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Beyond Students' Abilities: Mathematics Teachers' Multidimensional Attributions for their Success and Struggle

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Abstract

This study examined how in-service and pre-service elementary and middle school mathematics teachers attribute students' success and struggle in mathematics through a qualitative case study approach. The findings indicate that teachers' beliefs are multidimensional, but specifically personal and educational attributions when explaining the causes for success and struggle. Teachers view students' motivation, effort, self-confidence, and prior knowledge as key determinants of success. Educational attributions highlight factors related to instruction quality and classroom environment. Social attributions reflect the importance of a family-centered cultural structure. While genetic attributions are less common, some teachers cited innate mathematics ability or gender differences. This study indicates the significance of teacher education programs that will increase awareness of evaluating students' success and struggle in multidimensional ways.

Keywords: attributional beliefs, mathematics teachers, mathematics pre-service teachers, mathematical excellence.

Beyond Students' Abilities: Mathematics Teachers' Multidimensional Attributions for their Success and Struggle

Introduction

Key socializing factors, particularly parents and teachers, are of great importance to students' educational experiences as well as personal growth. Teachers' beliefs have an important role in shaping their students' academic outcomes, specifically in mathematics, where affective and cognitive issues are closely related to each other. Teachers' beliefs about their students' abilities, potentials for growth, and mathematical learning prominently influence teachers' instructional preferences and expectations (Natale et al., 2009; Pajares, 1992). These beliefs influence how teachers interpret their students' mathematical success or struggle. Therefore, these consequences can be considered as indicators of academic excellence.

The essential role of mathematical success in students' academic and personal development has attracted mathematics education researchers' attention due to its role in fostering critical thinking (Er, 2024), problem solving (Scherer & Beckmann, 2014), and logical reasoning skills (Cresswell & Speelman, 2020). Furthermore, mathematical success is closely related to students' confidence (Skaalvik et al., 2015), perseverance (Bettinger et al., 2018), and future career opportunities (Leyva et al., 2022). Conversely, early difficulties in mathematics can lead to conceptual gaps and widen over time. As mathematics develops in a cumulative way, lower performing students might struggle in time (Aunola et al., 2004). This also leads to increased mathematics anxiety in students (Pekrun et al., 2007). Therefore, students' mathematical experiences are influenced not only by their ability and effort, but also by how their teachers interpret these experiences are interpreted.

In this context, attribution theory offers a significant theoretical framework that examines the causes behind outcomes such as success and struggle. This theory originally

built on the work of Heider (1958), Rotter (1966) and Kelley (1967) and further developed by Weiner (1985). It proposes that individuals attempt to make sense of their own and others' actions by attributing behaviors to causes (Graham, 2020). Beliefs about causes (ability, effort, teacher characteristics, luck) can vary across age groups and cultures. In addition, they can also influence individuals' motivation, persistence, and success.

Students' mathematical success or struggle is shaped by multidimensional factors such as social influences, educational conditions, personal experiences, and even genetic predispositions. Family support, peer interactions, teacher quality, curriculum, previous experiences, motivation, effort, ability, gender are seen as significant factors in shaping students' mathematical success or struggle (Ocal et al., 2025). Attribution theory provides a valuable perspective for examining how individuals interpret these factors and how these interpretations influence their future learning. However, more research is needed on how these attributions developed over time by educators including in-service and pre-service teachers. Further research is also needed to examine how these attributions interact with contextual factors such as classroom environment, instructional processes, and assessment structures.

Teachers' beliefs about their students' success and struggle influence not only their instructional practices but also their expectations of success (Peterson & Barger, 1985), academic behaviors, and emotional reactions (Graham & Williams, 2009). In fact, teachers' cognitive behaviors are usually affected by their personal beliefs (Clark & Peterson, 1986). Therefore, the influence of teachers' beliefs on the educational process has drawn the researchers' attention (Fukuda et al., 2024). However, the implications of attribution theory in mathematics education are particularly salient and the significance of determining pre-service and in-service teachers' attributions. The effectiveness of various mathematical interventions is still emerging. Consequently, understanding how teachers attribute their students' success

and struggle in mathematics is important for developing effective teaching practices and promoting equal opportunities for students in education. The present study, based on attribution theory, aims to examine the causes that in-service and pre-service teachers attribute to their students' success and struggle in mathematics. Hence, the research question for this study is as follows:

- How do pre-service and in-service elementary and middle school mathematics teachers attribute students' success and struggle in mathematics?

Theoretical Background and Literature Review

Attributions of Mathematical Excellence (AME)

Individuals' interpretations about the origins of personal characteristics as well as achievements are central for investigating attitudes towards education and academic success. Various belief systems ranging from genetic and social determinism to school meritocracy influence people's explanations about their abilities and outcomes (Dweck, 2006). The belief in genetic determinism (BGD) considers that personal attributes, behaviors, and competencies influence characteristics such as intelligence, personality, and academic achievement (Jacobson et al., 2022). Based on it, the biological inheritance contributes to outcomes like intelligence, personality, or educational achievement (Kraphol et al., 2014). Deterministic interpretations are essential to promoting more nuanced, equitable, and scientifically grounded understandings of a person's potential. In contrast, the belief in social determinism (BSD) highlights the impact of environmental and structural conditions, such as socioeconomic background and cultural influences, and how a person's thoughts, behaviors. Life outcomes are frequently shaped by social structures and environmental conditions. Meanwhile, the belief in school meritocracy (BSM) is the idea that academic success is an indicator of a person's ability and effort. It remains a deeply embedded narrative within educational systems, which means that the system rewards the person's ability and efforts

(Young, 1958). This belief suggests that hard working results in academic achievement in the school environment (Duru-Bellat & Tenret, 2009). As presented in Table 1, these belief systems lead various ways individuals attribute mathematical excellence to individuals, whether through personal characteristics (AME-P), genetic predispositions (AME-G), social influences (AME-S), or educational opportunities (AME-E) (Yavuz et al., 2024). These attributions provide insight into the broader frameworks for interpreting mathematical success and struggle in general. Mathematical competency can be shaped by fixed and modifiable influences, which might stem from or influenced by innate or environmental aspects.

Table 1

Factors Influencing Mathematical Competency

Mathematical competency (success or struggle)	Fixed	Not fixed
Innate ability	Genetic predispositions (AME-G)	Personal characteristics (AME-P)
Environmental / Contextual	Social influences (AME-S)	Educational opportunities (AME-E)

Genetic Attribution (AME-G)

Genetic determinism attributes characteristics to natural causes like genes. Belief in genetic determinism emphasizes that genes are seen as having more influence on trait development than what scientific research supports (Gericke et al., 2017). Genetic attribution is defined as the tendency to explain human behavior, traits, or outcomes by referencing genetic causes. In educational contexts, genetics such as intelligence and aptitude can significantly influence both teachers' expectations and even students' self-perceptions. Individuals' attributional beliefs about personal characteristics including academic ability, performance relates to biology (Keller, 2005). Although 21st century biology rejects genetic

determinism, the substantial influence of genes on shaping body and mind remains widespread (Jamieson & Radick, 2017).

Social Attribution (AME-S)

Social environment has an impact on individuals. Social factors particularly shape the individuals' nature as well as their characters. Peoples' core characteristics are deeply and enduringly shaped by social influences (Rangel & Keller, 2011). The students' mathematical excellence is attributed to social circumstances, such as family background, cultural norms, peer influence, or socioeconomic status.

Personal Attribution (AME-P)

Personal attributions highlight the belief that mathematical success or struggle is primarily driven by personal characteristics or efforts. The explanation of behaviors or outcomes based on individual characteristics such as effort, ability, motivation, or personality traits indicates personal attributions. For instance, effort is found to be a major contributor to achievement, particularly in terms of gender and racial disparities (Fennema et al., 1990; Tiedemann, 2000). They prominently have an impact on both how teachers assess their students' performance and how students perceive their own academic experiences. Within personal attributions, individuals' beliefs about the causes of their mathematical success and struggle have an impact on their emotional responses and engagement levels. Moreover, poor academic achievement reasons from a lack of motivation or innate ability particularly among marginalized groups (Nasir & Shah, 2011). The growth mindset framework (Dweck, 2006) also places responsibility on students by underemphasizing the prominent role of teachers. People with a growth mindset focus on developing and improving their abilities, whereas those with fixed mindset believe that these abilities are unchangeable.

Educational Attribution (AME-E)

Based on attribution theory, educational attribution emphasizes how beliefs about the causes of performance shape students' success and struggle. Mathematical achievement is largely shaped by the quality of education. Teachers are seen as key factors in students' success. On the other hand, instructional quality issues and educational inequities are accepted as difficulties in mathematics (Wilhelm et al., 2017). Along with teachers, educational environments have a crucial role in students' success and struggle (Jackson et al., 2017).

Pre-service and In-service Mathematics Teachers' Attributional Beliefs

Various research about attribution theory has documented that there are three causal properties: locus of control (internal vs. external), stability (stable vs. unstable), and controllability (controllable vs. uncontrollable) (Weiner, 1985). Causal attributions define the consequences of academic success and struggle. Locus of control refers to the location of a cause, within or outside of the actor. For instance, a student with an internal locus of control may attribute their success to persistent preparation and effort, while one with an external locus may attribute it to luck or the exam difficulty. However, stability is related to the duration of a cause, whereas instability refers to causes that are temporary. While certain causes, such as aptitude, are perceived as stable and enduring, chance and effort are usually viewed as unstable and temporary. Controllability, lastly, influences reactions to outcomes and it is the extent to which an individual can influence it (Weiner, 1985). These causal attributions not only shape how teachers interpret their students' success or struggle but also influence their instructional preferences. Learning about teachers' attributional beliefs might enhance their students' overall success in the classroom. In this regard, it is significant to examine teachers' attributional beliefs specifically in mathematics education because they have an impact on their instructional process.

Mathematics teachers play a significant role in creating a classroom environment that supports students' mathematics learning (National Council of Teachers of Mathematics [NCTM], 1991). Throughout their tertiary education, pre-service teachers engage in a developmental process that involves mathematical knowledge, beliefs, skills, and self-awareness as a future teacher. However, as they enter teacher education programs, they still bring their previous knowledge and beliefs. These shape how they learn to teach mathematics. In addition, they have personal school experiences, particularly their negative primary school ones, which affect their beliefs about mathematics teaching (Grootenboer, 2002). Nevertheless, the effect of teacher education programs on pre-service teachers' mathematical beliefs have varied over time (Jao, 2017). Current teacher education programs focus on mathematical and pedagogical knowledge. Besides, they offer various challenging mathematical experiences, fostering pre-service teachers' sensitivity for their future students' feelings regarding mathematics and supporting their students' teaching and learning mathematics (Zaslavsky & Leikin, 1999). Teacher education programs, furthermore, need to consider their beliefs and provide experiences for coping with common misconceptions and misbeliefs about mathematics teaching and learning.

Early family and past school experiences, teacher education programs, and current classroom experiences are the main factors in formation of in-service teachers' mathematical beliefs (Raymond, 1997). In the literature, it is emphasized that teachers' beliefs about mathematics have a significant impact on how they deal with difficulties in their instructional processes (Ball et al., 2008). In this regard, attributional factors play a significant role in educational settings (Dresel et al., 2013). As Peterson and Krumboltz (1989) mentioned, teachers' instructional decisions are influenced by their beliefs. Moreover, their decisions have an influence on their students' learning. Clark and Peterson (1986) emphasized the significance of teachers' most significant beliefs about their students as their perceptions of

the causes of their students' behavior. In this regard, teachers' causal attributional beliefs about their students' success or struggle could influence their future achievement success (Peterson & Barger, 1985). More specifically, these attributions about success and struggle influence expectations for future successes (Graham & Williams, 2009; Weiner, 2000). Understanding the causal attributions behind students' success and struggle has gained increasing attention. Teachers' beliefs, as beliefs of socializers, are particularly often considered in this regard. The considerable effect of teachers' beliefs on their students' learning was studied in various research (Staub & Stern, 2002).

A small number of empirical studies considered teachers' attributional beliefs under affective, cognitive, and motivational dimensions of mathematics teaching and learning. For instance, in studies of Espinoza et al. (2014) and Fennema et al. (1990), teachers generally attribute girls' success in mathematics to effort while boys' mathematics achievement to ability. Conversely, teachers attributed boys' failure to laziness while girls' low mathematics performance to a lack of ability. In Diener and Dweck's (1978) study, they also found that teachers generally preferred to give feedback to girls based on the intellectual quality of their work. In other studies, the better students' mathematics performance, the more teachers tended to attribute students' success to ability and less to their help (Natale & Weiner, 2009).

It is worth investigating the relationship between students' mathematics success and struggle and teachers' attributional beliefs. Current literature indicates that pre-service teachers were inclined to mention teacher education programs, previous family and school experiences, immediate classroom situations and teaching practices as issues influencing their beliefs (Grootenboer, 2008). In addition, research about the in-service teachers' beliefs focused on the effect of teachers' beliefs on judgements about students (Francis et al., 2023), opportunities to engage in advanced mathematical challenges (Hoy et al., 2009), and how they set up their classroom environment (Pajares, 1992). This study has potential to enrich

how professional experience has an impact on teachers' beliefs and contributes valuable insights about teacher education programs.

Method

Participants

This qualitative case study adheres to the instrumental case study requirements (Stake, 2005). The participants consisted of 28 pre- and in-service teachers. Among them, 8 were in-service middle school mathematics teachers (teaching fifth through eighth-grade students), and 10 were in-service elementary education teachers (teaching first through fourth-grade students) from different cities in Türkiye. In addition, 5 participants were pre-service middle school mathematics teachers and 5 were pre-service elementary education teachers from a public university. The gender distribution of participants is consistent with Turkish Ministry of National Education statistics, where female teachers, particularly at the elementary level, are higher than male counterparts (MNE, 2022). All pre- and in-service teachers were assigned codes as IM, IE, PM, and PE, representing in-service middle school mathematics teachers, in-service elementary teachers, pre-service middle school mathematics teachers, and pre-service elementary teachers, respectively. Therefore, IM1 refers to the first in-service mathematics teacher. Table 2 summarizes the demographic information for the participants. The in-service teachers' teaching experience ranged from 1 to 20 years, with an average of 9.15 years, while it was 9.37 for IEs and 8.87 for IMs. Six in-service teachers had also completed a master's degree in the field of education. The pre-service teachers, on the other hand, were in their final year of teacher training programs. They voluntarily participated in the study.

Türkiye has a centralized education system and requires both elementary and middle schools to use the same curricula, prepared by the Board of Education and Training under the

Ministry of Education (MNE, 2018). In addition, education faculties nationwide follow similar teacher training programs recommended by the Turkish Council of Higher Education.

Table 2

Participants' Demographic Information

Participants		IE (n=10)	IM (n=8)	PE (n=5)	PM (n=5)	Total
Gender	Female	8	6	3	3	20
	Male	2	2	2	2	8
Experience (Mean)		9.37	8.87	Last year in program	Last year in program	28

Data Collection Tool and Procedure

This study is part of a larger project investigating the attribution beliefs of pre- and in-service teachers regarding success and struggle in mathematics. In this project, after the first insights into their beliefs were previously explored (Ocal et al., 2025), this study particularly focused on them in general from different perspectives and factors, including family-related and personal ones and individual differences.

A semi-structured interview protocol was used for this study, adapted from the outcomes of the project called *Attributions of Mathematical Excellence Teaching and Learning,* which investigated pre- and in-service teachers' knowledge and perceptions of mathematical success and struggle, and essential attributions for mathematical excellence (Francis et al., 2023; Jacobson et al., 2022). The fundamental attributions identified were genetic, social, personal, and educational, and the research questions were prepared accordingly. In this study, the interview questions were adapted and refined by the research team from the aforementioned project outcomes based on the AME framework by Jacobson et al. (2022) to suit the Turkish educational context.

The first part of the interview protocol involved general questions aimed at revealing their initial insights regarding success and struggle in mathematics. After asking about their

experiences and the student profiles they taught in terms of grade levels, socio-economic situations, and age ranges, participants were also asked to define success, struggle, and being unsuccessful in mathematics. The researchers did not focus on different factors influencing students' success and struggle in mathematics during this process. The findings gathered from these parts were not used in this study. The interview questions in the second part aimed to dive deeper into the possible factors behind the participants' beliefs. The findings from the second part serve as the data sources for this study. Among the questions asked in the interview were those related to the factors that might influence students' success and struggle in mathematics. These questions focused on how they identify whether students are successful or struggling, whether mathematical ability is innate, and how students' self-efficacy and family-related situations influence their success and struggle in mathematics. The interview protocol is available as Supplementary Material 1. After reviewing it, the interview protocol was subjected to expert opinions of two faculty members who had PhD and were specialized in the affective domain of mathematics. Cultural adaptations were also made. A draft version was created, and a pilot study was conducted with one in-service and one pre-service teacher. Feedback gathered from this process helped to finalize the interview protocol. So, the questions were designed to accurately reflect the important components of attributional beliefs regarding students' success and struggle in mathematics.

After obtaining ethics committee approval for the study, demographic information of the participants was collected through an online survey. Their voluntariness was confirmed, ensuring that their identities remained confidential. Interviews were conducted with the participants face-to-face or via Zoom. The meetings lasted 21 to 40 minutes with an average of approximately 29 minutes, and informed consent was obtained from all of them. The interviews were recorded, transcribed, and prepared for analysis using MAXQDA software.

Data Analysis

The interview data were examined through content analysis, and the teachers' beliefs were coded under four main themes (e.g., genetic, social, personal, and educational attributions) based on Jacobson et al.'s (2022) framework for mathematical excellence. The coding process was carried out based on the qualitative analysis procedure of Goetz and LeCompte (1981). A high level of coder agreement (Cohen's Kappa = 0.91) was achieved between the researchers. The coding decisions were documented in MAXQDA software. The codes emerged under the pre-determined themes were verified through expert opinion, and the reliability of the coding was reinforced by independent researcher control. In line with Jacobson et al.'s (2022) framework for mathematical excellence, various subcodes were developed under each theme. These codes were supported by the teachers' opinions, as presented in the findings section. The codebook provided in Supplementary Material 2 summarized the main themes, the categories associated with each theme, a brief description of these categories, and sample scripts. Drawing on Jacobson et al.'s (2022) attributional framework, the generic attribution of mathematical excellence (AME-G) consists of five categories: innate mathematics ability, types of intelligence and cognitive development, inherited or family-based genetic traits, gender-based dispositions, and health and developmental issues. Within this theme, teachers' attributions concerning students' innate ability, academic giftedness and mathematical intelligence were grouped under the category of innate mathematical ability. For instance, the phrases such as "she has a math brain" were coded in this category. The social attributions of mathematical excellence (AME-S) comprise six categories: family support and involvement, parental mathematical knowledge and educational background, societal norms and expectations, social opportunities and barriers, cultural and geographic sensitivity, and economic conditions and living standards. For example, teachers frequently referred to the role of family support in students' mathematical

learning, parents' collaboration with teachers and the challenges faced by students living away from their family. Such explanations were classified under this category.

The personal attributions of mathematical excellence (AME-P) are related to the factors connected to the individual learner and composed of eight categories: psychological factors and self-perception, physical and physiological states, behavioral and emotional responses, cognitive gaps and conceptual weaknesses, effort, practice and participation, academic performance and achievement indicators, and career orientation and long-term success. For instance, the category of psychological factors and self-perception reflects teachers' attributions regarding how students perceive themselves as mathematics learners. This includes references to students' self-confidence, anxiety, interest, identity, internal motivation and emotional relationship with mathematics. Finally, teachers' educational attributions of mathematical excellence (AME-E) encompass six categories: instructional quality and pedagogical approach, teacher-student interaction and expectations, learning environment and physical conditions, educational system and curriculum factors, linguistic comprehension and expression difficulties, and nature of mathematics and cognitive demands as categories under this theme. For example, the category of educational system and curriculum factors includes teachers' statements concerning the national education system, curriculum structure, cross-disciplinary integration, and students' prior educational experiences. These attributions were mainly associated with students' preparedness or struggles they encountered in learning mathematics according to students' explanations (see Supplementary Material 2 for descriptions and sample scripts for each code).

We used multi-level coding to capture both the range and complexity of the attributional beliefs. These categories were then refined and confirmed through triangulation. We also seek expert validation for these categorization and coding.

Findings

Overall Distribution of Attributions

The analysis of 28 participants yielded 2,103 coded segments classified under the Attributions of Mathematical Excellence (AME) framework. The framework, based on attribution theory, allowed teachers' explanations to be grouped into four main themes. Table 3 presents the overall distribution of codes across these categories.

Table 3

Distribution of Coded Segments Across Four Attribution Themes

	Personal	*Educational*	*Social*	*Genetic*	*Total*
IE (n=10)	375*	192	174	145	886 (unit 88,6)
IM (n=8)	257	102	82	55	496 (unit 62)
PE (n=5)	201	80	98	60	439 (unit 87.8)
PM (n=5)	106	74	59	43	282 (unit 56.5)
Total	939 (45%)	448 (21%)	413 (20%)	303 (14%)	2103

* Frequencies of mentions from pre- and in-service teachers

Personal attributions were the most common, accounting for nearly half of all coded segments (45%). Teachers frequently linked students' mathematical outcomes to factors such as motivation, confidence, persistence, and prior knowledge. Educational attributions (21%) ranked second, emphasizing the influence of instructional quality, curriculum, and classroom conditions. Social attributions (20%) highlighted the role of family, socioeconomic background, and peer culture, while genetic explanations (14%) were least frequent, involving references to innate ability or developmental characteristics. Overall, teachers primarily explained students' success and struggle through individual characteristics, with educational and social contexts playing secondary roles.

Group-Level Patterns

Although personal factors dominated across all groups, the relative emphasis differed. In-service teachers, especially at the elementary level, gave slightly more attention to instructional and curricular issues alongside student motivation. Middle school teachers

focused most heavily on individual effort and confidence. They paid less attention to contextual influences. On the other hand, pre-service teachers gave more attention to family support, peer relationships, and social expectations. These differences suggest that professional experience shapes how teachers interpret mathematical achievement. Experienced teachers positioned success partly in teaching and curriculum, while pre-service teachers viewed it more through social and environmental factors.

Personal Attributions (AME-P)

Personal attributions were the most prominent among the four themes. Teachers' explanations centered on students' internal characteristics such as motivation, confidence, effort, prior knowledge, and emotional responses as important reasons for mathematical success or struggle. Based on the AME codebook, Table 4 summarizes the identified codes within this theme.

Table 4

Distribution of Coded Segments for Personal Attributions

Code	IE	IM	PE	PM	Total
Psychological factors and self-perception	107*	63	73	31	274
Academic performance and achievement indicators	101	60	39	27	227
Cognitive gaps and conceptual weaknesses	53	70	26	14	163
Effort, practice, and engagement	45	28	34	16	123
Behavioral and emotional responses	26	21	14	7	68
Career orientation and long-term success	26	7	7	4	44
Physical and physiological states	17	8	8	7	40
Total	375	257	201	106	939

* Frequencies of mentions from pre- and in-service teachers

Teachers most often referred to students' psychological dispositions and observable performance when interpreting mathematical outcomes. Factors such as mindset, confidence, and visible academic results were emphasized more than external or contextual influences.

Teachers frequently discussed how students' confidence, self-belief, and early experiences codes with mathematics shaped their long-term achievement under *psychological factors and self-perception* category. A pre-service middle school mathematics teacher explained, "if a student thinks, 'I can't do math,' that belief itself becomes a barrier. Believing they are capable is the first step toward success" (PM2). Similarly, an in-service middle school mathematics teacher noted, "when students first encounter mathematics in a supportive way and feel they can succeed, they continue to perform well in later years" (IM1). Many participants also mentioned mathematics anxiety. They thought that some students enter class already convinced of their failure, which restricts their engagement and learning.

Teachers often defined success and struggle through visible performance outcomes such as test results, speed, and accuracy under academic performance and achievement indicators category. For instance, one elementary school teacher stated, "when a student answers quickly and correctly in class, it shows strong mathematical understanding" (IE5). Similarly, a pre-service teacher said, "grades are usually the first thing we look at; if a student performs well on exams, we see them as successful" (PM3). Across groups, observable performance was treated not only as evidence of understanding but also as a defining indicator of success.

Educational Attributions (AME-E)

Educational attributions formed the second largest theme. Teachers linked students' success and struggle in mathematics to instructional quality, curriculum design, classroom conditions, teacher–student interactions, and the broader educational system with their explanations (see Table 5). These reflections reveal pre- and in-service teachers' belief that schooling practices and systemic structures shape learning opportunities as much as students' individual characteristics.

Table 5

Distribution of Coded Segments for Educational Attributions

Code	IE	IM	PE	PM	Total
Instruction quality and pedagogical approach	83*	43	31	38	195
Educational system and curriculum factors	37	21	7	9	74
Learning environment and physical conditions	24	18	21	8	71
Teacher-student interaction and expectations	21	6	12	8	47
Nature of mathematics and cognitive demands	18	11	6	7	42
Linguistic comprehension and expression difficulties	9	3	3	4	19
Total	192	102	80	74	448

* Frequencies of mentions from pre- and in-service teachers

The most common educational explanation concerned the quality of instruction and teachers' pedagogical choices. Participants agreed that clear explanations, step-by-step teaching, and the use of real-life examples made mathematical ideas more accessible. On the other hand, abstract or monotonous teaching strategies created barriers to understanding. A middle school teacher indicated as follows: "Mathematics is related to life. When teachers make real-life connections, students learn more easily" (IM4). Similarly, an elementary school teacher noted as follows: "If you only explain abstractly, many students fail. But when you break it down with examples, they can grasp it" (IE8). Across all groups, teachers viewed pedagogy as a decisive factor that could either enable or limit students' success.

Many teachers linked mathematical achievement to the structure and intensity of the curriculum under *the educational system and curriculum factors* category. They argued that overloaded or rigid programs left little time to address students' gaps. On the other hand, strong grounds built in the early grades supported long-term success. An elementary school teacher indicated as follows: "Sometimes the problem is not the student but the curriculum. If

the program is overloaded, they cannot keep up" (IE1). Similarly, another teacher added that "weaknesses from elementary years continue in later grades" (IM1). These scripts illustrate how teachers saw curriculum design and educational continuity as important determinants of student outcomes.

Social Attributions (AME-S)

Social attributions accounted for 20% of all coded segments. Table 6 summarizes the identified categories within this theme. These reflections highlight teachers' recognition that learning is shaped not only by individual and instructional factors but also by the environments in which students live.

Table 6

Distribution of Coded Segments for Social Attributions

Code	IE	IM	PE	PM	Total
Family support and involvement	88*	39	43	27	197
Economic conditions and living standards	28	13	17	6	64
Societal norms and social expectations	18	15	15	12	60
Social opportunities and barriers	12	7	14	6	39
Parental math knowledge and educational background	15	5	6	4	30
Cultural and geographic sensitivity	13	3	3	4	23
Total	174	82	98	59	413

* Frequencies of mentions from pre- and in-service teachers

Family support and involvement category was the most frequently mentioned social factor. Teachers consistently emphasized that encouragement, interest, and consistent communication between parents and children promote motivation and responsibility in learning mathematics. Conversely, lack of support or excessive pressure was viewed as undermining progress. As one teacher explained, "when parents check homework and show they care, students feel responsible and succeed more easily" (IM1). Similarly, another

teacher indicated as follows: “If there is no support at home, school alone cannot be enough” (IE2). These scripts illustrated a shared belief that family engagement plays a essential role in shaping mathematical achievement.

Teachers frequently linked students’ opportunities to their family’s economic situation under *economic conditions and living standards* category. Limited access to resources, private tutoring, or technology was seen as major obstacles to learning. On the other hand, financial stability provided clear advantages. One teacher indicated as follows: “Students from low-income families cannot always afford materials or tutoring. This creates a gap between them and others” (IM2). Another said that “if the family has the means, they can provide extra lessons or technology, and if not, the student is left behind” (PM2). Such reflections show how teachers viewed economic inequality as an main factor for differential achievement.

Genetic Attributions (AME-G)

Genetic attributions were the least frequent, accounting for 14% of all coded segments. In this category, teachers explained students’ mathematical success or struggle through innate ability, cognitive development, gender-related differences, family inheritance, and health conditions (see Table 7). These explanations reveal that most teachers emphasized social, educational, or personal factors. On the other hand, a smaller group still viewed mathematical ability as partly biological or inherited.

Table 7

Distribution of coded segments for Genetic Attributions

Code	IE	IM	PE	PM	Total
Types of intelligence and cognitive development	65*	27	19	23	134
Gender-related dispositions	24	12	18	9	63
Innate mathematical ability	27	7	9	4	47
Inherited or family-based genetic traits	20	3	7	3	33
Health and developmental issues	9	6	7	4	26

Total	145	55	60	43	303

* Frequencies of mentions from pre- and in-service teachers

The most common genetic explanation concerned differences in intellectual profiles and developmental readiness under *types of intelligence and cognitive development* category. Teachers described how students progress at different rates in abstract thinking and reasoning. This was often interpreted as natural variation. A middle school teacher explained this situation as follows: “Some students are ready for abstract concepts earlier, while others need more time. If we rush them, they struggle” (IM3). Similarly, a pre-service teacher indicated as follows: “Every student has a different way of learning, some are stronger verbally, some numerically and this affects math success” (PM2). These reflections suggest that teachers perceived cognitive diversity as shaping how easily students grasp mathematical ideas.

Gender was another repeated code. Some teachers said that cultural messages present mathematics as a male subject, which influence students’ confidence and participation. A pre-service teacher indicated as follows: “Even today, some parents say boys are better at math. Girls who hear this lose confidence” (PM1). Others mentioned that boys often appear more confident, while girls tend to hesitate despite equal ability. Such perceptions indicated that gender stereotypes and classroom expectations continue to shape students’ engagement with mathematics.

Discussion and Conclusion

This study explored how in-service and pre-service elementary and middle school teachers explained students’ success and struggle in mathematics by using the Attributions of Mathematical Excellence framework (Jacobson et al., 2022; Ocal et al., 2025). Across the data gathered, personal explanations emerged as the most dominant, making up nearly half of all coded references. Teachers consistently described students’ motivation, effort, confidence, and prior knowledge as the primary factors shaping students’ academic performance. These

views reflected a strong tendency to place responsibility for outcomes within the learner. Similarly, attributional beliefs supported that students' own control on their learning leads to success compared to the ones who don't believe in their controls on their learning (Licht & Kistner, 1986; Weiner, 1985). In addition, this emphasis by teachers on psychological factors, particularly motivation, persistence and confidence, suggested that success or struggle in mathematics is closely linked to cognitive and affective dimensions. The dominance of personal attributions in the present study emphasized that teachers frequently consider effort, motivation and persistence as reasons for mathematical students' outcomes. This tendency is closely related with Weiner's attribution theory (1985) and prior research (Graham, 2020) This also draws attention to internal factors. For instance, effort was frequently mentioned as one of the influential determinants of students' success. Therefore, teachers' emphasis on their beliefs and persistence might be used for encouraging students' responsibility. This situation might also risk ignoring various factors that could constrain learning opportunities.

The next most common explanations were educational attributions. The focus was on instructional quality, classroom conditions, and the influence of curriculum and systemic structures. Hence, teachers acknowledged the significance of instructional quality and systemic structures. Teachers pointed out that effective pedagogy and supportive learning environments could enable success, while gaps in instruction or curriculum design often created barriers for students to learn. Instructional quality along with pre-existing negative stereotypes about mathematics also found influential in students' mathematical success and struggle (Saha et al., 2024). The emphasis placed on the decisive role of teaching quality and pedagogical approaches is particularly seen important. Participant teachers indicated that concretization, establishing connections to daily life, and differentiated teaching strategies increase student achievement, while abstract and monotonous teaching ones might result in learning difficulties. These findings are consistent with various studies emphasizing the

strong influence of effective teaching strategies on student achievement (Hiebert & Grouws, 2007). However, Tschannen-Moran and Hoy (2001) found that teachers sometimes underestimate their instructional role. As a result, they are more likely to attribute students' struggle to their deficits rather than instructional practices. At the same time, research on curriculum requirements, classroom situations or other systematic factors are influential in learning. In the present study, in-service teachers, in particular, were more likely to highlight these issues. They indicated that daily classroom factors draw attention to structural influences on students' success.

Social attributions were also evident with a lesser extent. Participants emphasized the role of families, economic resources, and peer expectations in shaping engagement with mathematics. These findings reflected the strong role of family involvement and socioeconomic context in Türkiye. In line with the participants' opinions, students' mathematics motivation and persistence were related with parental support, and this was significant for future achievement (Shukla et al., 2015). Family support and economic conditions appeared to be significant factors. This emphasis by teachers supported numerous studies demonstrating the role of socioeconomic status in mathematics achievement (Organisation for Economic Co-operation and Development [OECD], 2019; Sirin, 2005). Furthermore, teachers' opinions that social norms and gender-based expectations shaped students' perceptions of mathematics align with the literature on the impact of gender stereotypes on mathematics learning (Hyde et al., 2008). However, the emphasis among Turkish teachers might be particularly prominent given the centrality of family in the cultural and educational system. Thus, pre-service teachers' adherence to these issues may indicate their cultural norms regarding parental responsibility and might be influenced by peer effects.

Lastly, genetic attributions appeared least frequently. Although some teachers invoked ideas of natural talent, gender differences, or hereditary traits, these explanations were less

central compared to personal, educational, or social ones. Mathematics is an area that necessitates students' natural talent (Gunderson et al., 2017). In addition, in different studies (Espinoza et al., 2014; Fennema et al., 1990) teachers attribute students' mathematical success to gender differences, linking girls' success to effort and boys' success to ability. Although participants in the present study pointed out gender differences, they didn't specifically clarify how gender influenced the outcomes. Additionally, the findings suggested that the belief that "mathematical talent is innate" was persistent among teachers. However, such innate ability perspective risk limiting students' learning potential (Boaler, 2016). Overall, these findings suggested that teachers' attributional beliefs in natural talent shape their expectations.

Differences across teacher groups further enriched these patterns. In-service teachers, particularly those in elementary schools, relied most heavily on personal attributions. They also gave substantial attention to instructional and curricular factors, reflecting their daily engagement with classroom realities. In-service teachers have varied teaching experience. As a result, they are exposed to various student profiles. Since their mathematical beliefs were influenced by classroom experiences (Raymon, 1997), these beliefs shape their influence on their instructional processes (Ball et al., 2008). On the other hand, pre-service teachers, especially at the middle school level, also emphasized personal explanations. However, they were more likely to emphasize social influences such as family support, peer culture, and societal expectations. These contrasts inferred that teaching experience might sensitize educators to the structural and pedagogical dimensions of learning. On the other hand, pre-service teachers draw more heavily on normative beliefs and observations from their limited classroom exposure. Furthermore, pre-service teachers relied on their recent theoretical teacher training since their beliefs changed during this training (Jao, 2017).

Overall, this research indicated that teachers used multidimensional attributional categories to explain students' mathematical success and struggle. However, they placed a stronger emphasis on personal and educational factors. The findings discussed suggested that teacher education should focus specifically on student motivation, self-perception, strengthening conceptual foundations, and effective pedagogical strategies. Furthermore, developing teachers' awareness to social and economic conditions and challenging deterministic beliefs based on genetic attributions are important for creating more inclusive and supportive learning environments.

Implications for Teacher Beliefs and Teacher Education

The attribution patterns observed in this study have important implications for both classroom practice and the preparation of future teachers. When teachers predominantly explained students' success or struggle in terms of personal factors, such as motivation and effort, they unintentionally placed the burden of responsibility entirely on the learner. While such views may encourage students to persist, they may also frame underachievement seem like an individual problem. This may lead to discouragement, lowered expectations, or even an implicit attribution of responsibility to students. This narrow focus can hide the significant role that teachers, families, schools, and broader social conditions play in shaping students' learning opportunities.

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