dimension records the highest mean value among 5th graders (M=4.01, SD=1.77), while the identity dimension indicates the lowest mean value among 8th graders (M=3.19, SD=1.94).

Table 4.19. Descriptive statistics of mathematics identity by grade level.

Scale	**Mathematics Identity**			
Grade Level	**Dimension**	**N**	**M**	**SD**
5th Grade	Identity	151	3.85	1.83
6th Grade		149	3.37	1.91
7th Grade		151	3.34	1.92
8th Grade		153	3.19	1.94
5th Grade	Recognition	149	3.71	1.59
6th Grade		148	3.41	1.83
7th Grade		150	3.46	1.94
8th Grade		153	3.31	1.93
5th Grade	Performance-competence	149	3.93	1.65
6th Grade		148	3.62	1.79
7th Grade		151	3.63	1.83
8th Grade		152	3.30	1.82
5th Grade	Interest	151	4.01	1.77
6th Grade		148	3.52	1.94
7th Grade		151	3.38	1.90
8th Grade		153	3.09	1.91

4.3.2. Descriptive Statistics Results Related to STEM Disciplinary Stereotypical Beliefs

Aligned with the second research question, the study aimed to investigate the profiles of middle school students concerning STEM discipline stereotypical beliefs across relevant dimensions. To attain this objective, the student profile was analyzed through descriptive analysis, both in general and specifically by gender and grade level.

Table 4.20, Table 4.23, Table 4.26 and Table 4.29 outline the minimum and maximum MIIC values for femininity, masculinity, and socioeconomic status based disciplinary stereotypical beliefs, alongside the mean (M) and standard deviation (SD) MIIC values for these dimensions.

Table 4.21, Table 4.244, Table 4.27, and Table 4.30 display the total number of observations, mean, and standard deviation for femininity, masculinity, and socioeconomic status related disciplinary stereotypical beliefs, analyzed separately by gender.

Table 4.22, Table 4.25, Table 4.28, and Table 4.31 provide the total number of observations, mean, and standard deviation value of disciplinary stereotypical beliefs concerning femininity, masculinity, and socioeconomic status at each grade level.

According to Table 4.20, middle school students did not exhibit a mean value above the midpoint in science stereotypes based on femininity, masculinity and socioeconomic status. The mean MIIC values , ranked from high to low, are reported in the masculine dimension (M=3.79, SD=1.70), socioeconomic status dimension (M=3.75, SD=1.55), and feminine dimension (M=3.43, SD=1.61), respectively.

Table 4.20. Descriptive statistics for science stereotypes / stereotypical beliefs.

Scale	**Science Stereotypical Beliefs**			
Dimension	**Minimum**	**Maximum**	**M**	**SD**
Gender				
Feminine	1.00	7.00	3.43	1.61
Masculine	1.00	7.00	3.79	1.70
Socioeconomic Status	1.00	7.00	3.75	1.55

Table 4.21 outlines that only male students exceed the midpoint on both the masculine and SES dimensions. Although girls' mean higher than boys in feminine dimension, boys' mean higher in the both masculine and SES dimension. Both the highest and lowest mean value belong to male in the masculine dimension (M=4.12, SD=1.76), and in the feminine dimension (M=3.18, SD=1.60), respectively.

Table 4.21. Descriptive statistics of science stereotypes / stereotypical beliefs by gender.

Scale	**Science Stereotypical Beliefs**			
Gender	**Dimension**	**N**	**M**	**SD**
	Gender			
Female	Feminine	304	3.66	1.60
Male		300	3.18	1.60
Female	Masculine	304	3.46	1.59
Male		300	4.12	1.76
Female	Socioeconomic Status	303	3.40	1.58
Male		300	4.11	1.45

The table below shows that, Table 4.22, the mean MIIC values of all graders regarding all dimensions of science stereotypes remained below the midpoint. The highest average in the feminine dimension belongs to the 8th graders (M=3.68, SD=1.62), while in the masculine (M=3.95, SD=1.71), and SES dimensions (M=3.99, SD=1.54), it belongs to the 5th graders. The lowest average value was displayed in the feminine dimension (M=2.98, SD=1.55) by 7th graders, in masculine dimensions (M=3.64, SD=1.58) by 6th graders, and in SES dimension (M=3.50, SD=1.60), by the 8th graders.

Table 4.22. Descriptive statistics of science stereotypes/stereotypical beliefs by grade level.

Scale	**Science Stereotypical Beliefs**			
Grade Level	**Dimension**	**N**	**M**	**SD**
	Gender			
5th Grade	Feminine	151	3.55	1.62
6th Grade		149	3.48	1.60
7th Grade		151	2.98	1.55
8th Grade		153	3.68	1.62
5th Grade	Masculine	151	3.95	1.71
6th Grade		149	3.64	1.58
7th Grade		151	3.80	1.83
8th Grade		153	3.75	1.70
5th Grade	Socioeconomic Status	150	3.99	1.54
6th Grade		149	3.73	1.57
7th Grade		151	3.79	1.48
8th Grade		153	3.50	1.60

Table 4.23 indicates that the mean value for technology stereotypes based on masculinity exceeded the midpoint. The mean MIIC values , from high to low, are reported in the following order: the masculine dimension (M=4.34, SD=1.82), the socioeconomic status dimension (M=3.83, SD=1.53), and the femininity dimension (M=3.27, SD=1.67).

Table 4.23. Descriptive statistics for technology stereotypes / stereotypical beliefs.

Scale	**Technology Stereotypical Beliefs**			
Dimension	**Minimum**	**Maximum**	**M**	**SD**
Gender				
Feminine	1.00	7.00	3.27	1.67
Masculine	1.00	7.00	4.34	1.82
Socioeconomic Status	1.00	7.00	3.83	1.53

As seen in Table 4.24, only male students exhibited mean MIIC values above the midpoint in masculine and SES dimensions of technology identity. Boys tend to score higher than girls in the masculine and SES dimensions, while the reverse is observed in the feminine dimension. The highest and lowest mean MIIC values belong to men in the masculine (M=4.78, SD=1.78), and feminine (M=3.03, SD=1.71) dimensions, respectively.

Table 4.24. Descriptive statistics of technology stereotypes / stereotypical beliefs by gender.

Scale	**Technology Stereotypical Beliefs**			
Gender	**Dimension**	**N**	**M**	**SD**
	Gender			
Female	Feminine	304	3.50	1.71
Male		299	3.03	1.61
Female	Masculine	303	3.91	1.76
Male		299	4.78	1.78
Female	Socioeconomic Status	303	3.55	1.60
Male		299	4.11	1.40

According to Table 4.25, students across all grade levels displayed mean MIIC values exceeding the midpoint in the masculine dimension of technology stereotypes. The highest mean in these dimensions was observed among 5th graders. Regarding the feminine dimension, the highest mean value was recorded for 8th graders (M=3.49, SD=1.70), while the lowest mean value was recorded for 7th graders (M=3.04, SD=1.69). On the other hand, the lowest mean MIIC values in the masculine (M=4.26, SD=1.78) and SES (M=3.56, SD=1.60) dimensions were found among 6th and 8th graders, respectively.

Table 4.25. Descriptive statistics of technology stereotypes / stereotypical beliefs by grade level.

Scale	**Technology Stereotypical Beliefs**			
Grade Level	**Dimension**	**N**	**M**	**SD**
	Gender			
5th Grade	Feminine	150	3.26	1.54
6th Grade		149	3.29	1.74
7th Grade		151	3.04	1.69
8th Grade		153	3.49	1.70
5th Grade	Masculine	151	4.49	1.61
6th Grade		147	4.26	1.78
7th Grade		151	4.28	2.00
8th Grade		153	4.37	1.87
5th Grade	Socioeconomic Status	151	4.08	1.37
6th Grade		148	3.75	1.53
7th Grade		150	3.91	1.57
8th Grade		153	3.56	1.60

From the data provided in Table 4.26, it is evident that students' engineering stereotypes based on masculinity have a mean value above the midpoint. The lowest mean is observed in the feminine dimension (M=3.08, SD=1.64), while the highest mean is in the masculine dimension (M=4.43, SD=1.85).

Table 4.26. Descriptive statistics for engineering stereotypes / stereotypical beliefs.

Scale	**Engineering Stereotypical Beliefs**			
Dimension	**Minimum**	**Maximum**	**M**	**SD**
Gender				
Feminine	1.00	7.00	3.08	1.64
Masculine	1.00	7.00	4.43	1.85
Socioeconomic Status	1.00	7.00	3.89	1.61

For engineering stereotypes, both girls and boys have mean MIIC values above the midpoint on the masculine dimension, as reported in Table 4.27. In addition, girls' mean value was larger than boys' only on the feminine dimension. The highest average is recorded for male students in the masculine dimension (M=4.78, SD=1.81), while the lowest average is observed for males in the feminine dimension (M=2.94, SD=1.60).

Table 4.27. Descriptive statistics of engineering stereotypes / stereotypical beliefs by gender.

Scale	**Engineering Stereotypical Beliefs**			
Gender	**Dimension**	**N**	**M**	**SD**
	Gender			
Female	Feminine	304	3.21	1.68
Male		300	2.94	1.60
Female	Masculine	303	4.08	1.82
Male		300	4.78	1.81
Female	Socioeconomic Status	304	3.59	1.65
Male		299	4.20	1.52

As indicated in Table 4.28, 5, 5th graders have the highest mean MIIC values in the masculine dimension (M=4.87, SD=1.60) and the SES dimension (M=4.45, SD=1.50). Conversely, the lowest means for these dimensions are observed among 6th graders (M=4.19, SD=1.88) and 8th graders (M=3.66, SD=1.58), respectively. Moreover, the highest mean in the feminine dimension is recorded for 5th graders (M=3.22, SD=1.63), while the lowest mean is noted for 7th graders (M=2.73, SD=1.67).

Table 4.28. Descriptives statistics of participants.

Scale	**Engineering Stereotypical Beliefs**			
Grade Level	**Dimension**	**N**	**M**	**SD**
	Gender			
5th Grade	Feminine	151	3.22	1.63
6th Grade		149	3.15	1.66
7th Grade		151	2.73	1.67
8th Grade		153	3.19	1.58
5th Grade	Masculine	151	4.87	1.60
6th Grade		148	4.19	1.88
7th Grade		151	4.31	2.03
8th Grade		153	4.35	1.80
5th Grade	Socioeconomic Status	151	4.45	1.50
6th Grade		148	3.72	1.55
7th Grade		151	3.74	1.70
8th Grade		153	3.66	1.58

The mean MIIC values not exceeding the midpoint were observed in all dimensions of mathematics stereotypes as indicated in Table 4.29. These mean MIIC values , listed from high to low for dimensions respectively, are masculine (M=3.93, SD=1.74), socioeconomic status (M=3.82, SD=1.62), and feminine (M=3.69, SD=1.80).

Table 4.29. Descriptive statistics for mathematics stereotypes / stereotypical beliefs.

Scale	**Mathematics Stereotypical Beliefs**			
Dimension	**Minimum**	**Maximum**	**M**	**SD**
Gender				
Feminine	1.00	7.00	3.69	1.80
Masculine	1.00	7.00	3.93	1.74
Socioeconomic Status	1.00	7.00	3.82	1.62

Based on Table 4.30, only male students had mean MIIC values above the midpoint in masculine and SES dimensions. Also, females achieved a higher mean value than males only in the feminine dimension. The highest mean value belongs to boys in both masculine (M=4.23, SD=1.77) and SES dimensions (M=4.23, SD=1.50), while the lowest average belongs to girls (M=3.42, SD=1.64) in SES dimension.

Table 4.30. Descriptive statistics of mathematics stereotypes / stereotypical beliefs by gender.

Scale	**Mathematics Stereotypical Beliefs**			
Gender	**Dimension**	**N**	**M**	**SD**
	Gender			
Female	Feminine	303	3.86	1.86
Male		300	3.51	1.73
Female	Masculine	304	3.63	1.65
Male		300	4.23	1.77
Female	Socioeconomic Status	300	3.42	1.64
Male		300	4.23	1.50

In the mathematics discipline, among students at different grade levels, only 5th graders exhibited mean MIIC values exceeding the midpoint on stereotypes in masculine and SES dimensions, as reported in Table 4.31. Specifically, 5th graders have the highest mean value for all three dimensions. The highest mean value is observed in the masculine dimension (M=4.40, SD=1.52), while the lowest mean value is observed in the feminine dimension (M=3.52, SD=1.93).

Table 4.31. Descriptive statistics of mathematics stereotypes / stereotypical beliefs by grade level.

Scale	**Mathematics Stereotypical Beliefs**			
Grade Level	**Dimension**	**N**	**M**	**SD**
	Gender			
5th Grade	Feminine	151	3.95	1.56
6th Grade		148	3.70	1.85
7th Grade		151	3.52	1.93
8th Grade		153	3.58	1.82
5th Grade	Masculine	151	4.40	1.52
6th Grade		149	3.99	1.85
7th Grade		151	3.66	1.74
8th Grade		153	3.65	1.73
5th Grade	Socioeconomic Status	150	4.13	1.48
6th Grade		148	3.82	1.58
7th Grade		150	3.70	1.71
8th Grade		152	3.63	1.67

4.4. Inferential Statistics Results Related to Research Question 3

This section provides the analysis results pertaining to the third research question which explores the relationship between stereotypical beliefs and identity, along with related dimensions, across four STEM disciplines. These analyses were conducted while controlling for gender and grade level variables. In research of this nature, hierarchical multiple regression, a method of analysis, is employed to systematically incorporate variables or sets of variables into the model in a stepwise manner by statistically controlling for additional variables when assessing the predictive capability of a model (Pallant, 2016). By including these extra variables in the analysis, researchers can better understand how certain factors influence the relationship between the independent and dependent variables.

4.4.1. Hierarchical Multiple Regression Analysis

Prior to conducting hierarchical multiple regression analyses, the assumptions for each STEM discipline were checked and then the analyses outputs of the relevant discipline were presented in three tables with concise interpretations.

4.4.1.1. Assumptions of Hierarchical Multiple Regression. In order for hierarchical multiple regression analysis to ensure the credibility of its outcomes, several fundamental assumptions need to be satisfied. These are: sample size, multicollinearity and singularity, outliers, normality, linearity, homoscedasticity and independence of residuals (Pallant, 2016).

Sample Size: For the correlational studies, determining sample size commonly involves either using a rule of thumb formula or conducting a power analysis. The formula for sample size calculation suggests that N should be greater than 50 + 8m, where N represents the required sample size and m denotes the number of independent variables (Tabachnick and Fidell, 2013). Applying this formula to the current study, a sample size of $N > 98$ was determined (where m=6: 3 from STEM stereotypes

predictors and 3 from STEM identity predictors). Additionally, a power analysis was conducted using G*Power (Faul *et al.*, 2007) to ascertain the necessary number of subjects in advance to achieve a desired statistical power (Pituch and Stevens, 2016). This calculation yielded a total required sample size of 688 individuals (Effect size = 0.02, $\alpha = 0.05$, power = 0.80, number of predictors = 6). Similarly, the analysis was repeated for a medium effect size of 0.15, since anticipating meaningful associations between the predictors and the dependent variable according to the related literature. This suggests that the required number should be 98 (Effect size = 0.15, $\alpha = 0.05$, power = 0.80, number of predictors = 6).

The number of participants in the study, 604 people, is quite above the number of 98 people determined in the formula suggested by Tabachnick and Fidell (2013) to calculate the sample size by taking into account the number of independent variables. Additionally, the sample size of 604 individuals also exceeds the suggested size of 98 people provided by the calculation using G*Power according to the medium effect size.

Multicollinearity and Singularity: Multicollinearity, characterized by high correlations among independent variables (typically r=.9 and above), and singularity, where one independent variable is a linear combination of others, are undesirable because they undermine the quality of a regression model (Pallant, 2016). As seen in Table 4.32, Table 4.33, Table 4.34, and Table 4.35, there was no multicollinearity, as none of the variables show correlations that exceed the specified critical value. The concept of singularity also was not a concern since there were no independent variables formed by combining other independent variables.

Based on Table 4.32, there exists a statistically significant correlation between gender and the dimensions of feminine stereotypes, masculine stereotypes, and SES stereotypes. Since the reference group for the binary gender variable was female students, a significant positive correlation between gender and a variable suggests that male students exhibit significantly higher scores on the variable compared to female students. Consequently, male students demonstrate significantly higher scores than

female students in the dimensions of masculine stereotypes and SES stereotypes, while female students exhibit significantly higher scores than male students in the feminine stereotype dimension.

Table 4.32. Correlations among science related study variables.

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.Gender							
2.Identity	-0.020						
3.Recognition	0.001	0.703*					
4. Performance-competence	-0.053	0.684*	0.705*				
5.Interest	-0.029	0.675*	0.612*	0.762*			
6. Feminine stereotypes	-0.149*	0.109*	0.141*	0.049	0.051		
7. Masculine stereotypes	0.192*	0.153*	0.133*	0.107*	0.063	0.350*	
8.Socioeconomic status stereotypes	0.228*	0.059	0.104*	0.024	0.000	0.221*	0.420*
*p< 0.05, (2-tailed).							

According to Table 4.33, there exists a statistically significant correlation between gender and the dimensions of recognition, feminine stereotypes, masculine stereotypes, and SES stereotypes.

In this context, male students demonstrate significantly higher scores than female students in the dimensions of recognition, masculine stereotypes, and SES stereotypes, while female students exhibit significantly higher scores than male students in the feminine stereotype dimension.

Table 4.33. Correlations among technology related study variables.

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.Gender							
2.Identity	0.064						
3.Recognition	0.121*	0.738*					
4. Performance-competence	0.046	0.755*	0.749*				
5.Interest	-0.004	0.700*	0.634*	0.811*			
6. Feminine stereotypes	-0.139*	0.100*	0.139*	0.153*	0.113*		
7. Masculine stereotypes	0.239*	0.091*	0.129*	0.109*	0.052	0.258*	
8.Socioeconomic status stereotypes	0.181*	0.077	0.096*	-0.017	-0.029	0.206*	0.398*
*p< 0.05, (2-tailed).							

As indicated in Table 4.34, there exists a statistically significant relationship between gender and all dimensions except recognition. Male students show significantly higher scores than female students in the dimensions of identity, performance-competence, interest, masculine stereotypes, and SES stereotypes. Conversely, female students demonstrate significantly higher scores than male students in the feminine stereotypes dimension.

Table 4.34. Correlations among engineering related study variables.

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.Gender							
2.Identity	0.138*						
3.Recognition	0.067	0.130*					
4. Performance-competence	0.099*	0.677*	0.134*				
5.Interest	0.082*	0.631*	0.128*	0.798*			
6. Feminine stereotypes	-0.084*	0.236*	0.397*	0.220*	0.211*		
7. Masculine stereotypes	0.189*	0.046	0.467*	0.071	0.051	0.039	
8.Socioeconomic status stereotypes	0.187*	0.118*	0.334*	0.060	0.028	0.170*	0.402*
*p< 0.05, (2-tailed).							

As indicated in Table 4.35, there exists a statistically significant relationship between gender and the dimensions of performance-competence, interest, feminine

stereotypes, masculine stereotypes, and SES stereotypes. Specifically, female students demonstrate significantly higher scores than male students in the dimensions of performance-competence, interest, and feminine stereotypes. Conversely, male students exhibit significantly higher scores than female students in the dimensions of masculine stereotypes and SES stereotypes.

Table 4.35. Correlations among mathematics related study variables.

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.Gender 2.Identity	-0.062						
3.Recognition	0.039	0.823*					
4. Performance-competence	-0.088*	0.809*	0.845*				
5.Interest	-0.099*	0.785*	0.773*	0.867*			
6. Feminine stereotypes	-0.095*	0.188*	0.177*	0.156*	0.163*		
7. Masculine stereotypes	0.174*	0.174*	0.145*	0.127*	0.122*	0.314*	
8.Socioeconomic status stereotypes	0.251*	0.054	0.020	-0.013	0.029	0.207*	0.335*
*p< 0.05, (2-tailed).							

In order to detect multicollinearity issues that may not be apparent in the correlation matrix, Tolerance and VIF (Variance inflation factor) MIIC values are tested through collinearity diagnostics (Pallant, 2016). A small Tolerance value, typically below 0.10, suggests high correlation with other variables, indicating potential multicollinearity (Menard, 2002). Conversely, a VIF value exceeding 10 raise concerns, indicating multicollinearity (Myers, 1990). According to Table 4.36, Table 4.37, Table 4.38, and Table 4.39 the Tolerance levels are all above 0.10, and every VIF value falls below 10. Based on the collinearity statistics provided, multicollinearity does not appear to be a problematic concern for this study.

Table 4.36. Collinearity statistics of hierarchical multiple regression analysis' independent variables for the discipline of science.

Variable	**Tolerance**	**VIF**
Recognition	0.474	2.110
Performance-competence	0.326	3.071
Interest	0.408	2.453
Feminine stereotypes	0.858	1.166
Masculine stereotypes	0.746	1.340
Socioeconomic status stereotypes	0.809	1.235
Note. Dependent Variable: Science Identity.		

Table 4.37. Collinearity statistics of hierarchical multiple regression analysis' independent variables for the discipline of technology.

Variable	**Tolerance**	**VIF**
Recognition	0.424	2.357
Performance-competence	0.244	4.093
Interest	0.338	2.954
Feminine stereotypes	0.903	1.107
Masculine stereotypes	0.799	1.252
Socioeconomic status stereotypes	0.806	1.241
Note. Dependent Variable: Technology Identity.		

Table 4.38. Collinearity statistics of hierarchical multiple regression analysis' independent variables for the discipline of engineering.

Variable	**Tolerance**	**VIF**
Recognition	0.628	1.593
Performance-competence	0.360	2.780
Interest	0.361	2.767
Feminine stereotypes	0.776	1.289
Masculine stereotypes	0.683	1.464
Socioeconomic status stereotypes	0.801	1.248
Note. Dependent Variable: Engineering Identity.		

Table 4.39. Collinearity statistics of hierarchical multiple regression analysis' independent variables for the discipline of mathematics.

Variable	**Tolerance**	**VIF**
Recognition	0.277	3.614
Performance-competence	0.171	5.857
Interest	0.241	4.144
Feminine stereotypes	0.870	1.149
Masculine stereotypes	0.815	1.227
Socioeconomic status stereotypes	0.866	1.154
Note. Dependent Variable: Mathematics Identity.		

Outliers: Multiple regression analysis is notably influenced by outliers, particularly extreme scores that deviate significantly from the rest of the data. Outliers in this context are identified as data points with standardized residual MIIC values (the difference between the observed MIIC values of the dependent variable and the MIIC values predicted by a model) surpassing approximately 3.3 in either positive or negative directions (Tabachnick and Fidell, 2013). As illustrated by scatterplots in Figure 4.5, Figure 4.6, Figure 4.7 and Figure 4.8, there were a couple of observations falling below -3.3 and/or above 3.3. When there are only a few outliers that exceed these thresholds, there is typically no necessity to exclude any observations. Accordingly, these particular observations were retained in this analysis. Identifying influential cases is just as crucial as detecting outliers. Cook's distance serves to assess whether outliers, representing unusual cases, exert an excessive impact on the outcomes of the entire model (Pallant, 2016). For the fields of science, technology, engineering, and mathematics, the maximum Cook's distance MIIC values are 0.095, 0.039, 0.048, and 0.089, respectively. In that regard, the cases exhibiting Cook's Distance MIIC values greater than 1 are considered a potential issue (Cook, 2000). Since none of the residuals have a Cook's distance value exceeding 1, they are unlikely to pose a major problem for the research.

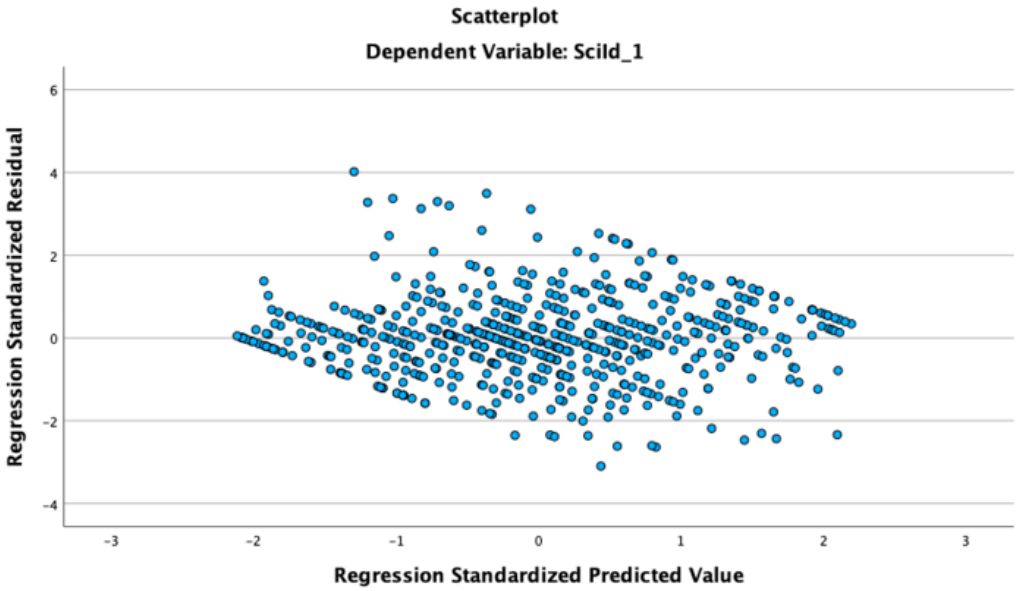

Figure 4.5. Scatterplot for science identity.

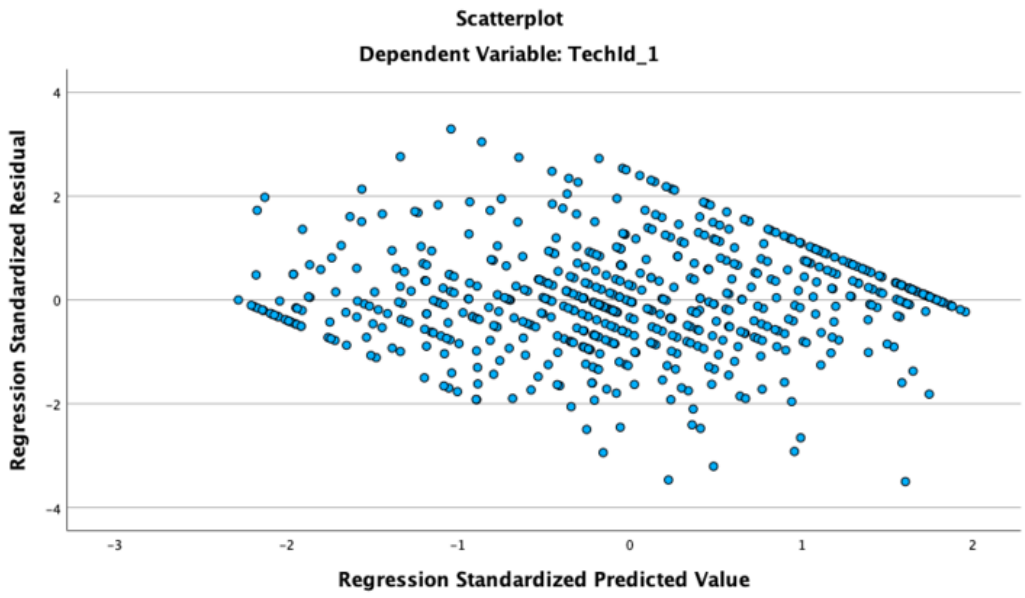

Figure 4.6. Scatterplot for technology identity.

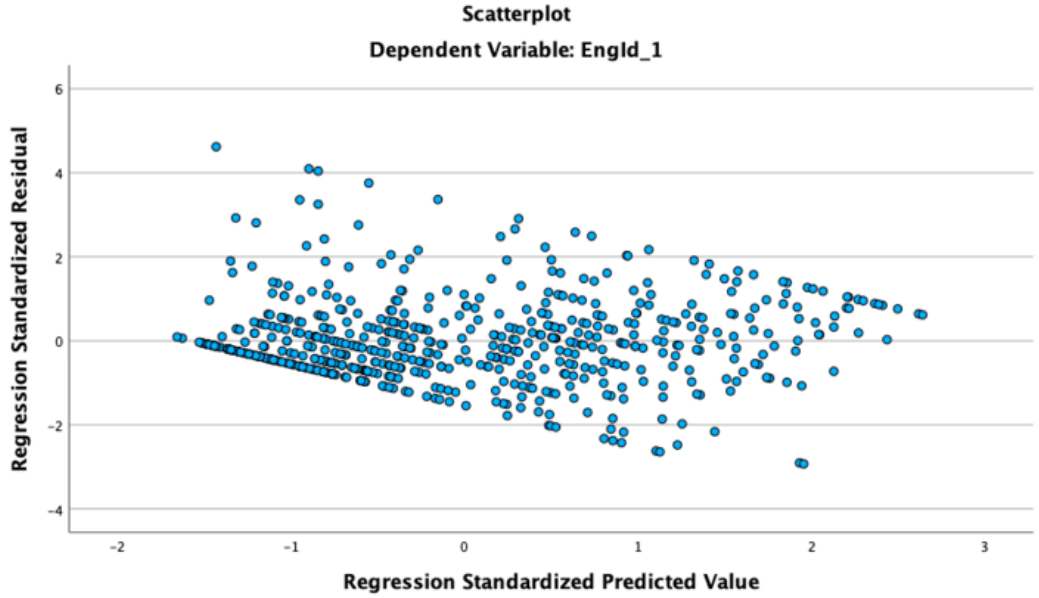

Figure 4.7. Scatterplot for engineering identity.

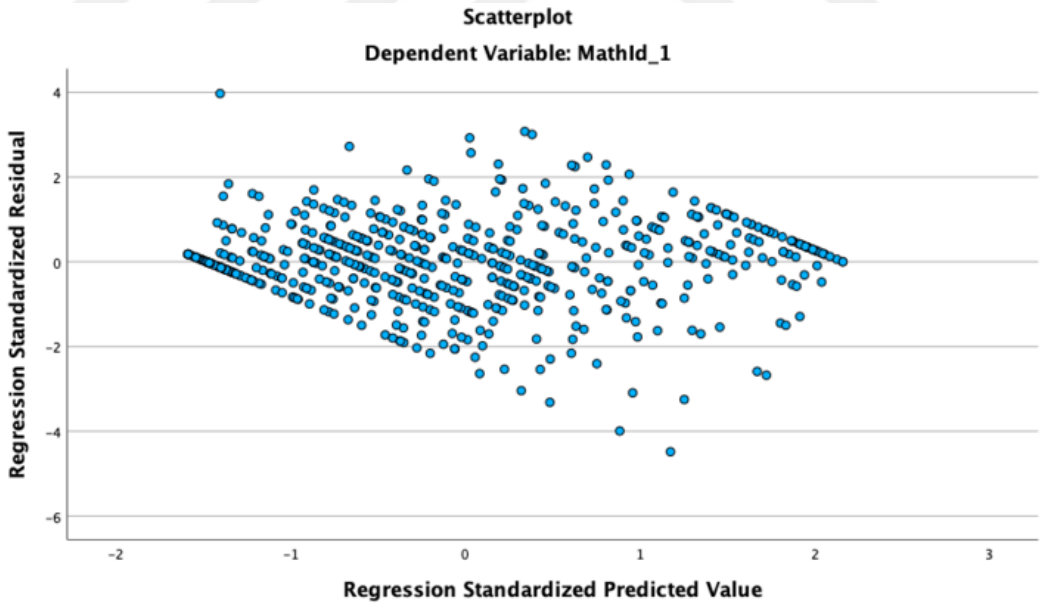

Figure 4.8. Scatterplot for mathematics identity.

Normality, Linearity, Homoscedasticity and Independence of Residuals: Normality The statistical tests conducted rely on the assumption of normal distribution for their validity. Skewness and kurtosis MIIC values are commonly used as statistics to assess the normality of a distribution. Skewness evaluates the degree of symmetry in

a variable's distribution, while kurtosis gauges whether the distribution is excessively peaked or flat (Hair et al, 2022). George and Mallery (2019) proposed threshold MIIC values as a general guideline for these metrics. In that sense, both skewness and kurtosis MIIC values falling the range of -1 to +1 are considered excellent, while a range of -2 to +2 is typically deemed acceptable. However, when skewness or kurtosis MIIC values fall beyond the range of -2 to +2, it indicates substantial nonnormality. From Table 4.40, Table 4.41, Table 4.42, and Table 4.43, it is evident that all skewness and kurtosis MIIC values fall within the excellent range of -1 to +1 or the acceptable range of -2 to +2. This suggests that the data exhibit a relatively normal distribution.

Table 4.40. Skewness and kurtosis MIIC values for dependent and independent variables related to science.

Variable	**Skewness**		**Kurtosis**	
	Statistics	**Standard error**	**Statistics**	**Standard error**
Identity	0.246	0.099	-0.812	0.199
Recognition	0.084	0.099	-0.772	0.199
Performance-competence	-0.041	0.099	-0.784	0.199
Interest	0.085	0.099	-0.993	0.199
Feminine stereotypes	0.138	0.099	-0.833	0.199
Masculine stereotypes	0.040	0.099	-0.858	0.199
Socioeconomic status stereotypes	0.019	0.099	-0.753	0.199

Table 4.41. Skewness and kurtosis MIIC values for dependent and independent variables related to technology.

Variable	**Skewness**		**Kurtosis**	
	Statistics	**Standard error**	**Statistics**	**Standard error**
Identity	-0.095	0.099	-1.009	0.199
Recognition	-0.062	0.099	-0.808	0.199
Performance-competence	-0.204	0.099	-0.752	0.199
Interest	0.133	0.099	-1.053	0.199
Feminine stereotypes	0.409	0.099	-0.632	0.199
Masculine stereotypes	-0.305	0.099	-0.903	0.199
Socioeconomic status stereotypes	-0.082	0.099	-0.661	0.199

Table 4.42. Skewness and kurtosis MIIC values for dependent and independent variables related to engineering.

Variable	**Skewness**		**Kurtosis**	
	Statistics	**Standard error**	**Statistics**	**Standard error**
Identity	0.765	0.099	-0.410	0.199
Recognition	-0.169	0.099	-0.496	0.199
Performance-competence	-0.581	0.099	-0.586	0.199
Interest	0.623	0.099	-0.635	0.199
Feminine stereotypes	0.531	0.099	-0.530	0.199
Masculine stereotypes	-0.325	0.099	-0.958	0.199
Socioeconomic status stereotypes	-0.153	0.099	-0.741	0.199

Table 4.43. Skewness and kurtosis MIIC values for dependent and independent variables related to mathematics.

Variable	**Skewness**		**Kurtosis**	
	Statistics	**Standard error**	**Statistics**	**Standard error**
Identity	0.479	0.099	-0.913	0.199
Recognition	0.392	0.099	-0.884	0.199
Performance-competence	0.324	0.099	-0.926	0.199
Interest	0.391	0.099	-1.010	0.199
Feminine stereotypes	0.209	0.099	-0.898	0.199
Masculine stereotypes	0.006	0.099	-0.875	0.199
Socioeconomic status stereotypes	-0.056	0.099	-0.760	0.199

Besides skewness and kurtosis MIIC values , the P-P Plot can also be utilized to assess the adequacy of a dataset for normal distribution. When standardized residuals are normally distributed, the scatters should fall on or very close to the normal distribution line (Pallant, 2016). Figure 4.9, Figure 4.10, Figure 4.11, and Figure 4.12 demonstrate that the residuals for the dependent variables-science identity, technology identity, engineering identity, and mathematics identity, respectively-display scatter

patterns closely aligned with the normal distribution line. This also implies a normal distribution of residuals.

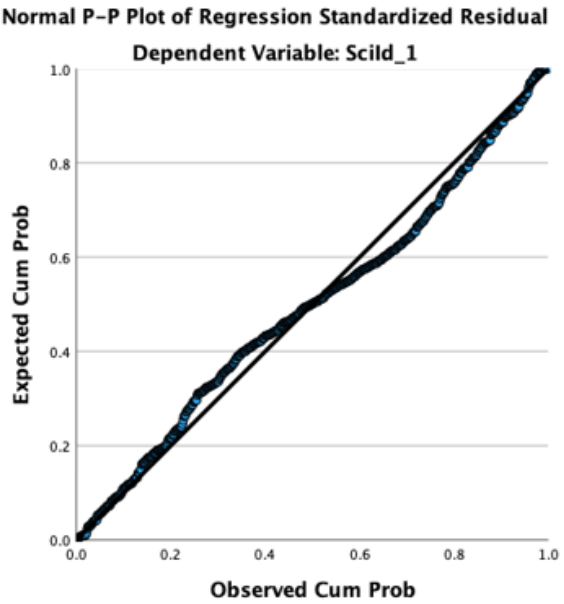

Figure 4.9. Normal p-p plot of regression standardized residual for science identity.

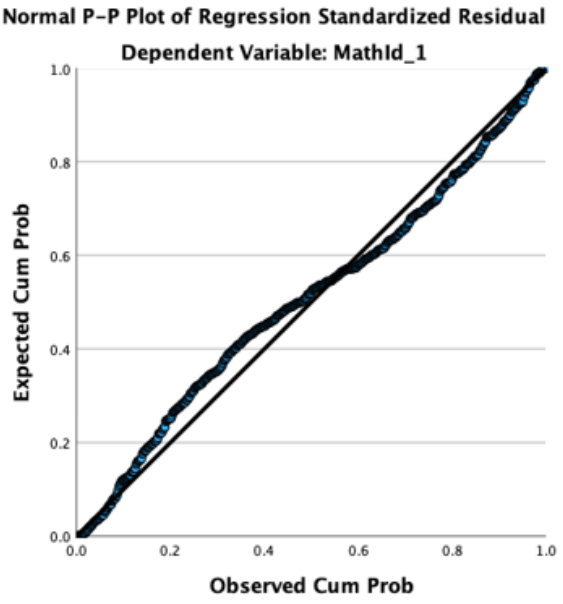

Figure 4.10. Normal p-p plot of regression standardized residual for technology identity.

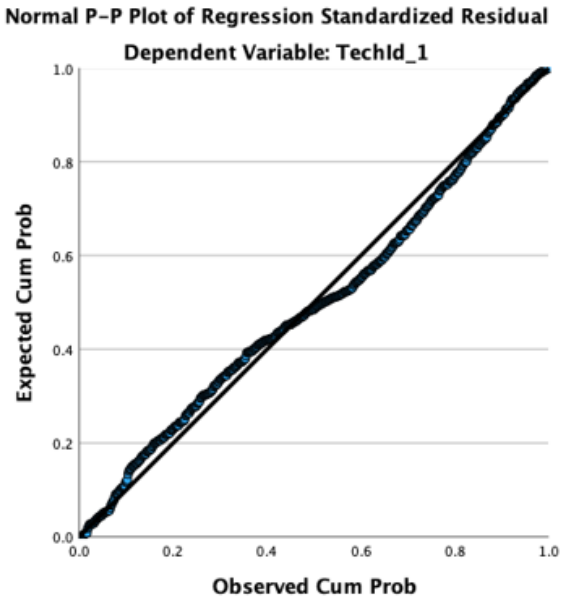

Figure 4.11. Normal p-p plot of regression standardized residual for engineering identity.

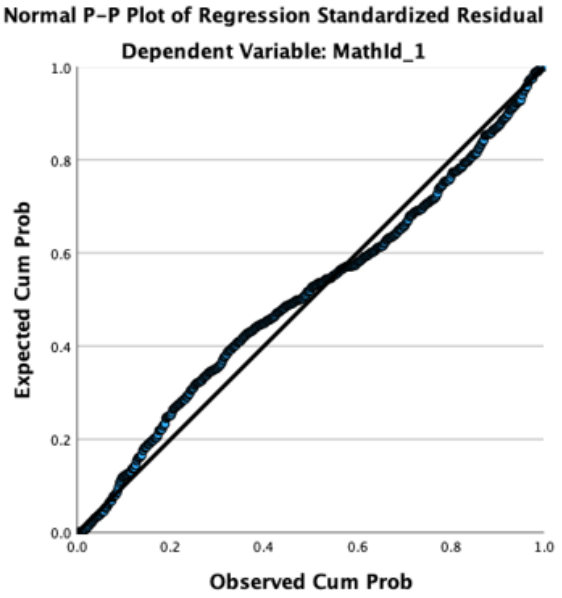

Figure 4.12. Normal p-p plot of regression standardized residual for mathematics identity.

Linearity: The residuals should demonstrate a linear relationship with predicted dependent variable scores rather than a curvilinear one (Pallant, 2016). In this study, a total of 24 scatter plots were analyzed, illustrating the relationship between each dependent variable, e.g. Science Identity and Mathematics Identity, and six corresponding independent variables, e.g. performance-competence and masculine stereotypes. Due to space constraints, only one scatter plot was provided below, chosen arbitrarily from the collection. As observed in the Figure 4.13, the scatterplot does not display any clear evidence of nonlinearity or curvilinearity.

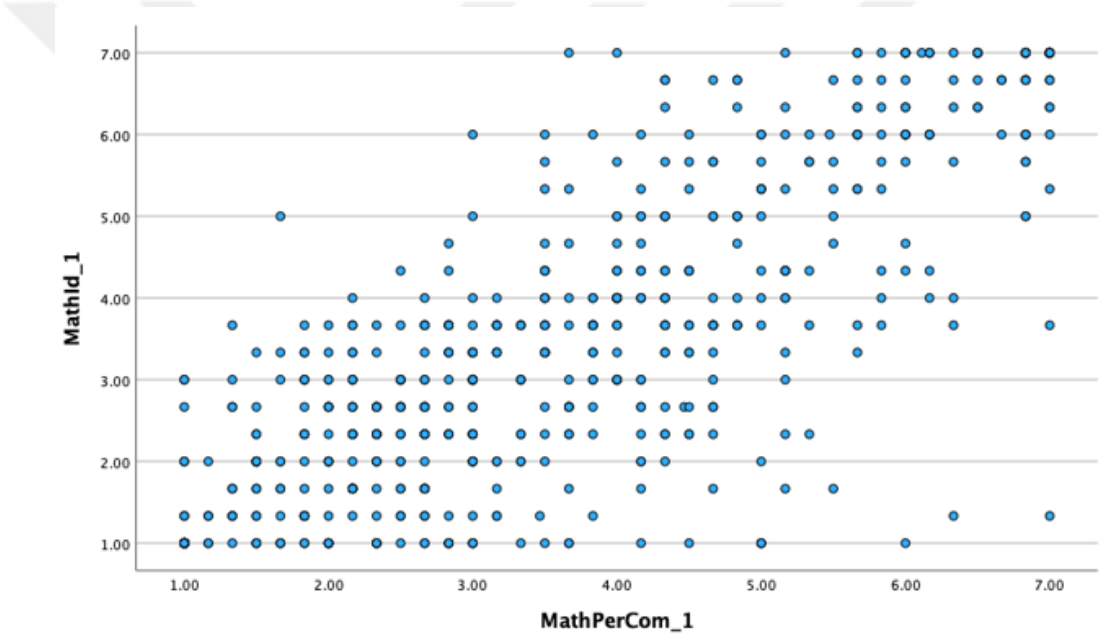

Figure 4.13. Relationship between the scores of mathematics identity and performance - competence in mathematics.

Homoscedasticity: According to this assumption, the variance of the residuals around predicted dependent variable scores should be consistent across all predicted scores (Pallant, 2016). When this condition is fulfilled, the assumption is satisfied. Residual scatter plots are utilized to visually evaluate the homoscedasticity assumption. In such instances, the scatter plot resembles an approximate rectangle, signifying that the scores are dispersed randomly along a horizontal line, predominantly centered around zero point (Tabachnick and Fidell, 2013). It can be seen in the scatterplots in Figure 4.5, Figure 4.6, Figure 4.7 and Figure 4.8 that the residues are distributed

roughly rectangularly, and the points are collected at point 0. In other words, there is no systematic modeling or clustering of scores that could cause violation of the assumption.

Independence of residuals: Imperfection of data estimated through regression lead to prediction errors, which are identified as residuals (Tabachnick and Fidell, 2013). In regression modeling, it is crucial for the residuals to be independent of one another (Pallant, 2016). The Durbin-Watson statistic is a statistical method employed to evaluate the level of correlation present within residuals. The Durbin-Watson statistic falls between 0 and 4 and value of 2 indicates a perfect absence of autocorrelation in the residuals. When it approaches 2, it is typically not considered problematic, but as the MIIC values move towards 0 or 4, it suggests stronger evidence of autocorrelation (Teo, 2014). These statistics were calculated for each discipline as 1.904 (see Table 4.44), 2.086 (see Table 4.47), 2.044 (see Table 4.50), and 2.039 (see Table 4.53), respectively. Consequently, these MIIC values near 2 do not violate the assumption of independence of residuals in regression analysis.

4.4.1.2. Results of Hierarchical Multiple Regression Analysis. The results of the hierarchical multiple regression analysis conducted for each discipline of STEM indicated whether the independent variables (recognition, performance-competence, interest, feminine stereotypes, masculine stereotypes and socioeconomic stereotypes) explained a statistically significant proportion of the variance in the dependent variable (identity) while controlling for gender and grade level.

Regression analysis operates under the presumption of correlation between variables. Through correlation testing, the significance of each variable is assessed, leading to the exclusion of unimportant variables in hierarchical multiple regression.

As illustrated respectively in Table 4.32, Table 4.33, Table 4.34 and Table 4.35 of Section 4.3.1.1.2, the results of the Pearson correlation analysis reveal that each variable exhibited a statistically significant correlation with at least three other variables in the

field of science, four other variables in the field of technology, three other variables in the field of engineering and three other variables in the field of mathematics, all falling within the 95% confidence interval.

Table 4.44 provides a summary of the comparison of nested regression models in hierarchical regression conducted for science identity. Following the introduction of dummy variables representing gender, being 5th grade student, being 6th grade student, and being 7th grade student in Block 1, the overall model accounted for 9.9% of the variance (0.099 × 100). With the inclusion of Block 2 variables (feminine stereotypes, masculine stereotypes, and socioeconomic stereotypes) the model's explanatory power increased to 12.2% of the variance (0.122 × 100). Subsequently, upon integrating Block 3 variables (recognition, performance-competence, and interest) the entire model explained 62% of the variance (0.620 × 100). R Square serves as an effect size, reflecting the strength of the relationship between dependent and independent variables. Cohen (1988) proposed a guideline where an R Square of 0.01 indicates a small effect size, 0.09 signifies a medium effect size, and 0.25 denotes a large effect size. Accordingly, a medium effect size was reported for both Model 1 and Model 2, whereas a large effect size was reported for model 3. The R Square change value in model 2 row shows that stereotype-based variables explain an additional 2.3 percent (0.023 x 100) of the variance in science identity when the effects of gender and grade level variables are statistically controlled. This signifies a statistically significant contribution (R Square change=.023, F change (3, 596) = 5.141, $p < 0.05$). The change in R Square value for Model 3 indicated that, following the removal of predictors in Model 1 and Model 2, approximately 49.8% of the total variance was accounted for by recognition, performance-competence, and interest. This also represented a statistically significant contribution *(R Square change=.498, F change* (3, 593) = 259.2, $p < 0.05$).

Table 4.44. Model summary[d] for predicted science identity.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			Sig. F Change	Durbin-Watson
						F Change	df1	df2		
1	0.315[a]	0.099	0.093	161.523	0.099	16.44	4	599	< 0.001*	
2	0.349[b]	0.122	0.111	159.874	0.023	5.141	3	596	0.002*	
3	0.787[c]	0.620	0.614	105.422	0.498	259.2	3	593	< 0.001*	1.904
a. Predictors: (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student										
b. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Masculine Stereotypes, Feminine stereotypes, Socioeconomic Status (SES) Stereotypes										
c. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Masculine Stereotypes, Feminine stereotypes, Socioeconomic Status Stereotypes, Performance-competence, Recognition, Interest										
d. Dependent Variable: Science Identity										
Note. *p< 0.05 (2-tailed).										

Table 4.45, presenting the ANOVA results, demonstrates that the overall model, encompassing both blocks of variables, was significant (F (10, 593) = 96.752, p< 0.05). It signifies that the linear combination of predictors predicted science identity in a statistically significant manner.

Table 4.45. ANOVA[a] results of three-step hierarchical regression analysis for predicting science identity.

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
1	Regression	171.561	4	42.890	16.440	$< 0.001^{b}$*
	Residual	1.562.772	599	2.609		
	Total	1.734.333	603			
2	Regression	210.982	7	30.140	11.792	$< 0.001^{c}$*
	Residual	1.523.352	596	2.556		
	Total	1.734.333	603			
3	Regression	1.075.285	10	107.529	96.752	$< 0.001^{d}$*
	Residual	659.048	593	1.111		
	Total	1.734.333	603			
a. Dependent Variable: Science Identity						
b. Predictors: (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student						
c. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Masculine Stereotypes, Feminine stereotypes, Socioeconomic Status (SES) Stereotypes						
d. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Masculine Stereotypes, Feminine stereotypes, Socioeconomic Status Stereotypes, Performance-competence, Recognition, Interest						
Note. *p< 0.05 (2-tailed).						

Table 4.46 below provides the regression coefficients for each model along with the significance MIIC values indicating whether these coefficients are statistically significant. Standardized regression coefficients, also known as beta coefficients (β), in hierarchical regression output demonstrate the contribution of each predictor to the

dependent variable after statistically removing the overlapping effects of all other variables.

The significance column for Model 1 reveals that only being a 5th grade student made a unique statistically significant contribution, with a beta coefficient of 0.301 ($p< 0.05$). However, gender, being a 6th grade student, and being a 7th grade student did not make unique contributions. The standardized coefficient serves as a measure of effect size as well. Following a rule of thumb, if the coefficient β falls between 0.10–0.29, it is considered a small effect size; between 0.30–0.49, it is medium; and if it is 0.50 or higher, it is deemed large (Cohen, 1988; Kraemer and Thiemann, 1987).

In this regard, being a 5th-grade student is perceived as having medium effect size. The significance column of Model 2 reveals that being a 5th grade student with a beta coefficient of 0.300 and masculine stereotypes with a beta coefficient of 0.132 uniquely and significantly contributed to predicting science identity ($p< 0.05$). Additionally, the first exhibited a medium effect size, while the second demonstrated a small to medium effect size with these coefficients. On the other hand, neither being a student other grade levels nor feminine and socioeconomic status stereotypes made a unique contribution ($p> 0.05$).

Finally, Model 3 demonstrated that three predictors related to the identity, being a fifth grader, and masculine stereotypes significantly influence identity prediction. These predictors, ranked by their level of importance, are recognition ($\beta= 0.383$), interest ($\beta= 0.285$), performance-competence ($\beta= 0.164$), being 5th grade student ($\beta= 0.090$) and masculine stereotypes ($\beta= 0.070$). The first predictor, recognition, exhibited a medium to large effect size, while interest and performance-competence demonstrated small the medium effect sizes. The last two predictors, on the contrary, demonstrated a small effect size.

Table 4.46. Regression coefficients for predicting science identity.

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
1	Constant	3.503	0.146		24.05	< 0.001*	3.217	3.789
	Gender	-0.074	0.131	-0.022	-0.56	0.572	-0.332	0.184
	Being 5th Grade Student	1.179	0.185	0.301	6.36	< 0.001*	0.815	1.543
	Being 6th Grade Student	-0.186	0.186	-0.047	-1.00	0.317	-0.551	0.179
	Being 7th Grade Student	0.105	0.185	0.027	0.57	0.571	-0.259	0.469

Table 4.46 Regression coefficients for predicting science identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
2	Constant	2.915	0.242		12.06	< 0.001*	2.440	3.390
	Gender	-0.107	0.139	-0.032	-0.77	0.441	-0.381	0.166
	Being 5th Grade Student	1.176	0.185	0.300	6.36	< 0.001*	0.813	1.539
	Being 6th Grade Student	-0.152	0.185	-0.039	-0.82	0.410	-0.515	0.210
	Being 7th Grade Student	0.151	0.187	0.038	0.80	0.421	-0.217	0.518
	Feminine Stereotypes	0.061	0.045	0.059	1.35	0.177	-0.028	0.151
	Masculine Stereotypes	0.131	0.045	0.132	2.92	0.004*	0.043	0.219
	SES Stereotypes	-0.032	0.048	-0.030	-0.68	0.497	-0.126	0.061

Table 4.46 Regression coefficients for predicting science identity. (cont.)

Model	Variable	Unstandardized Coefficients		Standardized Coefficients	t	p	95% Confidence Interval for B	
		B	Std. Error	Beta (β)			Lower Bound	Upper Bound
3	Constant	0.249	0.190		1.31	0.190	-0.124	0.623
	Gender	-0.043	0.092	-0.013	-0.46	0.642	-0.224	0.138
	Being 5th Grade Student	0.351	0.126	0.090	2.78	0.006*	0.103	0.598
	Being 6th Grade Student	-0.145	0.122	-0.037	-1.19	0.235	-0.384	0.094
	Being 7th Grade Student	-0.189	0.125	-0.048	-1.52	0.130	-0.434	0.056
	Feminine Stereotypes	0.000	0.030	0.000	-0.00	0.997	-0.060	0.059

Table 4.46 Regression coefficients for predicting science identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
	Masculine Stereotypes	0.069	0.030	0.070	2.33	0.020*	0.011	0.128
	SES Stereotypes	-0.020	0.031	-0.019	-0.65	0.517	-0.082	0.041
	Recognition	0.400	0.039	0.383	10.37	< 0.001*	0.324	0.476
	Performance-competence	0.172	0.047	0.164	3.66	< 0.001*	0.080	0.264
	Interest	0.272	0.038	0.285	7.09	< 0.001*	0.197	0.348
a.Dependent Variable: Science Identity								
Note. *p< 0.05 (2-tailed).								

Table 4.47 summarizes the hierarchical regression analysis comparing nested models for technology identity. Initially, in Block 1, dummy variables representing gender and grade level were introduced, collectively explaining 2.0% of the variance. With the addition of Block 2 variables (feminine stereotypes, masculine stereotypes, and socioeconomic stereotypes), the model's explanatory power increased to 3.6% of the variance. Subsequently, with the integration of Block 3 variables (recognition, performance-competence, and interest), the entire model explained 66.2% of the variance. In line with the guideline suggested by Cohen (1988), small effect sizes were reported for both Model 1 and Model 2, while a large effect size was reported for Model 3. In Model 2, the

R Square change value indicates that stereotype-based variables explain an additional 1.6% of the variance in technology identity when controlling for the effects of gender and grade level variables. This increase is statistically significant (R Square change = 0.016, F change (3, 596) = 3.221, $p < 0.05$). In Model 3, the change in R Square value reveals that after eliminating predictors from both Model 1 and Model 2, approximately 62.6% of the total variance was accounted for by recognition, performance-competence, and interest. This change is statistically significant, as indicated by the R Square change of 0.626 and the associated F change statistic of 365.633 with $p < 0.05$.

Table 4.47. Model summary[d] for predicted technology identity.

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**	**Change Statistics**			**Sig. F Change**	**Durbin-Watson**
						F Change	**df1**	**df2**		
1	0.142[a]	0.020	0.014	180.310	0.020	3.094	4	599	0.015*	
2	0.189[b]	0.036	0.025	179.316	0.016	3.221	3	596	0.022*	
3	0.813[c]	0.662	0.656	106.491	0.626	365.633	3	593	< 0.001*	2.086
a. Predictors: (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student										
b. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Socioeconomic Status (SES) Stereotypes, Masculine Stereotypes										
c. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Socioeconomic Status Stereotypes, Masculine Stereotypes, Interest, Recognition, Performance-competence										
d. Dependent Variable: Technology Identity										
Note. *p< 0.05, (2-tailed).										

Table 4.48, which displays the ANOVA results, indicates that the overall model, including both blocks of variables, was statistically significant (F (10, 593) = 115.978,

$p < 0.05$). This suggests that the collective linear combination of predictors predicted technology identity in a statistically significant manner.

Table 4.48. ANOVA[a] results of three-step hierarchical regression analysis for predicting technology identity.

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
1	Regression	40.236	4	10.059	3.094	0.015[b]*
	Residual	1.947.454	599	3.251		
	Total	1.987.690	603			
2	Regression	71.305	7	10.186	3.168	0.003[c]*
	Residual	1.916.385	596	3.215		
	Total	1.987.690	603			
3	Regression	1.315.214	10	131.521	115.978	< 0.001[d]*
	Residual	672.476	593	1.134		
	Total	1.987.690	603			
a. Dependent Variable: Technology Identity						
b. Predictors: (Constant), Being 7th Grade Student,						
Gender, Being 6th Grade Student, Being 5th Grade Student						
c. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Socioeconomic Status (SES) Stereotypes, Masculine Stereotypes						
d. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Socioeconomic Status Stereotypes, Masculine Stereotypes, Interest, Recognition, Performance-competence						
Note. *p< 0.05, (2-tailed).						

Table 4.49 presents regression coefficients for each model for predicting technology identity, alongside significance MIIC values indicating whether these coefficients are statistically significant. In Model 1, none of the variables made a unique statistically significant contribution ($p > 0.05$). However, in Model 2, feminine stereotypes uniquely and significantly contributed to predicting technology identity, with a beta coefficient of 0.101 ($p < 0.05$), indicating a small effect size. Conversely, gender, grade level related variables, masculine stereotypes and socioeconomic status stereotypes did not make unique contributions ($p > 0.05$). In Model 3, three predictors related to identity and socioeconomic status stereotypes significantly influenced identity prediction. These predictors, ranked by importance, are recognition ($\beta = 0.375$), performance-competence ($\beta = 0.296$), interest ($\beta = 0.225$), and SES stereotypes ($\beta = 0.063$). Recognition exhibited a medium to large effect size, while performance-competence and interest demonstrated small to medium effect sizes. SES stereotypes dimension exhibited small effect size.

Table 4.49. Regression coefficients for predicting technology identity.

Model	**Variable**	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**p**	**95% Confidence Interval for B**	
		B	**Std. Error**	**Beta (β)**			**Lower Bound**	**Upper Bound**
1	Constant	4.241	0.163		26.09	< 0.001*	3.922	4.561
	Gender	0.232	0.147	0.064	1.58	0.114	-0.056	0.520

Table 4.49 Regression coefficients for predicting technology identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
	Being 5th Grade Student	0.139	0.207	0.033	0.67	0.502	-0.267	0.545
	Being 6th Grade Student	-0.368	0.208	-0.087	-1.77	0.077	-0.775	0.040
	Being 7th Grade Student	0.244	0.207	0.058	1.18	0.239	-0.162	0.650
2	Constant	3.600	0.275		13.10	< 0.001*	3.060	4.139
	Gender	0.236	0.155	0.065	1.52	0.129	-0.069	0.541
	Being 5th Grade Student	0.148	0.208	0.035	0.71	0.478	-0.261	0.556

Table 4.49 Regression coefficients for predicting technology identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
	Being 6th Grade Student	-0.347	0.207	-0.082	-1.67	0.095	-0.753	0.060
	Being 7th Grade Student	0.288	0.208	0.069	1.38	0.167	-0.121	0.696
	Feminine Stereotypes	0.110	0.047	0.101	2.34	0.020*	0.018	0.202
	Masculine Stereotypes	0.038	0.046	0.039	0.84	0.402	-0.052	0.129
	SES Stereotypes	0.025	0.053	0.021	0.46	0.642	-0.080	0.130
3	Constant	0.171	0.195		0.88	0.380	-0.211	0.554
	Gender	-0.020	0.093	-0.005	-0.21	0.831	-0.203	0.163
	Being 5th Grade Student	0.184	0.124	0.044	1.48	0.139	-0.060	0.427

Table 4.49 Regression coefficients for predicting technology identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
	Being 6th Grade Student	-0.051	0.123	-0.012	-0.42	0.677	-0.294	0.191
	Being 7th Grade Student	0.023	0.124	0.006	0.19	0.850	-0.220	0.267
	Feminine Stereotypes	-0.033	0.028	-0.031	-1.18	0.242	-0.089	0.022
	Masculine Stereotypes	-0.019	0.027	-0.019	-0.71	0.477	-0.073	0.034
	SES Stereotypes	0.074	0.032	0.063	2.31	0.021*	-0.011	0.138
	Recognition	0.403	0.040	0.375	10.07	< 0.001*	0.325	0.482
	Performance-competence	0.322	0.053	0.296	6.11	< 0.001*	0.218	0.425
	Interest	0.224	0.041	0.225	5.47	< 0.001*	0.143	0.304
a.Dependent Variable: Technology Identity								
Note. *p< 0.05, (2-tailed).								

Table 4.50 presents the results of hierarchical regression analysis examining different models for predicting engineering identity. Initially, gender and grade level variables accounted for 2.4% of the variance (Block 1). Adding stereotype variables in Block 2 increased the explanatory power to 8.7%. Finally, integrating recognition, performance-competence, and interest variables in Block 3 resulted in the model explaining 50.2% of the variance. Following Cohen's guideline (1988), effect sizes were deemed small for Model 1, small to medium for Model 2, and large for Model 3. In Model 2, the R Square change value indicates that stereotype-based variables explain an additional 6.3% of the variance in engineering identity when controlling for the effects of gender and grade level variables. This increase is statistically significant (R Square change = 0.063, F change (3, 596) = 13.725, $p < 0.05$). In Model 3, after removing predictors from previous models, recognition, performance-competence, and interest collectively accounted for 41.5% of the variance, statistically significant according to R Square change (0.415) and associated F change statistics (165.040), $p< 0.05$.

Table 4.50. Model summary[d] for predicted engineering identity.

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**	**Change Statistics**				
						F Change	**df1**	**df2**	**Sig. F Change**	**Durbin-Watson**
1	0.155[a]	0.024	0.017	175.176	0.024	3.683	4	599	0.006*	
2	0.295[b]	0.087	0.076	169.848	0.063	13.725	3	596	< 0.001*	
3	0.709[c]	0.502	0.494	125.703	0.415	165.040	3	593	< 0.001*	2.044
a. Predictors: (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student										
b. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Masculine Stereotypes, Socioeconomic Status (SES) Stereotypes										
c. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Masculine Stereotypes, Socioeconomic Status (SES) Stereotypes, Interest, Recognition, Performance-competence										
d. Dependent Variable: Engineering Identity										
Note. *p< 0.05, (2-tailed).										

Table 4.51, presenting the ANOVA results, reveals that the overall model, encompassing both blocks of variables, was statistically significant (F (10, 593) = 59.890, $p < 0.05$). This implies that the combination of predictors used in the model predicted engineering identity in a statistically significant manner.

Table 4.51. ANOVA[a] results of three-step hierarchical regression analysis for predicting engineering identity.

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
1	Regression	45.206	4	11.302	3.683	0.006[b]*
	Residual	1.838.137	599	3.069		
	Total	1.883.344	603			
2	Regression	163.986	7	23.427	8.121	< 0.001[c]*
	Residual	1.719.358	596	2.885		
	Total	1.883.344	603			
3	Regression	946.334	10	94.633	59.890	< 0.001[d]*
	Residual	937.009	593	1.580		
	Total	1.883.344	603			
a. Dependent Variable: Engineering Identity						
b. Predictors: (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student						
c.Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Masculine Stereotypes, Socioeconomic Status (SES) Stereotypes						
d. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Masculine Stereotypes, Socioeconomic Status Stereotypes, Interest, Recognition, Performance-competence						
Note. *p< 0.05, (2-tailed).						

Table 4.52 displays regression coefficients for each model aimed at predicting engineering identity, alongside significance MIIC values indicating whether these coefficients are statistically significant. In Model 1, only gender made a unique statistically significant contribution, with a beta coefficient of 0.137 ($p < 0.05$). However,

being a 5th, 6th, and 7th-grade student did not make unique contributions. Moving to Model 2, both gender, with a beta coefficient of 0.153, and feminine stereotypes, with a beta coefficient of 0.244, uniquely and significantly contributed to predicting engineering identity ($p < 0.05$), indicating a small to medium effect size. Conversely, grade level variables, masculine stereotypes, and socioeconomic status stereotypes did not make unique contributions ($p > 0.05$). In Model 3, feminine stereotypes, SES stereotypes, performance-competence and interest significantly influenced identity prediction. Ranked by importance, these predictors are performance-competence (β= 0.461), interest (β= 0.245), feminine stereotypes (β= 0.078), and SES stereotypes (β= 0.069). Performance-competence exhibited a medium to large effect size, whereas interest exhibited a small to medium effect size. On the other hand, others demonstrated a small effect size.

Table 4.52. Regression coefficients for predicting engineering identity.

Model	**Variable**	**Unstandardized Coefficients**		**Standardized Coefficients**				
		B	**Std. Error**	**Beta (β)**	**t**	**p**	**95% Confidence Interval for B Lower Bound**	**Upper Bound**
1	Constant	2.592	0.158		16.41	< 0.001*	2.282	2.902
	Gender	0.485	0.143	0.137	3.40	< 0.001*	0.205	0.765

Table 4.52 Regression coefficients for predicting engineering identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
	Being 5th Grade Student	0.320	0.201	0.079	1.59	0.111	-0.074	0.715
	Being 6th Grade Student	0.044	0.202	0.011	0.22	0.828	-0.352	0.440
	Being 7th Grade Student	0.074	0.201	0.018	0.37	0.713	-0.321	0.469
2	Constant	1.625	0.267		6.09	< 0.001*	1.100	2.149
	Gender	0.540	0.143	0.153	3.78	< 0.001*	0.260	0.821
	Being 5th Grade Student	0.281	0.198	0.069	1.42	0.156	-0.108	0.670

Table 4.52 Regression coefficients for predicting engineering identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
	Being 6th Grade Student	0.048	0.196	0.012	0.25	0.806	-0.336	0.432
	Being 7th Grade Student	0.189	0.196	0.046	0.96	0.336	-0.196	0.573
	Feminine Stereotypes	0.262	0.043	0.244	6.05	< 0.001*	0.177	0.347
	Masculine Stereotypes	-0.016	0.041	-0.017	-0.40	0.692	-0.098	0.065
	SES Stereotypes	0.048	0.049	0.044	0.99	0.324	-0.047	0.143
3	Constant	0.188	0.210		0.89	0.372	-0.226	0.601
	Gender	0.264	0.107	0.075	2.47	0.014*	0.054	0.473
	Being 5th Grade Student	0.163	0.148	0.040	1.10	0.272	-0.128	0.453

Table 4.52 Regression coefficients for predicting engineering identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
	Being 6th Grade Student	0.104	0.146	0.025	0.71	0.476	-0.183	0.391
	Being 7th Grade Student	-0.121	0.146	-0.030	-0.83	0.408	-0.408	0.166
	Feminine Stereotypes	0.083	0.036	0.078	2.32	0.021*	0.013	0.154
	Masculine Stereotypes	-0.041	0.034	-0.043	-1.22	0.222	-0.108	0.025
	SES Stereotypes	0.076	0.036	0.069	2.09	0.037*	0.005	0.147
	Recognition	-0.014	0.044	-0.012	-0.33	0.744	-0.101	0.072
	Performance-competence	0.497	0.052	0.461	9.49	< 0.001*	0.394	0.600
	Interest	0.246	0.049	0.245	5.06	< 0.001*	0.150	0.341
a.Dependent Variable: Engineering Identity								
Note. *p< 0.05, (2-tailed).								

Table 4.53 presents the hierarchical regression analysis comparing different models for predicting mathematics identity. Initially, gender and grade level variables in Block 1 accounted for 2.1% of the variance. Adding stereotype variables in Block 2 increased the explanatory power to 6.5%. Finally, integrating recognition, performance-competence, and interest variables in Block 3 resulted in the model explaining 74.3% of the variance. Following Cohen's guideline (1988), effect sizes were considered small for Model 1, small to medium for Model 2, and large for Model 3. In Model 2, stereotype-based variables contributed an additional 4.4% of explained variance, statistically significant even after controlling for gender and grade level effects (R Square change = 0.044, F change (3, 596) = 9.332, $p < 0.05$). In Model 3, after removing predictors from previous models, recognition, performance-competence, and interest collectively accounted for 67.9% of the variance, with statistical significance (R Square change = 0.679, F change (3, 593) =522.129, $p < 0.05$)

Table 4.53. Model summary[d] for predicted mathematics identity.

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**	**Change Statistics**			**Sig. F Change**	**Durbin-Watson**
						F Change	**df1**	**df2**		
1	0.144a	0.021	0.014	189.911	0.021	3.155	4	599	0.014*	
2	0.254b	0.065	0.054	186.069	0.044	9.332	3	596	< 0.001*	
3	0.862c	0.743	0.739	0.97753	0.679	522.129	3	593	< 0.001*	2.039
a. Predictors: (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student										
b. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Socioeconomic Status (SES) Stereotypes, Masculine Stereotypes										
c. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Socioeconomic Status Stereotypes, Masculine Stereotypes, Recognition, Interest, Performance-competence										
d. Dependent Variable: Mathematics Identity										
Note. *p< 0.05, (2-tailed).										

Table 4.54, displays the ANOVA results, indicates that the overall model, incorporating both blocks of variables, reached statistical significance (F (10, 593) = 171.545, p < 0.05). This suggested that the combination of predictors utilized in the model predicted mathematics identity in a statistically significant manner.

Table 4.54. ANOVA[a] results of three-step hierarchical regression analysis for predicting mathematics identity.

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
1	Regression	45.515	4	11.379	3.155	0.014[b]*
	Residual	2.160.370	599	3.607		
	Total	2.205.885	603			
2	Regression	142.444	7	20.349	5.878	< 0.001[c]*
	Residual	2.063.441	596	3.462		
	Total	2.205.885	603			
3	Regression	1.639.233	10	163.923	171.545	< 0.001[d]*
	Residual	566.652	593	0.956		
	Total	2.205.885	603			
a. Dependent Variable: Mathematics Identity						
b. Predictors: (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student						
c. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Socioeconomic Status (SES) Stereotypes, Masculine Stereotypes						
d. Predictors: (Constant), (Constant), Being 7th Grade Student, Gender, Being 6th Grade Student, Being 5th Grade Student, Feminine stereotypes, Socioeconomic Status Stereotypes, Masculine Stereotypes, Recognition, Interest, Performance-competence						
Note. *p< 0.05, (2-tailed).						

Table 4.55 presents regression coefficients for each model aimed at predicting mathematics identity, along with significance MIIC values indicating whether these coefficients are statistically significant. In Model 1, being a 5th-grade student made a unique statistically significant contribution, with a beta coefficient of 0.114 ($p < 0.05$), indicating a small to medium effect size. Transitioning to Model 2, being a 5th-grade student (β= 0.114), feminine stereotypes (β= 0.134), and masculine stereotypes (β= 0.133) uniquely and significantly contributed to predicting mathematics identity ($p < 0.05$), demonstrating small to medium effect sizes. However, grade level variables and socioeconomic status stereotypes did not make unique contributions ($p > 0.05$). In Model 3, only identity-related variables significantly influenced identity prediction. Ranked by importance, these predictors are recognition (β= 0.442), interest (β= 0.251), and performance-competence (β= 0.208). Recognition exhibited a medium to large effect size, while interest and performance-competence demonstrated a small to medium effect size.

Table 4.55. Regression coefficients for predicting mathematics identity.

Model	**Variable**	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**p**	**95% Confidence Interval for B**	
		B	**Std. Error**	**Beta (β)**			**Lower Bound**	**Upper Bound**
1	Constant	3.312	0.171		19.35	< 0.001*	2.976	3.648
	Gender	-.241	0.155	-0.063	-1.56	0.119	-0.545	0.062
	Being 5th Grade Student	0.659	0.218	0.149	3.03	0.003*	0.231	1.087

Table 4.55 Regression coefficients for predicting mathematics identity. (cont.)

Model	Variable	Unstandardized Coefficients		Standardized Coefficients	t	p	95% Confidence Interval for B	
		B	Std. Error	Beta (β)			Lower Bound	Upper Bound
	Being 6th Grade Student	0.179	0.219	0.040	0.82	0.413	-0.250	0.608
	Being 7th Grade Student	0.152	0.218	0.034	0.70	0.486	-0.276	0.580
2	Constant	2.334	0.274		8.53	< 0.001*	1.797	2.871
	Gender	-0.268	0.160	-0.070	-1.67	0.095	-0.583	0.046
	Being 5th Grade Student	0.505	0.217	0.114	2.33	0.020*	0.079	0.930
	Being 6th Grade Student	0.117	0.215	0.026	0.54	0.588	-0.305	0.538
	Being 7th Grade Student	0.160	0.213	0.036	0.75	0.454	-0.259	0.579

Table 4.55 Regression coefficients for predicting mathematics identity. (cont.)

Model	Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta (β)	t	p	95% Confidence Interval for B Lower Bound	Upper Bound
	Feminine Stereotypes	0.142	0.045	0.134	3.13	0.002*	0.053	0.232
	Masculine Stereotypes	0.146	0.049	0.133	2.98	0.003*	0.050	0.242
	SES Stereotypes	-0.014	0.051	-0.012	-0.28	0.778	-0.115	0.086
3	Constant	-0.153	0.158		-0.96	0.335	-0.463	0.158
	Gender	-0.051	0.085	-0.013	-0.60	0.547	-0.217	0.115
	Being 5th Grade Student	0.045	0.116	0.010	0.38	0.701	-0.183	0.272
	Being 6th Grade Student	-0.071	0.113	-0.016	-0.62	0.533	-0.294	0.152
	Being 7th Grade Student	-0.056	0.113	-0.013	-0.50	0.620	-0.277	0.165
	Feminine Stereotypes	0.017	0.024	0.016	0.70	0.484	-0.030	0.064

Table 4.55 Regression coefficients for predicting mathematics identity. (cont.)

Model	Variable	Unstandardized Coefficients		Standardized Coefficients	t	p	95% Confidence Interval for B	
		B	Std. Error	Beta (β)			Lower Bound	Upper Bound
	Masculine Stereotypes	0.043	0.026	0.039	1.67	0.095	-0.008	0.094
	SES Stereotypes	0.030	0.027	0.026	1.12	0.265	-0.023	0.084
	Recognition	0.461	0.042	0.442	011.09	< 0.001*	0.380	0.543
	Performance-competence	0.223	0.054	0.208	4.12	< 0.001*	0.117	0.330
	Interest	0.252	0.043	0.251	5.84	< 0.001*	0.167	0.337
a.Dependent Variable: Mathematics Identity								
Note. *p$<$ 0.05, (2-tailed).								

5. DISCUSSION

This concluding chapter begins with a summary of the study, serving as a reminder of its purpose, rationale, theoretical background, and methodology. Subsequently, it highlights the outcomes of adapting the STEMDIds scale into a new format, along with the findings derived from both descriptive and inferential statistics. Furthermore, it explores the implications for future research based on these findings, with the aim of enhancing the identities of middle school students in STEM fields and eradicating their stereotypical beliefs. Lastly, it outlines the study's limitations and provides recommendations to address these limitations in future research endeavors.

5.1. Summary of Present Study

The evolving global economy is driving an increasing demand for STEM qualifications and skills, both currently and in the future. As a result, it is essential for individuals to cultivate strong STEM identities, enabling them to actively participate in STEM fields. The attainment of strong STEM identities is anticipated for every individual, regardless of gender (Hanson and Krywult-Albanska, 2020). Carlone and Johnson (2007) developed a flexible model for science identity, which was further refined by Hazari and her colleagues (2010). The main purpose of the present study was to evaluate the identity status of middle school students in STEM disciplines within the framework of this model.

Establishing and sustaining these identities can pose significant challenges, particularly for marginalized groups, such as girls or those from low socioeconomic backgrounds. A complicating factor in this context is the presence of stereotypical beliefs about STEM. Therefore, this study sought to explore students' profiles regarding the stereotypical beliefs they hold about four STEM disciplines. Additionally, it aimed to investigate how accurately the stereotypical beliefs suggested in the literature could predict STEM identities. To accomplish these objectives, 604 middle school students

were included in the study. The STEMDIds scale, derived from the Physics Identity Scale by Ulu and Yerdelen-Damar (2022), comprising 68 items, and the STEMDSBs scale, developed by Aydin *et al.* (2023), consisting of 48 items, were utilized. Quantitative data underwent analysis to check the construct validity of the adapted scale and assess descriptive and inferential statistics. The analyses indicated successful scale adaptation, diverse student profiles concerning STEM identities and stereotypes, and varying degrees of association between identity and stereotypes. The results are further explored along with potential explanations.

5.2. Discussion of the Results

5.2.1. Adaptation of STEM Disciplinary Identities Scale

STEM Disciplinary Identities Scale consists of four subscales: Science Identity Scale, Technology Identity Scale, Engineering Identity Scale, and Mathematics Identity Scale. Confirmatory factor analysis was conducted to test whether each subscale retains the four-dimensional structure as in the original physics identity scale (Cheng *et al.*, 2018) and its Turkish version (Ulu and Yerdelen-Damar, 2022). Multiple fit indices were used to evaluate the results. While TLI, CFI, and SRMR MIIC values for each disciplinary identity showed good fit for each STEM discipline, the RMSEA MIIC values fell within an acceptable range (Hu and Bentler, 1999; Marsh *et al.*, 2004). The magnitudes of factor loadings ranged from 0.68 to 0.82 for science, 0.73 to 0.88 for technology, 0.76 to 0.91 for engineering, and 0.79 to 0.89 for mathematics. These MIIC values exceed the desired minimum value of 0.50 and demonstrate good or excellent factor loadings (Hair *et al.*, 2009; Tabachnick and Fidell, 2013). Moreover, all items of the subscales loaded significantly onto their respective hypothesized factors. All these results support that the adapted subscales of STEM disciplinary identities scale have a four-dimensional structure similar to the Turkish version of the physics identity scale.

In order to assess the internal consistency of the results obtained from the subscales and dimensions, reliability statistics as Cronbach's alpha coefficient and MIIC

value were calculated. Alpha MIIC values were found to be 0.95 for the entire science identity subscale and 0.81-0.90 for its dimensions; 0.96 for the entire technology identity scale and 0.85-0.91 for its subscales; 0.96 for the entire engineering identity subscale and 0.87-0.92 for its dimensions; 0.97 for the entire mathematics identity scale and 0.89-0.93 for its dimensions. These alpha coefficients are greater than the recommended minimum cut-off value of 0.70 and they are even good or excellent (Cicchetti, 1994; Nunnally and Bernstein, 1978). MIIC MIIC values for the interested dimensions of disciplinary identities were found to vary between 0.58 and 0.65 for science, 0.60 and 0.72 for technology, 0.65 and 0.70 for engineering, and 0.70 and 0.76 for mathematics. These MIIC values are also greater than the recommended minimum cut-off value of 0.20 (Briggs and Cheek, 1986). In conclusion, the evidence collected in this study supported that the Science identity, technology identity, engineering identity and mathematics identity scales provide valid and reliable results. The four adapted subscales are ready for use by researchers in relevant disciplines, independently of each other.

Since each subscale describes identity through four dimensions, they provide a holistic picture of the perceptions that individuals reflect when considering, for example, what it means to be a "math person" (Cribbs and Utley, 2023). Meanwhile, measurements of each dimensions provide specific insights. The identity dimension singularly reflects the degree to which individuals view themselves as a particular type of person within a relevant discipline, such as identifying as a "science person" (Hazari *et al.*, 2010). The interest dimension indicates a person's inclination to learn more within the relevant STEM discipline, while recognition represents one's self-perception regarding acknowledgment as a member of that discipline (Hacıömeroğlu, 2020). Performance-competence dimension demonstrates participants' feelings of achievement in carrying out tasks related to engaged discipline, such as successfully completing STEM activities (Dou and Cian, 2020).

5.2.2. Profile of Middle School Students in Stem Disciplinary Identities and Related Dimensions

Except for identity and recognition dimension of science, all dimensions within these disciplines surpass the midpoint of 4.0. In contrast, none of the engineering and mathematics identity dimensions have mean MIIC values exceeding the midpoint. The means roughly for the identity and related dimensions, from high to low, were recorded in technology, science, mathematics, and engineering. It is claimed that especially technology identity from STEM identity in different (physical and digital) fields, are affected by the financial opportunities offered to young people (Godec *et al.*, 2020). In the 21st century, people are undoubtedly highly engaged with technology, and there is a high integration of technology into the other three disciplines. This might lead to students to have a stronger identity in technology. In terms of overall mathematics and engineering identities, their means being the lowest together justifies the conclusion reached by Gülen and Dönmez (2021) that mathematics identity affects engineering identity. In addition, the fact that the engineering identity mean is lower than others may indicate that students' self-perception as a 'type of person' in the field of engineering is limited (Dou and Cian, 2020). Similarly, a study investigating middle school students' understanding of engineering supported that they had a limited understanding of engineering and engineers (Jordan and Snyder, 2013).

Gender differences are apparent when examining average identity MIIC values and related dimensions among girls and boys. Girls tend to identify more with science and mathematics, portraying themselves as "science person" and "math person" respectively, whereas boys more frequently associate themselves with being a "tech person" and an "engineering person". This inclination of girls towards biology and chemistry topics compared to boys could contribute to their stronger science identity (Hazari *et al.*, 2013). In addition, efforts by educators are highlighted to mitigate the marginalization of girls, particularly in the prioritization of science and mathematics within formal education, which significantly influences identity formation in these domains. On the other hand, girls have low sense of recognition in all disciplines except mathematics.

This supports the fact that in STEM fields they often face little recognition (Cobb and Comfort, 2023). Notably, both girls and boys demonstrate higher performance-competence scores in technology compared to engineering. The high scores in the performance-competence dimension within the field of technology suggest that all students exhibit a strong belief in their capacity to excel in technology-related tasks, such as performing well on a technology exam and comprehending technological concepts (Godwin *et al.*, 2013). Conversely, the decline in scores related to engineering competence might be attributed to the limited exposure students have within the engineering community of practice, a finding consistent with prior research (Feder *et al.*, 2009). In the last dimension, interest, girls showed a lower mean value than boys only in the field of engineering. This reveals the importance of fostering and enhancing girls' interest in the field of engineering.

Another variable where the mean MIIC values of identity related dimensions differ is the grade levels of middle school students. Specifically, when it comes to the first dimension, identity, 5th graders tended to exhibit higher means in three out of four disciplines, except for the technology discipline. This aligns with the findings of research indicating a decline in STEM identification among students as they progress through middle school (Carlone *et al.*, 2014). Similarly, in the recognition dimension, 5th graders also show the highest means across all disciplines except for technology. The findings regarding the identity and recognition dimensions favoring 5th-grade students align with Ladachart and his colleagues' study (2023), which suggests that students who strongly identify with STEM are more likely to develop their STEM identities when they receive social recognition from others. Moreover, 5th-grade students also demonstrated the highest mean MIIC values in the performance-competence and interest dimensions within the fields of science and mathematics. Conversely, 7th grade students exhibited the highest mean MIIC values across all dimensions of identity within the technology field. Similarly, they also display the highest means in the performance-competence and interest dimensions of the engineering. Various factors could contribute to this outcome. However, the presence of a Technology and Design course tailored for 7th graders in the curriculum, which incorporates product devel-

opment processes related to technology and engineering and introduces role models in these fields, likely plays a significant role (MEB, 2018b). Interestingly, among all grade levels, Grades 6 and 8 were the only ones that did not show a single high mean value in any dimension of any discipline.

5.2.3. Profile of Middle School Students in STEM Disciplinary Stereotypical Beliefs and Related Dimensions

One notable finding regarding STEM stereotypical beliefs across STEM disciplines is that, across all disciplines, the mean scores for the masculine dimension are above the midpoint in the field of technology and engineering. The masculine dimension holds the highest average MIIC values in the other two dimensions as well. Furthermore, across all disciplines, the SES dimension has the next highest averages following the masculine dimension. This outcome aligns with the common perception that STEM fields are associated with masculinity and appeal more to individuals from higher socioeconomic backgrounds (Kuchynka *et al.*, 2018; Musso *et al.*, 2022). Meanwhile, the highest average scores for masculine and socioeconomic stereotypes are observed in engineering, while the lowest are in science. The female dimension achieved its highest average scores in mathematics and science, respectively. This finding corresponds with the stereotype often seen in middle school settings, where girls are stereotyped as excelling more in math and science than boys (Evans *et al.*, 2011; Passolunghi *et al.*, 2014).

Despite gender-based stereotypes taking root early, research indicates that children aged 7 to 11 believe in the potential for men and women to take on diverse roles irrespective of gender (Liben *et al.*, 2002). However, contrasting with this finding, the present study revealed gender disparities in students' perceptions of STEM stereotypes. STEM fields, often associated with talent stereotypes favoring men (Koenig, 2018). Surprisingly, when comparing the four STEM disciplines, girls displayed higher mean MIIC values for feminine stereotypes, while boys exhibited higher mean MIIC values for masculine stereotypes. A study examining individuals in middle childhood and

early adolescence found a result consistent with this study, such that boys showed more masculine biases, while girls showed more female biases (McGuire *et al.*, 2020). That is, participants in that study tended to perceive their own gender group as proficient in STEM fields, mirroring the results of this study. Furthermore, this study revealed that across all disciplines, boys exhibited higher mean MIIC values for masculine stereotypes compared to girls' mean MIIC values for feminine stereotypes. This suggests that male students may not have provided equitable responses regarding the representation of men and women in STEM. Notably, both girls and boys demonstrated the highest levels of femininity stereotypes in the mathematics field. In contrast, feminine stereotypes were more pronounced among girls in engineering, while boys exhibited higher masculine stereotypes in both technology and engineering fields. Regarding the third dimension, socioeconomic status, it was found that men displayed greater bias across all disciplines, particularly in mathematics.

The stereotypes embraced by middle school students are likely influenced by their grade levels, thus yielding different outcomes when compared across various grade levels. Initially, the analysis indicated that 8th-grade students studying science and technology disciplines, along with 5th-grade students focusing on engineering and mathematics disciplines, exhibit a higher prevalence of feminine stereotypes. Notably, among all disciplines, 7th graders exhibited the lowest average scores in this regard. Additionally, 5th graders across all four STEM disciplines displayed the highest average MIIC values for both the masculine and socioeconomic status dimensions. Specifically, regarding the masculine dimension, except for mathematics, the lowest averages were observed among 6th graders. Similarly, the lowest averages for the socioeconomic status dimension were found among 8th graders across all disciplines. Based on these findings, it is inconclusive whether there is a specific pattern regarding the increase or decrease of stereotypical beliefs across different grade levels. Nevertheless, it can be roughly claimed that mostly 5th graders tend to hold biased beliefs. Jones (2002) outlined four primary origins of stereotypes. When considering STEM stereotypical beliefs across different grade levels, it appears that fifth graders may be influenced by three out of these four sources. Their cognitive processes, the way they interpret

information from their surroundings, and the conclusions they draw about societal roles likely distinguish them from students in other grades. The mean MIIC values for the feminine dimension across all disciplines consistently fall behind those for the masculine and socioeconomic status dimensions. This aligns with existing literature, which suggests that STEM stereotypes encompass the notion that STEM fields are biased towards males or are more attractive to individuals from higher socioeconomic backgrounds (Kessels, 2015; Musso *et al.*, 2022).

5.2.4. The Relation of Stereotypical Beliefs to Identity Dimensions in STEM Disciplines

A three-step Hierarchical Multiple Regression analysis was performed for each STEM discipline to explore the relation between several independent variables (feminine stereotypes, masculine stereotypes, socioeconomic status stereotypes, recognition, performance-competence, and interest) and a dependent variable, identity. This analysis controlled for the influences of gender and grade level. Several studies have established associations between certain factors such as gender, age, and perceptions of stereotypes, suggesting their predictive power concerning identity (Miller *et al.*, 2015; Schimmack, 2021; Starr, 2018). A similar revelation was explained by the present study. For each discipline, all three sets of predictors-gender and grade level in the first set, stereotype dimensions in the second set, and identity dimensions in the third set-were found to significantly predict identity. Gender and students' grade level explained the variance in identity in the following order from highest to lowest: science (9.9%), engineering (2.4%), mathematics (2.1%), and technology (2.0%). The highest variance observed in science identity is consistent with the conclusion that the identities of middle school students are significantly influenced by their age (as an indicator of grade level) and gender, particularly in the context of science (Vincent-Ruz and Schunn, 2018). The stereotypes individuals hold interact with their STEM identity (Leaper, 2015). In this regard, this study demonstrated that the cluster of stereotype-related variables accounted for the variability in engineering (6.3%), mathematics (4.4%), science (2.3%), and technology (1.6%) identities, in descending order of magnitude. This

finding once again affirms the predictive influence of stereotypes on individuals' identification with engineering and mathematics in STEM fields, as highlighted by previous studies (Gunderson *et al.*, 2012; Jordan and Snyder, 2013). Across all disciplines, the identity-related variables stood out in explaining a significantly higher proportion of the variance compared to other sets. They accounted for more than forty percent of the variability in identity (e.g., science and engineering identity), and occasionally even exceeded sixty percent of the variability in identity (e.g., technology and mathematics identity). This indicates that the observed coefficient of determination (designated as R square) of the variables in the final set closely aligned with the findings of similar studies (Dou and Cian, 2022; Cheng *et al.*, 2018). Besides these observations, as indicated in the ANOVA tables, three models from each discipline were significant at the p = 0.05 level. Notably, across all disciplines, Model 3 consistently exhibited the highest F value. In simpler terms, the 3. regression model appears to be particularly effective in capturing and explaining the variability in identity.

When examining the distinct contributions of predictors to identities in overall models, discrepancies between disciplines become apparent. Initially, it was observed that recognition, interest, performance-competence, and being a 5th-grade student were sequentially influential in predicting science identity. The analysis indicated that SES stereotypes, recognition, performance, and interest each have unique impacts on technology identity. However, when considering their regression coefficient MIIC values , it is evident that SES stereotypes exhibit a notably weaker predictive influence on this identity compared to the other predictors. The subsequent analysis concluded that the variables, ranked in descending order of importance, performance-competence, interest, feminine stereotypes, gender stereotypes, and SES stereotypes, each had unique effects on the third disciplinary identity examined within STEM, namely engineering identity.

In the final model, the dependent variable, mathematics identity, was solely predicted by the identity-related variables recognition, performance-competence, and interest. Notably, the impact of recognition significantly outweighed that of the other two variables. Hazari *et al.* (2010) also arrived at a similar conclusion for physics iden-

tity, asserting that among all these dimensions, the dimension most closely correlated to it is recognition.

Both descriptive and regression analyses demonstrated unique patterns within each discipline. This reinforces the significance of investigating STEM identities and stereotypes on a disciplinary basis rather than approaching them holistically. The analyses revealed that the relevant identity variable in each STEM discipline is influenced by various independent variables to different extents. Among these, the feminine stereotype variable was not significantly identified, which aligns with existing literature that primarily focuses on male stereotypes rather than female ones. However, research for this dimension was still carried out because it serves the same purpose as Aydin and her colleagues (2023) in their study examining STEM stereotypes: incorporating feminine stereotypes aims to prevent the potential offensiveness of masculine stereotypes to female students.

5.3. Implications

This research holds implications that may be of future interests and studies for various groups, including policymakers, researchers, educators, teachers, and stakeholders involved in the STEM field.

Through hierarchical multiple regression analysis, the study revealed particular variables that predicted science, technology, engineering, and mathematics identity. Another analytical approach, structural equation modeling, can be employed by researchers to explore the connections among variables. This method offers a sophisticated path model, enabling the identification of direct and indirect effects as well as mediators.

Besides, qualitative research can be employed with the cooperation of teachers, educators, policymakers and stakeholders to provide a richer understanding of students' identities. Such studies also offer nuanced insights into how students develop stereo-

typical beliefs and the various influences shaping these beliefs. Additionally, similar studies can be conducted individually or collectively for high school level students in STEM-related fields such as biology or chemistry. Comparative analyzes of the results can be made by working with students in schools where STEM-related education is effectively implemented. Moreover, the results of the study can also be used in cross-cultural studies since identities and stereotypes are often influenced and shaped within cultural contexts. Lastly, experimental studies can be undertaken to address identity or stereotype issues among students from disadvantaged groups and genders, as indicated by the findings. For instance, strategies aimed at fostering engineering identities among female students could be implemented. Furthermore, these experimental studies can be carried out holistically or focusing on specific dimensions.

Identity development and the adoption of stereotypical beliefs are greatly influenced by social environments. To support these processes, collaborative efforts of teachers, educators, poşicymakers and parents are essential. There are several strategies to nurture STEM identities and prevent the adoption of biased beliefs. Firstly, hands-on experiences should be promoted, enabling direct interaction with STEM concepts through experiments and projects. Moreover, exposure to diverse role models and mentors who have excelled in STEM fields is vital for inspiration and guidance. Emphasizing representation from various backgrounds is key. Creating inclusive learning environments where all individuals feel respected and supported regardless of their background is essential. Addressing biases and stereotypes in STEM is also crucial, promoting diversity and inclusion. Introducing students to a broad spectrum of STEM careers and pathways is important as well, showing the array of opportunities available and how their interests can lead to fulfilling careers.

5.4. Limitations and Recommendations

The primary constraint of this study stems from its utilization of convenience sampling. This method, though convenient, lacks robust representational capability. Convenience sampling, by drawing from an easily accessible subset of the popula-

tion rather than employing random selection, may not accurately represent the entire population. This can limit the generalizability of findings beyond the sample group, resulting in inferences that primarily reflect the specific attributes of the convenience sample rather than those of the broader population under study. There are several strategies available to mitigate the limitations associated with convenience sampling. One is expanding the diversity of the convenience sample. It involves actively seeking participants from various demographic backgrounds, locations, or other pertinent characteristics. This approach can minimize bias and enhance the overall representativeness of the sample. Employing multiple recruitment channels, including online platforms, can also broaden the participant pool, thereby increasing diversity. In this study, the strategy of gathering data from three distinct types of schools, coupled with ensuring eligibility criteria encompassed diverse backgrounds and personal characteristics, effectively bolstered participant diversity. Comparing findings with studies utilizing different sampling methods is another valuable tactic. Aligning our results with those of more rigorously sampled studies can enhance the reliability of our findings and mitigate the limitations of convenience sampling. Additionally, supplementing quantitative data with qualitative insights, such as interviews or focus groups, can offer deeper understanding and contextualization of participant perspectives and experiences, enriching the overall findings.

Despite the anonymity, having participants answer the scales on their own also limits the study. Such methods create the potential for response bias, where participants may inaccurately report their thoughts, behaviors, or characteristics due to social desirability or other factors. Additionally, there could be issues with participants' comprehension of survey items or biases in their recollection, which could impact the reliability and validity of the collected data within this context. To prevent this issue, the participants were provided with comprehensive explanations of the scale items when needed, and additional time was allocated to facilitate better recall. Collecting data for all four STEM disciplines simultaneously might prompt students to give their answers by ranking the disciplines in order of importance or provide similar responses across disciplines to maintain consistency.

Finally, it is worth noting that students may have a limited understanding of engineering and related concepts, as it may be less prominent in their daily lives compared to the other three disciplines. To address this potential limitation students' perceptions of engineering can be examined with a short question-answer session and a brief summary about engineering can be given.

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APPENDIX A: DEMOGRAPHIC FORM

This is the demographic form utilized in the study.

Cinsiyet: ☐ Kadın ☐ Erkek	**Sınıf Seviyesi:** ☐ 5. Sınıf ☐ 6. Sınıf ☐ 7. Sınıf ☐ 8. Sınıf

Figure A.1. Demografik form.

APPENDIX B: STEM DISCIPLINARY IDENTITIES (STEMDIds) SCALE (STEM DİSİPLİNER KİMLİKLERİ ÖLÇEĞİ)

This is the STEM Disciplinary Identities scale, which is an adaptation of the Physics Identity scale to the four disciplines of STEM. It was utilized in the study for investigating STEM related identities through relevant dimensions.

Sevgili öğrenciler, bu anket, STEM (Fen, Teknoloji, Mühendislik ve Matematik) ile ilgili tutum ve deneyimleriniz aracılığı ile her bir STEM alanına ait oluşturduğunuz kimliğinizi ölçmeyi amaçlamaktadır. Ölçek 4 bölümden oluşmaktadır. Anketin maddelerini dikkatle okuyun ve maddelere dair düşüncelerinizi en iyi tanımlayan seçeneği (X) işaretini koyarak ifade ediniz. Ölçekteki her bir ifade için 7 seçenek yer almaktadır ve seçenekler "1: Beni hiç yansıtmıyor" ile "7: Beni tam olarak yansıtıyor" şeklindedir. Tüm ifadeleri mutlaka cevaplamanız gerekmektedir. İfadelerin doğru ya da yanlış cevap yoktur. Lütfen ölçeği içten ve samimi olarak cevaplayınız. Cevaplarınız gizli tutulacak ve hiçbir kimseyle paylaşılmayacaktır. Katkılarınızdan dolayı teşekkür ederiz.

	Fen Bilimleri	Beni hiç yansıtmıyor	1	2	3	4	5	6	7	Beni tam olarak yansıtıyor
1	Kendimi fen bilimlerine yatkın biri olarak görüyorum.		☐	☐	☐	☐	☐	☐	☐	
2	Fen bilimleri ile ilgilenmekten vazgeçmek zorunda kalsaydım bir kayıp hissederdim.		☐	☐	☐	☐	☐	☐	☐	
3	Fen bilimleri benim öğrenci kimliğimin önemli bir parçasıdır.		☐	☐	☐	☐	☐	☐	☐	
4	Öğretmenlerim beni fen bilimlerine yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
5	Ailem beni fen bilimlerine yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
6	Arkadaşlarım veya sınıf arkadaşlarım beni fen bilimlerine yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
7	Başkaları benim fen bilimleriyle ilgili fikirlerime danışır.		☐	☐	☐	☐	☐	☐	☐	
8	Fen bilimleri ile ilgili konuları anlayabildiğime eminim.		☐	☐	☐	☐	☐	☐	☐	
9	Fen bilimleri bilgisi gerektiren sorularda başarılı olabilirim.		☐	☐	☐	☐	☐	☐	☐	
10	Fen bilimleri ile ilgili çalıştığım kavramları anlıyorum.		☐	☐	☐	☐	☐	☐	☐	
11	Fen bilimleri ile ilgili şeyleri öğrenirken kendimi rahat hissederim.		☐	☐	☐	☐	☐	☐	☐	
12	Fen bilimleri bilgisi gerektiren soruları çözerken kendime güvenirim.		☐	☐	☐	☐	☐	☐	☐	
13	Fen bilimleri bilgisi gerektiren konularda başarısızlığı aşabilirim.		☐	☐	☐	☐	☐	☐	☐	

Figure B.1. STEM disipliner kimlikleri ölçeği.

14	Fen bilimleri ile ilgili daha çok şey öğrenmeye ilgiliyim.		☐	☐	☐	☐	☐	☐	☐	
15	Fen bilimleri konuları bende merak uyandırır.		☐	☐	☐	☐	☐	☐	☐	
16	Fen bilimleri ile ilgili konuları öğrenmekten keyif alırım.		☐	☐	☐	☐	☐	☐	☐	
17	Fen bilimleri ile ilgili konular benim için eğlencelidir.		☐	☐	☐	☐	☐	☐	☐	
	Teknoloji	**Beni hiç yansıtmıyor**	**1** ☐	**2** ☐	**3** ☐	**4** ☐	**5** ☐	**6** ☐	**7** ☐	**Beni tam olarak yansıtıyor**
18	Kendimi teknolojiye yatkın biri olarak görüyorum.		☐	☐	☐	☐	☐	☐	☐	
19	Teknoloji ile ilgilenmekten vazgeçmek zorunda kalsaydım bir kayıp hissederdim.		☐	☐	☐	☐	☐	☐	☐	
20	Teknoloji benim öğrenci kimliğimin önemli bir parçasıdır.		☐	☐	☐	☐	☐	☐	☐	
21	Öğretmenlerim beni teknolojiye yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
22	Ailem beni teknolojiye yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
23	Arkadaşlarım veya sınıf arkadaşlarım beni teknolojiye yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
24	Başkaları benim teknolojiyle ilgili fikirlerime danışır.		☐	☐	☐	☐	☐	☐	☐	
25	Teknoloji ile ilgili konuları anlayabildiğime eminim.		☐	☐	☐	☐	☐	☐	☐	
26	Teknoloji bilgisi gerektiren sorularda başarılı olabilirim.		☐	☐	☐	☐	☐	☐	☐	
27	Teknoloji ile ilgili çalıştığım kavramları anlıyorum.		☐	☐	☐	☐	☐	☐	☐	
28	Teknoloji ile ilgili şeyleri öğrenirken kendimi rahat hissederim.		☐	☐	☐	☐	☐	☐	☐	
29	Teknoloji bilgisi gerektiren soruları çözerken kendime güvenirim.		☐	☐	☐	☐	☐	☐	☐	
30	Teknoloji bilgisi gerektiren konularda başarısızlığı aşabilirim.		☐	☐	☐	☐	☐	☐	☐	
31	Teknoloji ile ilgili daha çok şey öğrenmeye ilgiliyim.		☐	☐	☐	☐	☐	☐	☐	
32	Teknoloji konuları bende merak uyandırır.		☐	☐	☐	☐	☐	☐	☐	
33	Teknoloji ile ilgili konuları öğrenmekten keyif alırım.		☐	☐	☐	☐	☐	☐	☐	
34	Teknoloji ile ilgili konular benim için eğlencelidir.		☐	☐	☐	☐	☐	☐	☐	
	Mühendislik	**Beni hiç yansıtmıyor**	**1** ☐	**2** ☐	**3** ☐	**4** ☐	**5** ☐	**6** ☐	**7** ☐	**Beni tam olarak yansıtıyor**
35	Kendimi mühendisliğe yatkın biri olarak görüyorum.		☐	☐	☐	☐	☐	☐	☐	
36	Mühendislik ile ilgilenmekten vazgeçmek zorunda kalsaydım bir kayıp hissederdim.		☐	☐	☐	☐	☐	☐	☐	

Figure B.2. STEM disipliner kimlikleri ölçeği 1.

37	Mühendislik benim öğrenci kimliğimin önemli bir parçasıdır.		☐	☐	☐	☐	☐	☐	☐	
38	Öğretmenlerim beni mühendisliğe yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
39	Ailem beni mühendisliğe yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
40	Arkadaşlarım veya sınıf arkadaşlarım beni mühendisliğe yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
41	Başkaları benim mühendislikle ilgili fikirlerime danışır.		☐	☐	☐	☐	☐	☐	☐	
42	Mühendislik ile ilgili konuları anlayabildiğime eminim.		☐	☐	☐	☐	☐	☐	☐	
43	Mühendislik bilgisi gerektiren sorularda başarılı olabilirim.		☐	☐	☐	☐	☐	☐	☐	
44	Mühendislik ile ilgili çalıştığım kavramları anlıyorum.		☐	☐	☐	☐	☐	☐	☐	
45	Mühendislik ile ilgili şeyleri öğrenirken kendimi rahat hissederim.		☐	☐	☐	☐	☐	☐	☐	
46	Mühendislik bilgisi gerektiren soruları çözerken kendime güvenirim.		☐	☐	☐	☐	☐	☐	☐	
47	Mühendislik bilgisi gerektiren konularda başarısızlığı aşabilirim.		☐	☐	☐	☐	☐	☐	☐	
48	Mühendislik ile ilgili daha çok şey öğrenmeye ilgiliyim.		☐	☐	☐	☐	☐	☐	☐	
49	Mühendislik konuları bende merak uyandırır.		☐	☐	☐	☐	☐	☐	☐	
50	Mühendislik ile ilgili konuları öğrenmekten keyif alırım.		☐	☐	☐	☐	☐	☐	☐	
51	Mühendislik ile ilgili konular benim için eğlencelidir.		☐	☐	☐	☐	☐	☐	☐	
	Matematik	**Beni hiç yansıtmıyor**	**1** ☐	**2** ☐	**3** ☐	**4** ☐	**5** ☐	**6** ☐	**7** ☐	**Beni tam olarak yansıtıyor**
52	Kendimi matematiğe yatkın biri olarak görüyorum.		☐	☐	☐	☐	☐	☐	☐	
53	Matematik ile ilgilenmekten vazgeçmek zorunda kalsaydım bir kayıp hissederdim.		☐	☐	☐	☐	☐	☐	☐	
54	Matematik benim öğrenci kimliğimin önemli bir parçasıdır.		☐	☐	☐	☐	☐	☐	☐	
55	Öğretmenlerim beni matematiğe yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
56	Ailem beni matematiğe yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
57	Arkadaşlarım veya sınıf arkadaşlarım beni matematiğe yatkın biri olarak görür.		☐	☐	☐	☐	☐	☐	☐	
58	Başkaları benim matematikle ilgili fikirlerime danışır.		☐	☐	☐	☐	☐	☐	☐	
59	Matematik ile ilgili konuları anlayabildiğime eminim.		☐	☐	☐	☐	☐	☐	☐	
60	Matematik bilgisi gerektiren sorularda başarılı olabilirim.		☐	☐	☐	☐	☐	☐	☐	

Figure B.3. STEM disipliner kimlikleri ölçeği 2.

61	Matematik ile ilgili çalıştığım kavramları anlıyorum.	☐ ☐ ☐ ☐ ☐ ☐ ☐
62	Matematik ile ilgili şeyleri öğrenirken kendimi rahat hissederim.	☐ ☐ ☐ ☐ ☐ ☐ ☐
63	Matematik bilgisi gerektiren soruları çözerken kendime güvenirim.	☐ ☐ ☐ ☐ ☐ ☐ ☐
64	Matematik bilgisi gerektiren konularda başarısızlığı aşabilirim.	☐ ☐ ☐ ☐ ☐ ☐ ☐
65	Matematik ile ilgili daha çok şey öğrenmeye ilgiliyim.	☐ ☐ ☐ ☐ ☐ ☐ ☐
66	Matematik konuları bende merak uyandırır.	☐ ☐ ☐ ☐ ☐ ☐ ☐
67	Matematik ile ilgili konuları öğrenmekten keyif alırım.	☐ ☐ ☐ ☐ ☐ ☐ ☐
68	Matematik ile ilgili konular benim için eğlencelidir.	☐ ☐ ☐ ☐ ☐ ☐ ☐

Figure B.4. STEM disipliner kimlikleri ölçeği 3.

APPENDIX C: STEM DISCIPLINARY STEREOTYPICAL BELIEFS (STEMDSBs) SCALE (STEM DİSİPLİNER STEREOTİPİK İNANIŞLAR ÖLÇEĞİ)

This is the STEM Disciplinary Stereotypical Beliefs (STEMDSBs) Scale utilized in the study for investigating STEM related stereotypes through relevant dimensions.

Sevgili öğrenciler, bu ölçek sizin STEM (Fen, Teknoloji, Mühendislik ve Matematik) ile ilgili alanlara (dersler, projeler ve meslekler) ilişkin düşüncelerinizi belirlemeyi amaçlamaktadır. Ölçek 4 bölümden oluşmaktadır. Anketin maddelerini dikkatle okuyun ve maddelere dair düşüncelerinizi en iyi tanımlayan seçeneği (X) işaretini koyarak ifade ediniz. Ölçekteki her bir ifade için 7 seçenek yer almaktadır ve seçenekler "1: Kesinlikle Katılmıyorum" ile "7: Kesinlikle Katılıyorum" şeklindedir. Tüm ifadeleri mutlaka cevaplamanız gerekmektedir. İfadelerin doğru ya da yanlış cevap yoktur. Lütfen ölçeği içten ve samimi olarak cevaplayınız. Cevaplarınız gizli tutulacak ve hiçbir kimseyle paylaşılmayacaktır. Katkılarınızdan dolayı teşekkür ederiz.

Fen Bilimleri

*Fen ile ilgili mesleklere Doktor, Biyolog, Kimyager, Eczacı, Tıbbi Teknisyen, Fizyoterapist, Uzay Bilimci vb. örnek olarak verilebilir.

* Fen projelerine canlıların sınıflandırılması ile ilgili üç boyutlu şema tasarlamak, kirlilik sorununu çözmek için bir proje planlamak, yenilenebilir enerji kaynaklarını kullanarak bir ürün tasarlamak, uzay mekiği modeli hazırlamak ve solunum sisteminin çalışma mekanizmasını model tasarlayarak göstermek vb. örnek olarak verilebilir.

		Kesinlikle katılmıyorum	1	2	3	4	5	6	7	Kesinlikle katılıyorum
1	Fen ile ilgili alanlarda yer alan bir kişinin kız olma olasılığı daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
2	Fen ile ilgili alanlarda yer alan bir kişinin erkek olma olasılığı daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
3	Fen ile ilgili alanlarda kızlar genellikle daha yeteneklidir.		☐	☐	☐	☐	☐	☐	☐	
4	Fen ile ilgili alanlarda erkekler genellikle daha yeteneklidir.		☐	☐	☐	☐	☐	☐	☐	
5	Fen ile ilgili mesleklerin çalışma ortamı koşulları genellikle kızlara daha uygundur.		☐	☐	☐	☐	☐	☐	☐	
6	Fen ile ilgili mesleklerin çalışma ortamı koşulları genellikle erkeklere daha uygundur.		☐	☐	☐	☐	☐	☐	☐	
7	Fen ile ilgili alanları genellikle aileleri orta ve yüksek gelirli olan kişiler tercih eder.		☐	☐	☐	☐	☐	☐	☐	
8	Fen ile ilgili bir mesleğe sahip olma olasılığı, aileleri orta ve yüksek gelirli olan kişiler için daha fazladır.		☐	☐	☐	☐	☐	☐	☐	

Figure C.1. STEM disipliner stereotipik inanışlar ölçeği.

9	Fen ile ilgili alanlar genellikle aileleri orta ve yüksek gelirli olan kişiler için daha işe yarardır.	☐	☐	☐	☐	☐	☐	☐	
10	Fen ile ilgili alanları genellikle aileleri iyi eğitimli kişiler tercih eder.	☐	☐	☐	☐	☐	☐	☐	
11	Fen ile ilgili bir mesleğe sahip olma olasılığı, aileleri iyi eğitimli kişiler için daha fazladır.	☐	☐	☐	☐	☐	☐	☐	
12	Fen ile ilgili alanlar genellikle aileleri iyi eğitimli kişiler için daha işe yarardır.	☐	☐	☐	☐	☐	☐	☐	

Teknoloji

*Teknoloji ile ilgili mesleklere Web Tasarımcısı, Yazılım Geliştirici, Bilgisayar Programcılığı, Veri Bilimci, Elektrik-elektronik Teknisyenliği, Bilgisayar Sistemleri Yöneticiliği, Bilgi Teknolojileri Yöneticiliği, Veri Tabanı Programcılığı-Yöneticiliği vb. Örnek olarak verilebilir.

* Teknoloji projelerine bir sorunu çözmek için bir bilgisayar programı tasarlamak, robotik ürün geliştirmek ve dijital uygulamaları kullanarak güncel problemlere çözüm üretmek vb. uygulamalar örnek olarak verilebilir.

		Kesinlikle katılmıyorum	**1** ☐	**2** ☐	**3** ☐	**4** ☐	**5** ☐	**6** ☐	**7** ☐	**Kesinlikle katılıyorum**
13	Teknoloji ile ilgili alanlarda yer alan bir kişinin kız olma olasılığı daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
14	Teknoloji ile ilgili alanlarda yer alan bir kişinin erkek olma olasılığı daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
15	Teknoloji ile ilgili alanlarda kızlar genellikle daha yeteneklidir.		☐	☐	☐	☐	☐	☐	☐	
16	Teknoloji ile ilgili alanlarda erkekler genellikle daha yeteneklidir.		☐	☐	☐	☐	☐	☐	☐	
17	Teknoloji ile ilgili mesleklerin çalışma ortamı koşulları genellikle kızlara daha uygundur.		☐	☐	☐	☐	☐	☐	☐	
18	Teknoloji ile ilgili mesleklerin çalışma ortamı koşulları genellikle erkeklere daha uygundur.		☐	☐	☐	☐	☐	☐	☐	
19	Teknoloji ile ilgili alanları genellikle aileleri orta ve yüksek gelirli olan kişiler tercih eder.		☐	☐	☐	☐	☐	☐	☐	
20	Teknoloji ile ilgili bir mesleğe sahip olma olasılığı, aileleri orta ve yüksek gelirli olan kişiler için daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
21	Teknoloji ile ilgili alanlar genellikle aileleri orta ve yüksek gelirli olan kişiler için daha işe yarardır.		☐	☐	☐	☐	☐	☐	☐	
22	Teknoloji ile ilgili alanları genellikle aileleri iyi eğitimli kişiler tercih eder.		☐	☐	☐	☐	☐	☐	☐	
23	Teknoloji ile ilgili bir mesleğe sahip olma olasılığı, aileleri iyi eğitimli kişiler için daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
24	Teknoloji ile ilgili alanlar genellikle aileleri iyi eğitimli kişiler için daha işe yarardır.		☐	☐	☐	☐	☐	☐	☐	

Figure C.2. STEM disipliner stereotipik inanışlar ölçeği 1.

Mühendislik

*Mühendislik ile ilgili mesleklere Bilgisayar Mühendisliği, Endüstri Mühendisliği, Makine Mühendisliği, Kimya Mühendisliği, Gıda Mühendisliği, İnşaat Mühendisliği vb. örnek olarak verilebilir.

* Mühendislik projelerine güneş arabaları inşa etmek, günlük hayattaki sorunları ortadan kaldıran ya da hayatı kolaylaştıran ürünler tasarlamak vb. örnek olarak verilebilir.

		Kesinlikle katılmıyorum	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Kesinlikle katılıyorum
25	Mühendislik ile ilgili alanlarda yer alan bir kişinin kız olma olasılığı daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
26	Mühendislik ile ilgili alanlarda yer alan bir kişinin erkek olma olasılığı daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
27	Mühendislik ile ilgili alanlarda kızlar genellikle daha yeteneklidir.		☐	☐	☐	☐	☐	☐	☐	
28	Mühendislik ile ilgili alanlarda erkekler genellikle daha yeteneklidir.		☐	☐	☐	☐	☐	☐	☐	
29	Mühendislik ile ilgili mesleklerin çalışma ortamı koşulları genellikle kızlara daha uygundur.		☐	☐	☐	☐	☐	☐	☐	
30	Mühendislik ile ilgili mesleklerin çalışma ortamı koşulları genellikle erkeklere daha uygundur.		☐	☐	☐	☐	☐	☐	☐	
31	Mühendislik ile ilgili alanları genellikle aileleri orta ve yüksek gelirli olan kişiler tercih eder.		☐	☐	☐	☐	☐	☐	☐	
32	Mühendislik ile ilgili bir mesleğe sahip olma olasılığı, aileleri orta ve yüksek gelirli olan kişiler için daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
33	Mühendislik ile ilgili alanlar genellikle aileleri orta ve yüksek gelirli olan kişiler için daha işe yarardır.		☐	☐	☐	☐	☐	☐	☐	
34	Mühendislik ile ilgili alanları genellikle aileleri iyi eğitimli kişiler tercih eder.		☐	☐	☐	☐	☐	☐	☐	
35	Mühendislik ile ilgili bir mesleğe sahip olma olasılığı, aileleri iyi eğitimli kişiler için daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
36	Mühendislik ile ilgili alanlar genellikle aileleri iyi eğitimli kişiler için daha işe yarardır.		☐	☐	☐	☐	☐	☐	☐	

Matematik

*Matematik ile ilgili mesleklere Ekonomist, İstatistik Uzmanı, Finans Uzmanı, Bankacı, Muhasebeci, Ekonometri Uzmanı vb. örnek olarak verilebilir.

* Matematik projelerine örüntüleri kullanarak model tasarlamak, geometrik şekilleri kullanarak ürün tasarlamak, matematiksel ölçü birimlerini modelleyerek göstermek ve matematiksel işlemlerin kullanılacağı bir oyun tasarlamak örnek olarak verilebilir.

		Kesinlikle katılmıyorum	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Kesinlikle katılıyorum
37	Matematik ile ilgili alanlarda yer alan bir kişinin kız olma olasılığı daha fazladır.		☐	☐	☐	☐	☐	☐	☐	
38	Matematik ile ilgili alanlarda yer alan bir kişinin erkek olma olasılığı daha fazladır.		☐	☐	☐	☐	☐	☐	☐	

Figure C.3. STEM disipliner stereotipik inanışlar ölçeği 2.

39	Matematik ile ilgili alanlarda kızlar genellikle daha yeteneklidir.	☐ ☐ ☐ ☐ ☐ ☐ ☐
40	Matematik ile ilgili alanlarda erkekler genellikle daha yeteneklidir.	☐ ☐ ☐ ☐ ☐ ☐ ☐
41	Matematik ile ilgili mesleklerin çalışma ortamı koşulları genellikle kızlara daha uygundur.	☐ ☐ ☐ ☐ ☐ ☐ ☐
42	Matematik ile ilgili mesleklerin çalışma ortamı koşulları genellikle erkeklere daha uygundur.	☐ ☐ ☐ ☐ ☐ ☐ ☐
43	Matematik ile ilgili alanları genellikle aileleri orta ve yüksek gelirli olan kişiler tercih eder.	☐ ☐ ☐ ☐ ☐ ☐ ☐
44	Matematik ile ilgili bir mesleğe sahip olma olasılığı, aileleri orta ve yüksek gelirli olan kişiler için daha fazladır.	☐ ☐ ☐ ☐ ☐ ☐ ☐
45	Matematik ile ilgili alanlar genellikle aileleri orta ve yüksek gelirli olan kişiler için daha işe yarardır.	☐ ☐ ☐ ☐ ☐ ☐ ☐
46	Matematik ile ilgili alanları genellikle aileleri iyi eğitimli kişiler tercih eder.	☐ ☐ ☐ ☐ ☐ ☐ ☐
47	Matematik ile ilgili bir mesleğe sahip olma olasılığı, aileleri iyi eğitimli kişiler için daha fazladır.	☐ ☐ ☐ ☐ ☐ ☐ ☐
48	Matematik ile ilgili alanlar genellikle aileleri iyi eğitimli kişiler için daha işe yarardır.	☐ ☐ ☐ ☐ ☐ ☐ ☐

Figure C.4. STEM disipliner stereotipik inanışlar ölçeği 3.

APPENDIX D: PERMISSION FROM ETHICAL COMMITTEE OF THE BOGAZICI UNIVERSITY

This is the permission from Ethical Committee of the Boğaziçi University.



T.C.
BOĞAZİÇİ ÜNİVERSİTESİ REKTÖRLÜĞÜ
Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik Kurulu
(Fminarek)

Sayı : E-84391427-050.01.04-149082 10.10.2023
Konu : 2023/27 Kayıt no'lu başvurunuz hakkında

Sayın Doç. Dr. Sevda YERDELEN DAMAR

"STEM KİMLİĞİNİN STEM STEREOTİPLERİ İLE İLİŞKİSİ (THE RELATION OF STEM IDENTITY TO STEM STEREOTYPES)" başlıklı projeniz ile Boğaziçi Üniversitesi Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik Kurulu (FMİNAREK)'e yaptığınız 2023/27 kayıt numaralı başvuru 02.10.2023 tarihli ve 2023/10 No.lu kurul toplantısında incelenerek etik onay verilmesi uygun bulunmuştur.

Bu karar tüm üyelerin toplantıya on-line olarak katılımıyla ve oybirliği ile alınmıştır. Onay mektubu tüm üyeler adına Komisyon Başkanı tarafından e-imzalanmıştır. Bilginize sunarız.

Saygılarımızla,

Prof. Dr. Tınaz EKİM AŞICI
Kurul Başkanı

Bu belge, güvenli elektronik imza ile imzalanmıştır.
Belge Doğrulama Kodu : 0M75-0N37-09JU Belge Doğrulama Adresi : https://www.turkiye.gov.tr/bogazici-universitesi-ebys

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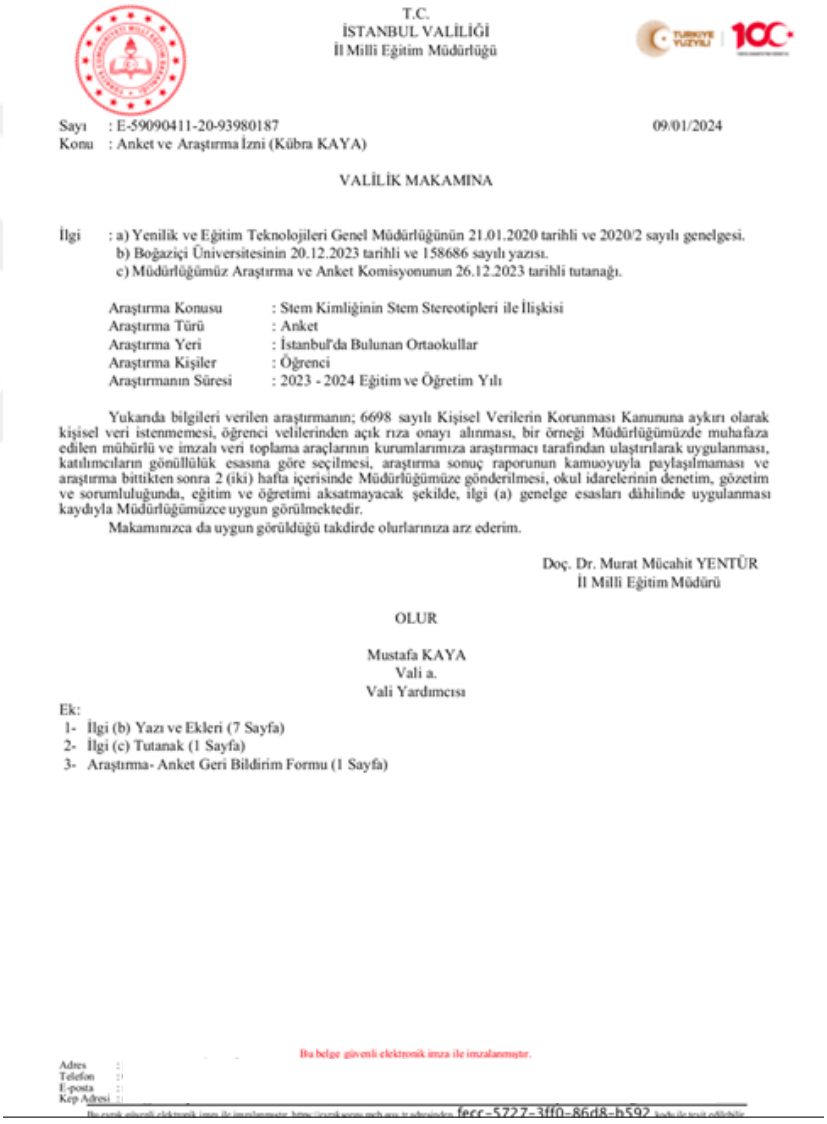
e-Posta:
Kep Adresi:
Fax No:
İnternet Adresi: https://www.boun.edu.tr/
Bilgi İçin:Nurşen MUNAR
Mühendis
Telefon No:

Figure D.1. Permission from ethical committee of the Boğaziçi university.

APPENDIX E: PERMISSION FROM THE MINISTRY OF EDUCATION

This is the permission from Ministry of Education.



T.C.
İSTANBUL VALİLİĞİ
İl Milli Eğitim Müdürlüğü

Sayı : E-59090411-20-93980187 09/01/2024
Konu : Anket ve Araştırma İzni (Kübra KAYA)

VALİLİK MAKAMINA

İlgi : a) Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 21.01.2020 tarihli ve 2020/2 sayılı genelgesi.
b) Boğaziçi Üniversitesinin 20.12.2023 tarihli ve 158686 sayılı yazısı.
c) Müdürlüğümüz Araştırma ve Anket Komisyonunun 26.12.2023 tarihli tutanağı.

Araştırma Konusu	: Stem Kimliğinin Stem Stereotipleri ile İlişkisi
Araştırma Türü	: Anket
Araştırma Yeri	: İstanbul'da Bulunan Ortaokullar
Araştırma Kişiler	: Öğrenci
Araştırmanın Süresi	: 2023 - 2024 Eğitim ve Öğretim Yılı

Yukarıda bilgileri verilen araştırmanın; 6698 sayılı Kişisel Verilerin Korunması Kanununa aykırı olarak kişisel veri istenmemesi, öğrenci velilerinden açık rıza onayı alınması, bir örneği Müdürlüğümüzde muhafaza edilen mühürlü ve imzalı veri toplama araçlarının kurumlarımıza araştırmacı tarafından ulaştırılarak uygulanması, katılımcıların gönüllülük esasına göre seçilmesi, araştırma sonuç raporunun kamuoyuyla paylaşılmaması ve araştırma bittikten sonra 2 (iki) hafta içerisinde Müdürlüğümüze gönderilmesi, okul idarelerinin denetim, gözetim ve sorumluluğunda, eğitim ve öğretimi aksatmayacak şekilde, ilgi (a) genelge esasları dâhilinde uygulanması kaydıyla Müdürlüğümüzce uygun görülmektedir.
Makamınızca da uygun görüldüğü takdirde olurlarınıza arz ederim.

Doç. Dr. Murat Mücahit YENTÜR
İl Milli Eğitim Müdürü

OLUR

Mustafa KAYA
Vali a.
Vali Yardımcısı

Ek:
1- İlgi (b) Yazı ve Ekleri (7 Sayfa)
2- İlgi (c) Tutanak (1 Sayfa)
3- Araştırma- Anket Geri Bildirim Formu (1 Sayfa)

Bu belge güvenli elektronik imza ile imzalanmıştır.

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E-posta :
Kep Adresi :

Figure E.1. Anket araştırma izini.

APPENDIX F: PARENT CONSENT FORM (VELİ ONAM FORMU)

This form is used to obtain parental consent for students to participate in the study.

Araştırmayı destekleyen kurum: Boğaziçi Üniversitesi
Araştırmanın adı: STEM Kimliğinin STEM Stereotipik İnanışlar ile İlişkisi
Proje Yürütücüsü/Araştırmacının adı: Kübra KAYA
E-mail adresi:

Sayın Veli,

Boğaziçi Üniversitesi Matematik ve Fen Bilimleri Eğitimi Bölümü yüksek lisans öğrencisi Kübra KAYA, Doç. Dr. Sevda YERDELEN-DAMAR danışmanlığında "STEM Kimliğinin STEM Stereotipik İnanışlar ile İlişkisi" adlı tez çalışmasını yürütmektedir. Bu çalışmada, öğrencilerin STEM'in dört disiplinine ait sahip oldukları stereotipik inanış/stereotipler (basmakalıp inanışlar) ile STEM alanlarına ilişkin kimlikleri arasındaki ilişkinin araştırılması amaçlanmaktadır. Araştırmanın amacı doğrultusunda, üç bölümden oluşan bir ölçüm aracı kullanılacaktır. Ölçüm aracının ilk bölümünde demografik bilgiler (cinsiyet ve sınıf düzeyi) istenmektedir. İkinci bölümünde her bir STEM alanına ait 17 toplamda 68 maddeden oluşan STEM Disipliner Kimlikler ölçeğinin ve üçüncü bölümünde ise her bir STEM alanına ait 12 toplamda ise 48 maddeden oluşan STEM Disipliner Stereotipik İnanışlar ölçeğinin yanıtlanması beklenmektedir.

Söz konusu ölçüm aracı araştırma sürecine yardımcı olmayı kabul eden öğretmenler tarafından uygulanacaktır. Ölçeğin cevaplanma süreci için bir ders saati ayrılacaktır. Çalışmaya katılım tamamen gönüllülük esasına dayanmaktadır. Çocuğunuz çalışmada katılımcı olarak yer almaması durumunda herhangi ters bir

tutum veya olumsuzluk (not vb.) ile karşılaşmayacaktır. Çocuğunuz çalışmanın herhangi bir aşamasında çekilebilme hakkına sahiptir. Çalışmadan çekildiği takdirde onun verileri kullanılmayacak ve geri dönüşümsüz olarak yok edilecektir. Çalışma anonim olarak yürütülecektir. Çocuklarınızdan isimlerini yazmaları istenmeyecektir ve kişisel cevapları kesinlikle gizli tutulacaktır. Toplanacak veriler sadece bilimsel araştırma amacıyla kullanılacaktır. Cevaplanmış olan ölçeklere erişim sadece yukarıda adı geçen araştırmacılar tarafından sağlanabilecek kilitli bir dolapta muhafaza edilecektir ve başka kimselerle paylaşılmayacaktır. Toplanan veriler bilimsel çalışmalarda kullanılmak üzere analiz edildikten sonra, cevaplanmış ölçekler geri dönüşümsüz olarak yok edilecektir.

Katılımcı olmanın olası yararları ve (varsa) potansiyel riskleri:

Ölçekte yer alan soruların Doğru ya da Yanlış cevabı yoktur, çocuklarınızın sadece ilgili konudaki görüşleri araştırılmaktadır. Çocuğunuzun çalışmaya katılımının ve yanıtlayacağı soruların onun psikolojik veya fiziksel gelişimine hiçbir olumsuz etkisi olmayacağından emin olabilirsiniz. Araştırmanın sonuçları STEM alan yazınına ve öğretimine katkı sağlamak için kullanılacaktır.

Onam:

Bu araştırmaya katılımı için onay verdiğiniz takdirde çocuğunuz ölçeği okulda bir ders saatinde dolduracaktır. Sizden izin istenildiği gibi çalışmaya başlamadan önce çocuğunuzun da sözel olarak rızası alınacaktır. Bu formu imzaladıktan sonra da çocuğunuzun araştırmanın herhangi bir aşamasında ayrılma hakkı vardır. Çalışmanın sonunda, araştırma sonuçlarının özeti tarafımızdan okulunuza iletilecektir. Çalışma hakkında daha fazla bilgi edinmek ve sorularınız için yukarıdaki araştırmacı ile iletişim kurabilirsiniz. Araştırmaya dair olası şikayetlerinizi Boğaziçi Üniversitesi Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik Kurulu'nun e-mail adresine gönderebilirsiniz.

Saygılarımızla,

Eğer bu araştırmaya çocuğunuzun katılarak yapacağımız bilimsel çalışmaya katılım sağlamayı kabul ediyorsanız, lütfen bu formu imzalayıp formu çocuğunuzla okula geri gönderiniz. Öğrencilerimizin katılımları bizim için çok değerlidir.

A) Bu araştırmaya çocuğum 0.....'nın katılımcı olmasına izin veriyorum. Çocuğumun çalışmayı istediği zaman yarıda kesip bırakabileceğini biliyorum ve verdiği bilgilerin bilimsel amaçlı olarak kullanılmasını kabul ediyorum.

Baba Adı-Soyadı..... Anne Adı-Soyadı.....

İmza 0..... İmza 0.....

B) Bu çalışmaya çocuğum 0.....'nın katılımcı olmasına izin vermiyorum.

Baba Adı-Soyadı..... Anne Adı-Soyadı.....

İmza 0..... İmza 0.....