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An Examination of Middle School Students' Mathematical Identities in a Social Context

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ABSTRACT

This study examines the mathematical identities of middle school students in a social context. Mathematical identity is an important factor affecting students' relationships with mathematics and their success in mathematics. Identity is formed by individuals' interactions with their perceptions and environment. In this context, mathematical identity is also shaped by social environment, education system, socio-cultural norms, and socio-economic status. In this research, the case study design, one of the qualitative research methods, was used. This research was conducted with 24 middle school students studying in different six public schools in a provincial center in the Marmara Region in the 2023-2024 academic year in Turkey, and 24 relatives determined by these students. The participants were selected through the maximum diversity sampling method. In the data collection stage, the "Mathematics Identity Scale" and the "Mathematics Identity Social Context Interview Form" developed by the researchers were used. The data were analyzed through a content analysis method. Findings indicate that themes such as attitudes toward the social environment, education system, socio-cultural norms, and socio-economic status significantly affect students' mathematical identities. In addition, it has been determined that individual characteristics such as mathematical communication skills, mathematical literacy, attitude towards mathematics, and mathematical persistence also affect the formation of mathematical identity. In conclusion, students' social environments and individual characteristics play a significant role in shaping their mathematical identities. Researchers are recommended to conduct similar studies in different social and cultural contexts and to examine the changes in students' mathematical identities through longitudinal studies.

Keywords: Middle school students, mathematical identity, social context in mathematics.

Introduction

The middle school period is considered a significant phase in the identity development of students. During this time, individuals undergo rapid cognitive and emotional development. Research indicates that family, peer groups, and teachers play influential roles in the identity development of middle school students (Aliyev & Tunç, 2017). Peer groups play a critical role in shaping students' social identities (Jones et al., 2014). During this period, students begin to identify with and associate themselves with the groups they belong to. Additionally, middle school students, who tend to explore their differences, start to question their values and beliefs as they shape their identities (Eccles, 2009). Therefore, creating environments that support both the academic success and identity development of middle school students is essential for fostering healthy identity development. Identity begins with the individual's process of perceiving themselves as a unique and separate entity, a process shaped through continuous interactions with their life story and environment. Throughout these interactions, individuals consider both their expectations and those of their surroundings (Scheuringer, 2016). Identity also reflects an individual's sense of belonging to social groups and their interactions with these groups. These interactions are crucial in fostering a sense of social security and belonging (Finuras, 2023). In this context, identity can be viewed as a complex structure shaping the relationships between individuals and societies. Weidner (2013) and Scheuringer (2016) emphasize that identity comprises both individual and social elements, which take form through interactions with one's sociocultural environment. Hence, identity should be considered a dynamic process encompassing how individuals perceive themselves and how they are perceived by others. This process includes individuals' social roles, expectations, and relationships with groups, which form the fundamental building blocks of identity (Finuras, 2023). The relationships between the individual and society reflect both the individual and society aspects of identity. This interaction determines how identity is

understood, analyzed, and interpreted within both the inner world of the individual and at a societal level. Vignoles (2018) argues that identity is both personal and social in terms of its content and the processes through which it is constructed, maintained, and changed over time. Connolly (1995) defines identity as who we are and how we are recognized. These definitions suggest that identity is influenced by the perspectives of others.

Social identity is defined as a structure shaped by individuals' interactions with social groups and environments, determining how one perceives themselves and others. The concept of social identity helps us understand the boundaries of our identity, how we contribute to it, its context, the intersection of different identity aspects, and how identity can serve as a source for action (Ásta, 2018). Poche (1997) notes that collective identities are influenced by one's environment, rather than merely representing political or economic positions. This influence suggests that identities have an autonomous form in a social context. Persoob (2014) states that individuals tend to categorize themselves into groups when interacting in social contexts, making social identity a critical element. Social identities can facilitate individuals' understanding of themselves, their development, and their relationships with others in a social context. Finke (2022) emphasizes the importance of individuals' relationships and recognition within their social environments in forming social identities. Bronfenbrenner (1979), in his ecological systems theory, argues that individuals develop through interactions within various environmental systems and that these interactions have profound effects on personal development. This theory includes five layers: the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. This research focuses on the microsystem and mesosystem layers, examining the immediate environmental contexts with which the individual directly interacts—such as family, friends, school, and neighborhood—and the relationships among these contexts.

Identities consist of sub-identities that individuals acquire within various social contexts and groups. These sub-identities are components of an individual's primary identity, becoming more pronounced in certain contexts. For example, a person may be both an academic and a parent, and they may also hold a mathematical identity. These roles represent different facets of the individual's identity and emerge as distinct sub-identities in specific situations. Ásta (2018) emphasizes that identity is multidimensional, with various sub-identities coming social environments, including family, friends, and together to form an individual's holistic identity. Social identity theory posits that these sub-identities are shaped through individuals' interactions with their social environments and the resulting social categories (Poche, 1997). Therefore, sub-identities play an important role in helping individuals understand themselves and organize their relationships with others within social contexts (Persoob, 2014).

Mathematical identity can be described as the process by which individuals' mathematical abilities and identities are recognized by themselves and their surroundings. This process can influence students' relationships with mathematics, their attitudes toward it, and their success in the subject. Mathematical identity is regarded as a socio-motivational construct that is a significant determinant of students' mathematics achievement, with the social environment playing a crucial role in its formation (Barba, 2022). Research on middle school students' mathematical identities (Martin, 2001; Nasir & Hand, 2006) has shown the impact of family, peers, and teachers on shaping these identities. Boaler et al. (2000) emphasize that young individuals' developing identities significantly affect their success in middle and high school mathematics. Kafoussi et al. (2019) examined the influence of parents on sixth-grade students' formation of mathematical identity, revealing qualitative differences between students who identified as "good" or "average." It was found that engaging in math-related activities with parents at home supports students in approaching mathematical tasks with a positive attitude and belief. Gweshe and Brodie (2019) identify that factors such as family members, peers, career prospects, and the desire to please others play a significant role in shaping students' mathematical identities. Horn (2008) suggests that students' identities of mathematical competence emerge from the interaction between the mathematical worlds they encounter at school and their existing identities. Another study by Boaler et al. (2000) highlights that the developing identities of young individuals have a significant yet often overlooked impact on their middle and high school mathematics achievements. Students commonly view mathematics as a difficult and rigid subject, indicating that they particularly struggle to find meaning in it. These findings underscore that mathematical identity is a critical variable in helping students better understand mathematics and reduce the challenges they face in the subject. Investigating mathematical identity is therefore essential for enhancing students' success in mathematics. Additionally, students' mathematical identities are greatly influenced by the attitudes and interactions within their

teachers. This study aims to provide insights into the impact of these social factors on mathematical identity. To improve the quality of mathematics education, policies and strategies that positively influence students' mathematical identities should be developed. This research can offer data and analysis necessary for shaping educational policies and providing more effective mathematics education to students. Studies on mathematical identity in Turkey are primarily focused on scale development (Arslan, 2023; Hacıömeroğlu, 2020; Satmaz & Kıncal, 2023) and the mathematical identity of teacher candidates (Ergen et al., 2023). This study, however, focuses on middle school students and the social context of mathematical identity. Therefore, it fills a significant gap and contributes both to academic research and educational practices.

The primary aim of this study is to examine middle school students' mathematical identities within a social context. To achieve this objective, the following questions have been explored:

- What factors influence middle school students' mathematical identity in a social context?
- What individual characteristics shape middle school students' mathematical identities in a social context?

These sub-objectives aim to understand the multidimensional structure of students' mathematical identities and their dynamic connection with social interactions.

Method

Research Design

This research is a qualitative study focusing on examining middle school students' mathematical identities within a social context and is designed using a single-case study approach. A case study is a research method used to examine a specific event, situation, individual, or group in depth (Yin, 2018). This method provides researchers with the opportunity to understand and interpret complex phenomena within their real-life context, making it widely applicable in fields such as social sciences, education, business, and health sciences (Creswell & Poth, 2018). This design was selected to gain an in-depth understanding of students' relationships with mathematics and how this relationship intertwines with their social identities. The case under investigation is the mathematical identities of middle school students. Different units of analysis, including the student's mother, father, friend, and math teacher, were considered for evaluating this case. A diagram of the research model is presented in Figure 1.

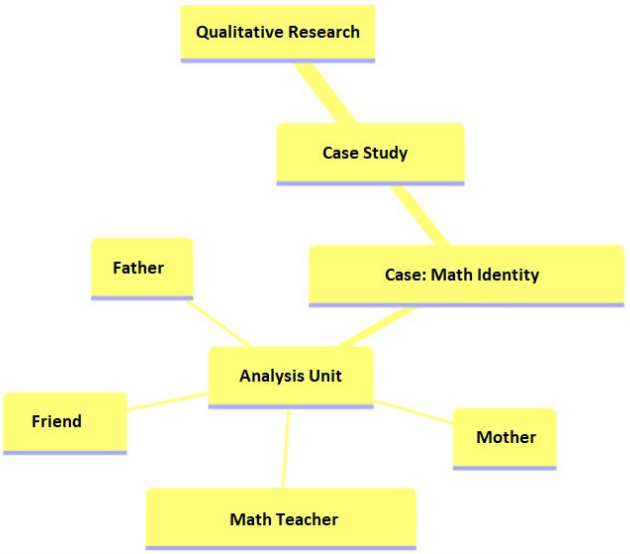

Figure 1.
Model of the Research

Participant Group

In selecting the participant group for this research, the maximum variation sampling method, one of the purposeful sampling types, was utilized. Maximum variation sampling is a strategy that allows researchers to select cases or participants with a wide range of variations (Patton, 2015). This strategy aims to maximize diversity within the sample to encompass all possible cases, perspectives, and characteristics related to the research question, thereby enhancing the generalizability and depth of the study (Creswell & Poth, 2018). This research was conducted with 48 participants, including 24 middle school students and 24 individuals identified by these students as close contacts, attending public schools affiliated with the Ministry of National Education in the central district of a provincial city in the Marmara Region, northwestern Turkey, during the 2023-2024 academic year. Information regarding the participants is presented in Table 1.

Table 1.

Participant Information

Student	Grade	Gender	Student Affinity
S1	5. grade	Female	Mother
S2	6. grade	Male	Math Teacher
S3	7. grade	Female	Math Teacher
S4	5. grade	Female	Father
S5	7. grade	Male	Sister
S6	8. grade	Male	Mother
S7	7. grade	Female	Father
S8	5. grade	Male	Math Teacher
S9	8. grade	Male	Mother
S10	8. grade	Female	Father
S11	6. grade	Female	Math Teacher
S12	7. grade	Male	Friend
S13	5. grade	Female	Mother
S14	6. grade	Male	Father
S15	8. grade	Male	Friend
S16	5. grade	Male	Friend
S17	8. grade	Male	Mother
S18	6. grade	Female	Math Teacher
S19	7. grade	Female	Mother
S20	6. grade	Male	Friend
S21	5. grade	Female	Father
S22	8. grade	Female	Primary school teachers
S23	7. grade	Male	Primary school teachers
S24	8. grade	Female	Friend

Table 1 presents the information on participants' grade levels, gender distribution, and social environment distribution. A total of 24 students participated: 6 students from grade 5, 5 students from grade 6, 6 students from grade 7, and 7 students from grade 8. An equal gender distribution was maintained, with 12 female and 12 male students. The participants, representing the students' family members and educators, included 6 mothers, 5 fathers, 5 friends, 5 mathematics teachers, 2 primary school teachers, and 1 older sister. The students are labeled as S1, S2, S3, … S24.

Data Collection Instruments

In the initial phase of the research, the "Mathematics Identity Scale" developed by Satmaz and Kıncal (2023) was used. This scale consists of 16 items and includes no reverse items. It encompasses three sub-factors—interest in mathematics, recognition, and performance—and has a reliability coefficient of .863. In the second phase of the research, the "Mathematics Identity Social Context Interview Form" was utilized. This form, developed by the researchers of the current study, consists of two sections. The first section provides an "informed consent" text for participants, and the second section includes the "interview questions." The interview questions consist of six questions addressing participants' relationships with mathematics, role models and sources of support in mathematics, emotions toward mathematics, recommendations, and applications of mathematics in daily life. The interview form was finalized after being reviewed by five experts: two in curriculum and instruction, one in mathematics education, one in assessment and evaluation, and one in Turkish language. The agreement status for the first part of the research is presented in Table 2.

Table 2.

Agreement Status

Student	Student Affinity	Estimated	Scale Result	Compatibility Status
S1	Mother	Low	Low	Compatible
S2	Math Teacher	High	High	Compatible
S3	Math Teacher	Low	Low	Compatible
S4	Father	Low	Medium	Incompatible
S5	Sister	High	Medium	Incompatible
S6	Mother	Medium	Medium	Compatible
S7	Father	Medium	Medium	Compatible
S8	Math Teacher	High	High	Compatible
S9	Mother	Medium	Medium	Compatible
S10	Father	Medium	High	Incompatible
S11	Math Teacher	High	High	Compatible
S12	Friend	Low	Medium	Incompatible
S13	Mother	High	High	Compatible
S14	Father	High	High	Compatible
S15	Friend	High	High	Compatible
S16	Friend	Medium	High	Incompatible
S17	Mother	High	Medium	Incompatible
S18	Math Teacher	Medium	Medium	Compatible
S19	Mother	Medium	Low	Incompatible
S20	Friend	Medium	Medium	Compatible
S21	Father	Low	Low	Compatible
S22	Primary school teachers	High	High	Compatible
S23	Primary school teachers	Medium	Low	Incompatible
S24	Friend	Low	Low	Compatible

Upon examining Table 2, it can be observed that a total of 48 individuals participated in the first phase of the research, consisting of 24 students and 24 close contacts of these students. The "Mathematics Identity Scale" developed by Satmaz and Kıncal (2023) was administered to the participating students, along with the question, "Who best describes you in mathematics?" Based on the students' responses, the researchers contacted their close contacts and asked, "How would you assess the mathematics

identity level of [student's name]?" Following the researchers' review, 16 consistent results were found between the measurement outcomes of the 24 students and the descriptions provided by their close contacts. The category with the highest consistency rate (100%) was identified as "teacher." Inconsistent results were excluded from the study, and the decision was made to proceed with the consistent findings. The researchers conducted phone interviews with the participants to ask whether they would like to participate in the second phase. Some participants expressed their unwillingness to continue due to reasons such as work commitments, lack of time, and distrust in research. These participants were thanked for their involvement in the first phase. One participant expressed a desire to continue with the study under the condition of being a backup participant. The second phase of the research proceeded with 12 voluntary participants, who were labelled as P1, P2, P3, … P12. The characteristics of these participants are presented in Table 3.

Table 3.

Characteristics of Participants

Participant	Student Affinity	Participant Gender
P1	Mother	Female
P2	Mother	Female
P3	Mother	Female
P4	Father	Male
P5	Father	Male
P6	Father	Male
P7	Friend	Female
P8	Friend	Male
P9	Friend	Male
P10	Math Teacher	Male
P11	Math Teacher	Female
P12	Math Teacher	Female

In the second phase of the research, 12 voluntary close contacts participated. Analyzing the relationships of the participants, it was found that three were mothers, three were fathers, three were friends, and three were mathematics teachers. The group consisted of six females and six males. Face-to-face interviews were conducted with the participants. These interviews took place either at the participants' homes or in the researchers' offices at the university. Participants were informed about the research, and their consent was obtained. The interviews were recorded with the participants' permission and each session lasted approximately 45 to 60 minutes.

The ethical process in the study was as follows:

- Ethics committee approval was obtained from Çanakkale Onsekiz Mart University Social and Humanitarian Ethics Committee (Date: 04.05.2023, Number: E-84026528-050.01.04-2300100856).
- Written informed consent was obtained from students and student affinity who participated in this study.

Data Analysis

The data from the research were analyzed using the content analysis method. Content analysis is the systematic examination of texts to identify and classify specific themes or concepts (Hsieh & Shannon, 2005). The research data were collected through semi-structured interviews with participants. The collected data were analyzed using coding, aiming to reveal the social relationships of students with mathematics, their identities, and how these identities were formed. This process was based on the analysis steps proposed by Braun and Clarke (2006). In the analysis of the data, a literature review was conducted first, followed by the coding of relevant data segments and the formation of themes. The themes created by the researchers were presented to field experts for their opinions. The final versions were developed based on the feedback received from these experts. MAXQDA qualitative data analysis software and Microsoft Word were used for all modeling and analysis tasks.

Validity and Reliability

When conducting qualitative research on middle school students' mathematical identities in social contexts, the validity and reliability of the obtained data are of critical impMediumnce. In qualitative research, validity and reliability are assessed through concepts such as consistency, credibility, transferability, confirmability, and objectivity. These concepts enhance the reliability of qualitative research and are essential for the acceptance of the results (Lincoln & Guba, 1985). The consistency of the research has been ensured by the researcher clearly documenting the process and decisions made throughout the study. The credibility of the research has been bolstered by obtaining participants' approval, maintaining long-term interactions, and spreading the data collection process over time. The transferability of the research has been strengthened by comparing the characteristics and results of participant groups with similar situations. The confirmability of the research has been achieved by transparently reporting the data collection and analysis processes. Throughout the research process, the researchers have acted independently of any biases.

Results

Findings Regarding Factors Affecting Middle School Students' Mathematical Identity in a Social Context

The parameters affecting middle school students' mathematical identity in a social context are grouped under the themes of social environment attitudes, the education

system, socio-cultural norms, and socioeconomic status. These themes are illustrated in Figure 2. Direct quotations related to these themes are provided below.

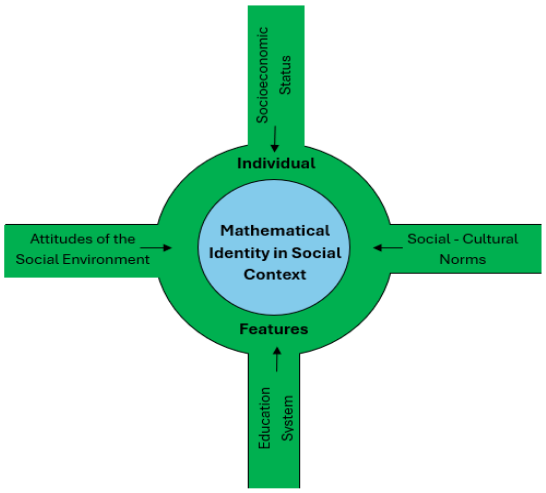

Figure 2.
Parameters Affecting Mathematical Identity in a Social Context

Attitudes of the Social Environment

Direct quotes regarding the attitudes of the social environment that affect middle school students' mathematical identity in a social context are presented below.

P1*: "I think mathematics is an important subject, but it is not indispensable. When we look at many of the people who govern the country today, I think they are successful because they can express themselves better verbally. Of course, this doesn't mean that mathematics is ineffective."*

P2: *"Mathematics is very important to me. I believe that whatever profession my child chooses in the future, mathematics will be like a key. It will help open every door they wish to."*

P3: *"I think my child is influenced by their friends. They are very affected by comments like 'this topic is hard' that they hear from their friends about certain math topics. It seems to create some prejudice."*

When the direct quotes are examined, it is understood that the attitudes of the social environment are an important factor affecting middle school students' mathematical identity in a social context. Relatives of the students have indicated that they are influenced by people in their social environment.

Education System

Direct quotes regarding the views on the education system affecting middle school students' mathematical identity in a social context are as follows.

P10: *"Actually, I think the mathematics curricula are good. There is a spiral structure in our math programs. Therefore, I believe that students who have a solid foundation in mathematics will do better as they progress to higher age groups."*

P11: *"I think the classroom systems in schools are not very suitable for learning mathematics. In this system, teachers are always explaining, and students are in the listening part. Afterward, students are made to solve many problems by the teacher. So, students are learning to solve problems, not mathematics."*

When examining the direct quotes, it is evident that the education system is an important factor influencing middle school students' mathematical identity in a social context. Components of the education system, such as curricula, classroom interactions, and teaching methods, have been determined to be effective in shaping students' mathematical identity.

Social-Cultural Norms

Direct quotes regarding the views on social-cultural norms as parameters affecting middle school students' mathematical identity in a social context are presented below.

P5: *"I have a daughter and a son. If I have to compare them, my daughter is more organized and successful in mathematics. Recently, I think girls are more successful in mathematics than boys. Maybe it was like this before too, but the attendance rate of girls in school was low. We didn't know about this situation."*

P12: *"As a nation, we are bad at mathematics. I don't know where we are making mistakes, but we definitely can't handle this."*

When the direct quotes are examined, it is seen that social-cultural norms are an important factor affecting middle school students' mathematical identity in a social context. Especially, it appears that misleading or incomplete stereotypes within society have an impact on individuals' thoughts.

Socioeconomic Status

Direct quotes regarding the views on socioeconomic status as parameters affecting middle school students' mathematical identity in a social context are presented below.

P6: *"I try to provide all kinds of opportunities for my daughter. I think the textbooks provided at school are insufficient. I buy different resource books. Additionally, we have also purchased an online education system. It's all to help her improve in mathematics."*

P7: *"I know that some of my friends take private lessons. Therefore, they have an advantage over us. If my friend's family could afford private lessons, she could also be more successful in mathematics."*

When the direct quotes are examined, it is evident that individuals' socioeconomic statuses are important factors affecting middle school students' mathematical identity in a social context. Participants indicated that the extra opportunities provided to students positively influence their mathematical identities.

Findings Regarding Individual Characteristics Shaping Middle School Students' Mathematical Identities in a Social Context

When examining the individual characteristics shaping middle school students' mathematical identities in a social context, they are grouped under the themes of mathematical communication skills, mathematical literacy, attitudes toward mathematics, and mathematical resilience. These themes are shown in Figure 3. Direct quotes related to these themes are presented below.

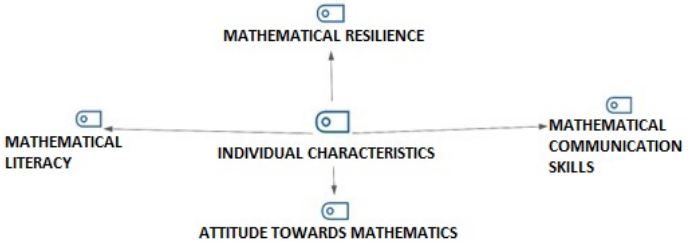

Figure 3.
Individual Characteristics

Mathematical Communication Skills

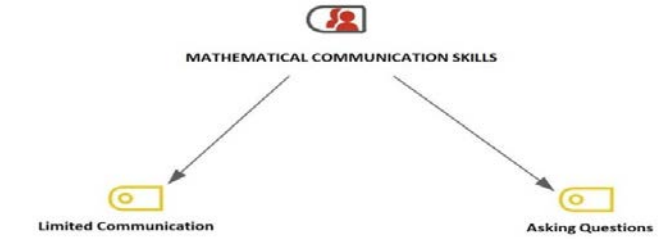

Figure 4.
Mathematical Communication Skills

Direct quotes regarding the views of secondary school students on their mathematical communication skills and their characteristics that affect their mathematical identity in the social context are given below.

P12: *"It takes effort to learn. He needs to ask questions he doesn't understand. He closes communication when it comes to math. But if I ask him, he communicates. Otherwise, the questions he can't answer just stay there."*

P10: *"I see him successful in mathematics. He asks everything he doesn't understand. The more he asks, the more his success increases. His self-confidence increases."*

When direct quotes are examined, it is seen that students' limited or effective use of communication skills is a factor affecting their mathematical identities. Emphasizing the importance of mathematical communication is accepted as an indicator of a positive change in mathematical identity.

Mathematical Literacy

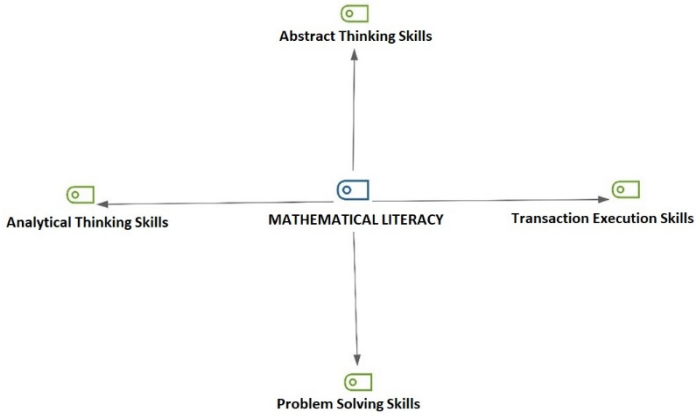

Figure 5.
Mathematical Literacy

Direct quotes regarding mathematical literacy as an individual characteristic affecting middle school students' mathematical identity in a social context are presented below.

P2: *"She is very good at math. She understands everything that is explained. She has analytical thinking skills. Her operational execution skills are very successful because her mathematical foundation is strong."*

P7: *"I think her mathematical foundation is not good. Sometimes she says she understands the topics well, but she makes very simple mistakes in operations. This creates a huge disappointment for her."*

When examining the direct quotes, it is observed that the active use of students' metacognitive skills positively impacts their mathematical literacy, and this situation is a positive factor in their mathematical identity.

Mathematics Attitude

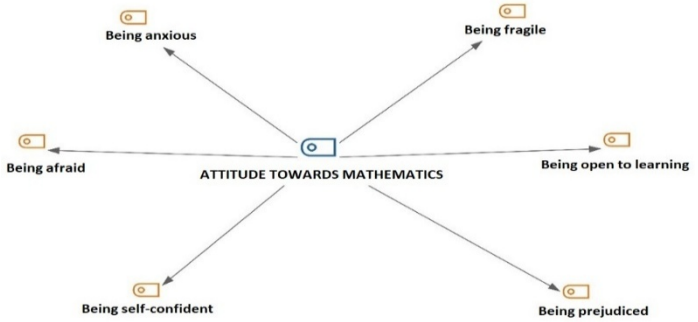

Figure 6.
Mathematics Attitude

Direct quotes regarding attitudes toward mathematics as an individual characteristic affecting middle school

students' mathematical identity in a social context are presented below.

P8: *"My friend is very indifferent toward mathematics. I sometimes suggest that we can study together, but he refuses. He seems a bit scared. I actually think that if he puts in some effort, he could succeed."*

P9: *"She loves mathematics very much. Her interest in math is very high. She values it more than other subjects. I can say that math is her favorite subject."*

When examining the direct quotes, it is evident that students' attitudes toward mathematics are an important factor influencing their mathematical identities. Positive attitudes toward mathematics strengthen students' mathematical identity, while negative attitudes weaken it.

Mathematical Resilience

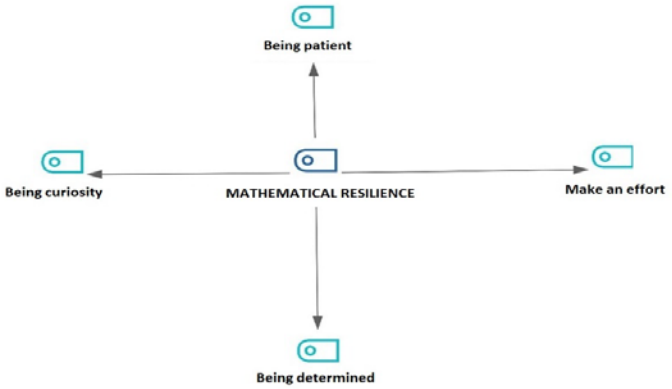

Figure 7.
Mathematical Resilience

Direct quotes regarding mathematical resilience as an individual characteristic affecting middle school students' mathematical identity in a social context are presented below.

P4: *"He is struggling with the math section. He asked us for support. We got help from a university student. Now he is feeling a bit better. We are trying to support him as much as we can."*

P11: *"I think he is good at math. He is very determined. He is a student open to learning. As long as he can focus, he will continue to get very good results."*

When examining the direct quotes, it is evident that the level of students' mathematical resilience is an important factor in their mathematical identity. Students with a high level of resilience tend to develop a more positive identity regarding mathematics, while those with a low level of resilience are at risk of developing a more negative identity related to mathematics.

Discussion

The social environment of middle school students is important in the formation of their mathematical identities. Mathematical identity is not only related to individual cognition but is deeply embedded in social contexts involving interactions with family, peers, and teachers (Nasir, 2002). Family and cultural background have significant impacts on shaping students' mathematical identities, and influencing their attitudes, beliefs, and values regarding mathematics (Grootenboer & Zevenbergen, 2008). Children's motivational beliefs were found to be related to their parents' beliefs about mathematics (Baranauskaitė & Butkienė, 2023). Miller-Cotto and Lewis (2020) state that classroom practices shape mathematics identity. Mathematics identity is especially important in the mathematics domain, as it determines whether students persist and take on advanced mathematics activities or classes. Socio-historical context, community dynamics, family expectations, and peer influences play critical roles in the development of students' mathematical identities (Martin, 2000). Students' mathematical identities are affected by social interactions and the cultural context in which they live (Sfard & Prusak, 2005). Classroom expectations, practices, and the values and beliefs encountered in broader social contexts are shaped by student-teacher interactions (Boaler, 2002). The education system affects mathematical identity through the broad societal meanings attributed to mathematics (Hansen, 1991). The most important elements of the education system are students, teachers, and parents. Participation in various mathematics-related activities contributes to the development of students' mathematical identities (Cobb & Hodge, 2002). Nicolaidou and Philippou (2003) noted that social-environmental factors, such as teacher support and peer interactions, influence students' attitudes toward mathematics and, consequently, their mathematical performance. Ampadu and Anokye-Poku (2022) stated that a supportive educational environment provided by teachers and peers could positively affect students' mathematical identities. A similar statement can be made for students' families. The attitudes of families toward mathematics can influence students' motivation for learning mathematics and how they perceive themselves in this field (Baranauskaitė & Butkienė, 2023). Participation in mathematics-related courses and careers can shape students' attitudes toward mathematics (Watt & Bornholt, 2000). Emotional responses and discourses about mathematics education affect this shaping process (Black et al., 2011). The mathematics activities students participate in may occur both within and outside of school. Out-of-school learning environments can strengthen

mathematical identity (Díez-Palomar et al., 2006). These environments may be critical in creating learning experiences that promote mathematical identity among diverse student populations. The classroom environment and interactions with teachers and peers in mathematics classes significantly affect students' mathematical identities (Roos, 2019). Alternative education programs and curricula can improve students' attitudes toward mathematics by integrating various pedagogical approaches (Hill, 2004). There is a relationship between students' mathematical identities and their cultural identities (Domite & Valle, 2015). Blending mathematics learning with principles of social justice offers opportunities for marginalized students to develop a positive mathematical identity (Miller-Cotto & Lewis, 2020). Students in schools with low and middle socioeconomic status are often grouped at a lower band in terms of mathematical achievement, and these students tend to prefer basic practical activities over in-depth mathematical conceptual understanding (Nicholas & Fletcher, 2017).

Minarti and Wahyudin (2019) found that middle school students' mathematical communication skills are significantly affected by their mathematical inclinations. Kuncoro et al. (2023) demonstrated that students with interpersonal communication skills communicate their mathematical ideas more effectively. Nurwahid and Ashar (2022) stated that there is a strong relationship between mathematical identity and mathematical literacy. Vithal and Bishop (2006) expressed that students should ideally develop their mathematical identity and mathematical literacy simultaneously in mathematics classes. The impMediumnce of components of mathematical literacy, such as mathematical expression skills, in developing students' mathematical thinking and problem-solving skills is emphasized (Yore et al., 2007). Variables effective in mathematical identity include mathematical ability (Graven & Heyd-Metzuyanim, 2019), mathematical problem-solving skills (Ndemo, 2019), mathematical operation skills (Owens, 2008), and mathematical abstract thinking skills (Maddox, 2008). Cribbs et al. (2021) stated that students' feelings of self-efficacy, levels of self-competence, and anxiety toward mathematics affect their mathematical identities, which are determining factors in career choices. Hannula et al. (2016) noted that attitudes toward mathematics are effective in mathematical identity and can lead to significant changes in students' mathematical achievement. Mathematical resilience is part of mathematical identity (Xenofontos & Mouroutsou, 2023). Joseph et al. (2020) noted that students who are determined and patient in mathematics may experience changes in their mathematical identities. Boaler and Greeno (2000) stated that many successful mathematics students experience a conflict between how they see themselves and who they want to be, leading them to choose not to continue studying mathematics.

Conclusion and Recommendations

This study identified several critical social-contextual factors influencing the mathematical identities of middle school students, including the attitudes of the social environment, the educational system, socio-cultural norms, and socioeconomic status. The research demonstrated that these factors significantly shape how students perceive and engage with mathematics.

Moreover, individual characteristics such as mathematical communication skills, mathematical literacy, attitudes toward mathematics, and mathematical resilience were found to profoundly affect students' mathematical identities. Students who actively communicate about mathematics, demonstrate strong mathematical literacy, and possess positive attitudes and resilience are more likely to develop robust mathematical identities, thereby enhancing their engagement and success in mathematics.

Based on these findings, it is recommended that future research explore mathematical identities across various cultural and social contexts to examine potential differences and commonalities. Conducting longitudinal studies could also provide deeper insights into how mathematical identities evolve over time. Furthermore, educational policymakers and educators should prioritize creating supportive educational environments that foster positive attitudes, resilience, and effective communication in mathematics. Encouraging family engagement and providing equitable access to quality educational resources can also strengthen students' mathematical identities. Finally, schools should develop inclusive, student-centered educational practices and extracurricular opportunities to support positive identity formation, particularly among students from diverse backgrounds.

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