

The relationship between classroom support and mathematical resilience

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Abstract: Mathematical resilience is a construct that plays a role in mitigating the prevalence of mathematics anxiety and other negative attitudes towards mathematics. In addition, it is interrelated to social factors such as support. Thus, this study examines the relationship between the three facets of mathematical resilience (Value, Struggle, and Growth) and classroom support (mathematics teacher support and classmates support). In total, 863 (60.8 % female, 2.9% did not answer) Indonesian 9th and 10th-graders answered 5-point Likert scales of mathematics teacher support, classmates support, and mathematical resilience. Structural Equation Modeling with Maximum Likelihood with robust standard errors was used for the main data analysis. The results revealed that mathematics teacher support was positively related to students' Value and Struggle, but not to Growth. While classmates support was positively significant to students' Value, it was not related to Struggle. Surprisingly, classmates support had a negative relationship with students' Growth. The results offer a better understanding of the role of mathematics teachers in fostering and presenting suitable challenges to cultivate students' mathematical resilience. Moreover, it is advisable for schools to thoughtfully approach the grouping of students to avoid the development of a fixed mindset that could arise among peers.

Keywords: classmates support, growth, mathematics teacher support, struggle, value

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1 Introduction

Learning mathematics can be challenging and may cause anxiety and negative attitudes (Hunt & Maloney, 2022). In many studies, these negative emotions and attitudes toward mathematics are closely related to low mathematics performance. Yet, the PISA 2022 results revealed that mathematics anxiety and its negative impact on mathematics learning outcomes can be controlled by positive attitudes towards mathematics (OECD, 2023). One of those constructs that represent these positive attitudes is mathematical resilience (Lee & Johnston-Wilder, 2017). Previous studies have shown a negative relation between mathematical resilience and mathematics anxiety (Johnston-Wilder et al., 2021; Ragusa et al., 2023). Therefore, developing mathematical resilience is believed to reduce mathematics anxiety and other negative attitudes that may arise from mathematical challenges.



Since the concept of mathematical resilience is based on social constructivism (Vygotsky, 1980), the social environment plays an important role in its development. Several studies have demonstrated that teacher-student and inter-student interactions contribute to mathematical resilience. Previous studies found that classmates support and mathematics teacher support are important sources of resilience in mathematics learning (Hall et al., 2022; Hamidy & Wibowo, 2023; Lyakhova & Joubert, 2022; Mota et al., 2016; Romano et al., 2021). Yet, previous studies have not simultaneously tested the significance of mathematics teachers and classmates support of mathematical resilience while focusing on the different facets of mathematical resilience, i.e., Value, Struggle, and Growth (Kookan et al., 2016). This study aims to fill this research gap by examining the relationship between the three facets of mathematical resilience and classroom support (mathematics teacher and classmates support). The results are expected to provide a clearer picture of mathematical resilience development based on the classroom context.

2 Theoretical framework

2.1 Mathematical resilience

Borrowing the long-standing term resilience in psychology (Luthar et al., 2000), mathematical resilience is having a positive attitude towards challenges and failures to overcome them and then succeed in learning mathematics (Lee & Johnston-Wilder, 2017). As a pragmatic construct, mathematical resilience helps students deal with negative experiences and grow optimally, instead of generating anxiety and negative attitudes when faced with challenges and failures in learning mathematics (Johnston-Wilder et al., 2021; Kookan et al., 2016).

Kookan et al. (2016) explored the construct of mathematical resilience and found three empirically separable facets: Value, Struggle, and Growth. The Value facet refers to the ability to be resilient to mathematics by giving its importance to one's current and future goals (Kookan et al., 2016). Thus, the Value facet is closely related to the concept of utility value in expectancy-value theory (Wigfield & Eccles, 2000), that students persist in (challenging) tasks because of the benefits to their future. This facet is also associated with the need for autonomy in self-determination theory (SDT; Ryan & Deci, 2018). There, students choose what they want to learn based on their internal motivation, such as understanding the value of challenges. The Struggle facet of mathematical resilience represents an individual's awareness that learning

mathematics involves challenges and even failure—regardless of one’s mathematical competence (Kookken et al., 2016). According to Bandura (1989), encountering challenges and setbacks helps students become aware of the effort and perseverance required, leading to the development of resilience instead of self-doubt. The Growth facet is related to the incremental growth theory of intelligence (Yeager & Dweck, 2012), which refers to the development of a mindset that everyone can develop their (here: mathematical) ability if they work at it (Kookken et al., 2016). This progressive mindset contrasts with the fixed mindset, which contributes to mathematics anxiety (Gonzalez-DeHass et al., 2024). A growth mindset is also related to the individual basic need to experience oneself as competent (Ryan & Deci, 2018). With respect to the development of mathematical resilience, Johnston-Wilder and Lee (2024) also mention the awareness of the value of collaborative work, which relates to environmental support. If we think about secondary school students in the context of their classroom, we typically consider the social support they receive from both their peers and their mathematics teacher. The next section will, therefore, explain the role of perceived classroom support in mathematical resilience development.

2.2 Relationship between classroom support and mathematical resilience

Students are integrated into a social network of people from whom they give support to some and receive support from others (Tardy, 1985). This give-and-take support in the mathematics classroom is beneficial for academic well-being development, which is closely related to mathematical resilience (Johnston-Wilder & Lee, 2024). Social support can be divided into a structural component and a functional aspect (Semmer et al., 2008). The former describes the size and type of social network, such as whether it comprises individuals or groups, older (more experienced) people, or peers (Malecki et al., 2014; Semmer et al., 2008). In the educational context, social support can come from teachers, parents, classmates, and closest friends (Malecki et al., 2014). In our study, we focus on classmates and mathematics teachers.

The functional aspect of social support describes open behavioral transactions between supporting and supported persons (Semmer et al., 2008). It can be further subdivided into emotional and instrumental support (Federici & Skaalvik, 2013; Malecki et al., 2014; Semmer et al., 2008). Emotional support is characterized, for example, by caring empathy, encouragement, esteem, and friendliness (Federici & Skaalvik, 2013; Semmer et al., 2008) and is therefore described as nurturing (Federici & Skaalvik, 2013). Closely related to emotional support is the need for social

relatedness from SDT (Ryan & Deci, 2018), either a relatedness between students or between students and teachers. Instrumental support can be experienced through tangible support in solving problems, for example, by providing practical help, asking questions, clarifying, correcting, elaborating or demonstrating (Federici & Skaalvik, 2013; Semmer et al., 2008). All these actions aim to contribute to the understanding, problem-solving, or development of skills so that they are action-facilitating support (Federici & Skaalvik, 2013). In a classroom context, they can be provided by both classmates and teachers.

A supportive mathematics classroom represents the quality of support from mathematics teachers and classmates. As an environmental system, both have the potential to provide valuable support to students in developing mathematical resilience as several studies have indicated (Xenofontos & Mouroutsou, 2023). However, mathematics teachers and classmates may affect different aspects of mathematical resilience. Regarding the Value facet, experiencing support from a teacher increases aspiration about future education and career (Federici & Skaalvik, 2014; Lyakhova & Neate, 2019), while working together with peers in learning advanced mathematics can help maintain their perception of the value of mathematics (Lyakhova & Joubert, 2022). Furthermore, Hall et al. (2022) found that a lack of teacher support resulted in lower resilient students, indicated by anger to challenges, which is related to Struggle. The studies of Buckley and Sullivan (2023) and Russo et al. (2020) also suggested the role of the teacher to encourage students to embrace difficulties in mathematics. The significance of peers in preparing students for mathematical challenges is also explained by Johnston-Wilder and Lee (2019). Regarding the Growth facet, the vital role of mathematics teachers in developing students' growth mindset was found in the study by Johnston-Wilder et al. (2021), while other studies (Lyakhova & Joubert, 2022; Mota et al., 2016) revealed that classmates helping each other can help reduce anxiety and foster a belief in the ability to learn mathematics, even at more advanced levels. However, the effect of classmates' support may differ in a homogeneous class, as students may not experience interaction with high and low achievers (Risdiyanto, 2021).

2.3 Research question

To the best of our knowledge, previous studies have only revealed the role of mathematics teacher and classmate support on mathematical resilience in general. Thus, to get a more fine-grained understanding of mathematical resilience, the aim of

this study is to examine the relationship between mathematics teachers and classmates support and the three facets of mathematical resilience: Value, Struggle, and Growth (Kookan et al., 2016). Our research question is: How do mathematics teachers and classmates support related to the Value, Struggle, and Growth facets of mathematical resilience?

3 Methods

3.1 Instruments

To answer the research question, we adapted established English scales from previous studies. We made necessary adjustments to suit the educational level of the research subjects and translated the questionnaire into Indonesian. The translated questionnaire was then reviewed by an experienced researcher proficient in both English and Indonesian, along with several Indonesian mathematics teachers. All items were measured on 5-point Likert scales in which high values correspond to high levels of agreement.

To measure the three facets of mathematical resilience, first, we used the mathematical resilience scales from Kookan et al. (2016), which consist of three subscales: Value (e.g., “Math is essential for my future”), Struggle (e.g., “Everyone struggles with math at some point”), and Growth (e.g., “Some people cannot learn math”). Next, we measured the perceived teacher support (TS) with a scale from Federici and Skaalvik (2013) comprising two subscales: emotional (e.g., “My math teacher is friendly”) and instrumental support (e.g., “My math teacher provides me good guidance”). In addition to the emotional support items, we also introduced four new items describing mathematics teacher support when students experience failures and difficulties in mathematics (e.g., “My math teacher comforts me when I get (relatively) poor grades in math”). Third, we measured the perceived classmates support (CS) with a subscale of the Child and Adolescent Social Support Scale (CASSS, Malecki et al., 2014). This instrument was modified by specifying the context of the mathematics classroom (e.g., “In math, my classmates treat me nicely”) and the addition of items that reflect classmates support when students experience failure and difficulty in mathematics (e.g., “In math, my classmates comfort me when I get (relatively) poor grades”).

3.2 Data collection

The participants were 877 Indonesian 9th or 10th graders aged 12-18 years. They completed an online questionnaire in their mathematics classroom. Participation was anonymous and voluntary, non-participation did not have any negative consequences for the students. To ensure data accuracy, we applied a data screening procedure (Ward & Meade, 2023) to identify students who responded carelessly to the tasks. Fourteen students were excluded from the data set. Finally, 863 (60.8 % female, 2.9% did not answer) respondents were included in this study (average age: 15.2).

3.3 Data analysis

Negatively worded items were inverted prior to the analysis, so higher scores indicate greater agreement with the underlying construct. As a first step to check the psychometric quality of the scales, we conducted confirmatory factor analyses (CFA) and omega reliability estimation using the lavaan package (Rosseel, 2012) of R (R Core Team, 2023). We then carried out descriptive analyses using classical means and standard deviations to get an easily accessible overview of the scales. Finally, a structural equation model (SEM, cf. Figure 1) was fit to the data. For estimation, we applied maximum likelihood with robust standard errors (MLR) using the lavaan package. Thereby, missing values were controlled by full information maximum likelihood.

4 Results

From the result of CFA, we had to exclude one item of the Growth subscale because the factor loading was less than 0.4 (Stevens, 2002). Model fit suggests that mathematics teacher support and classmates support could be treated as two-dimensional constructs (emotional vs. instrumental support) or a second-order factor. However, the mathematical resilience scale is better as a three-dimensional construct: Value, Struggle, and Growth.

The means, standard deviations, correlation matrix, and omega reliability (ω) coefficients for each variable are given in Table 1. While both supports, as well as Value and Struggle have relatively high means, Growth seems less relevant to the students, having a mean of slightly less than 3. According to the correlation matrix, both students' perceived mathematics teacher support and classmates support are

positively associated with Value and Struggle. However, students' perceived classmates support and Value are negatively associated with their Growth mindset.

Table 1. Means, standard deviations, correlation matrix and omega reliability coefficients.

	Means	SD	1	2	3	4	ω reliability
1. Mathematics Teacher Support (TS)	4.139	0.536					0.90
2. Classmates Support (CS)	3.603	0.569	0.484***				0.88
3. Mathematical Resilience (Value)	3.907	0.665	0.451***	0.348***			0.92
4. Mathematical Resilience (Struggle)	4.156	0.623	0.426***	0.246***	0.481***		0.89
5. Mathematical Resilience (Growth)	2.897	0.780	-0.049	-0.142***	-0.172***	-0.0001	0.84

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The SEM results for the model indicate an acceptable model fit: χ^2 (1363) = 3504.445, CFI = 0.907, TLI = 0.902, RSMEA = 0.047, SRMR = 0.052. The standardized estimates of the effects and their standard errors are presented in Table 2.

Table 2. Standardized estimates and standard errors of variables.

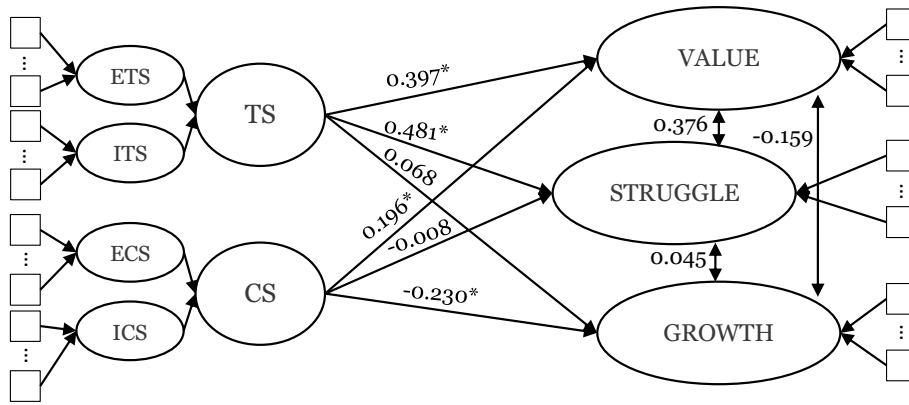
Variables	Est. std	SE	Variables	Est. std	SE	Variables	Est. std	SE
Value			Struggle			Growth		
TS	0.397***	0.065	TS	0.481***	0.066	TS	0.068	0.063
CS	0.196***	0.061	CS	-0.008	0.062	CS	-0.230***	0.075

Note. TS: Mathematics Teacher Support; CS: Classmates Support; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

These results show that mathematics teacher support and classmates support were positively related to students' Value ($\beta = 0.392$, $p < 0.001$ and $\beta = 0.192$, $p < 0.001$, respectively). Furthermore, mathematics teacher support was a positive, significant predictor of students' Struggle ($\beta = 0.477$, $p < 0.001$), while classmates support was not ($\beta = -0.013$, $p > 0.05$). Surprisingly, students' Growth was inversely

related to classmates support ($\beta = -0.218, p < 0.001$), whereas teacher support was not significantly related ($\beta = 0.058, p > 0.05$).

Figure 1. Model and measured relationships between mathematics teacher support, classmates support, Value, Struggle, and Growth.



Note. E: Emotional Support; I: Instrumental Support; TS: Mathematics Teacher Support; CS: Classmates Support; * $p < 0.001$.

5 Discussion

The aim of this study is to examine the relationship between classroom support (mathematics teacher support and classmates support) and each facet of mathematical resilience (Value, Struggle, and Growth). The results show a positive relationship between mathematics teacher support and Value, supporting previous studies (Federici & Skaalvik, 2014; Lyakhova & Neate, 2019). Based on the teacher support construct (Federici & Skaalvik, 2013), a supportive mathematics teacher provides appropriate help and feedback, such as clarifying, elaborating, and appreciating, to enhance students' understanding without removing challenges. The support then leads students to value their current knowledge as important capital for advancing in mathematics. In addition, a safe, respectful, and autonomous environment created by a supportive teacher improves the chances of grasping the benefits of mathematics. In turn, learning mathematics could fulfil students' satisfaction and autonomy (Ryan & Deci, 2018) in learning mathematics and then develop their persistence in it.

Our results also reveal that students who experience a supportive mathematics teacher tend to be more aware that Struggle is a characteristic of learning mathematics. The finding supports the study of Buckley and Sullivan (2023) that the

teachers' role is to encourage students to embrace challenges in mathematics to promote a positive attitude when facing difficulties. The finding also matches the results by Russo et al. (2020) that teachers' positive belief in struggle in mathematics was related to their intention to develop resilience, which, in turn, the support is not only about comforting and addressing students' difficulties but also about developing an awareness of challenges so that they become resilient (Bandura, 1989).

However, there was no significant relationship between mathematics teacher support and students' Growth. The result contradicts the vital role of teacher support in developing students' growth mindset in the study by Johnston-Wilder et al. (2021). Johnston-Wilder and Lee (2024) had anticipated this result due to the inconsistency perception of the growth mindset development in schools and society. Thus, specific and extensive support for a growth mindset is needed to maintain students' mindsets while learning mathematics. Furthermore, since the emergence of a growth mindset is strongly related to experiencing difficulties and setbacks (Yeager & Dweck, 2020), students who do not encounter negative experiences in mathematics may perceive this mindset differently.

Regarding peer support in the classroom context, the increase in students' Value was positively related to classmates support. This result is in line with the study by Lyakhova and Joubert (2022) that students perceive the value of mathematics based on their social activities with peers. A supportive classroom environment fosters collaboration, which in turn, encourages frequent communication of mathematical ideas among students. The situations help students feel more connected to mathematics and understand its personal and societal value (Johnston-Wilder & Lee, 2024; Ryan & Deci, 2018).

However, the relationship between classmates support and students' Struggle was not significant. This contradicts Johnston-Wilder and Lee's (2019) suggestion that peer collaboration helps students prepare for challenges, possibly due to the level of difficulty students feel in mathematics classrooms. Mathematics tasks that are too hard or too easy can make students feel helpless or meaningless, despite how well their classmates support them. Thus, they may not be aware that difficulty in mathematics is a normal situation. In addition, students' belief in their mathematics ability may also affect how they perceive the level of mathematics challenges, which in turn exposes the interplay between internal and external factors of mathematics resilience (Xenofontos & Mouroutsou, 2023).

Furthermore, classmates support was negatively related to students' Growth mindset. The result contradicts the positive influence of classmates support in the studies by Lyakhova and Joubert (2022) and Mota et al. (2016). Students' self-concept and the type of classmates support may play a role in the inverse relationship. Students with a low self-concept may become worse when getting emotional support from low-achieving peers who also struggle in mathematics, while academic support from high-achieving classmates may reinforce helplessness (Lee & Johnston-Wilder, 2017). In addition, the negative impact of classmates may also be due ability grouping, which is common worldwide (OECD, 2013), including Indonesia (Ayu & Junaidah, 2020; Risdiyanto, 2021). This situation reinforces the notion that some people are naturally good at mathematics while others are not, which is the foundation of the fixed mindset (Johnston-Wilder & Lee, 2024).

The findings of this study imply that a supportive classroom environment is crucial for developing students' value of mathematics, which in turn fosters a positive attitude toward mathematics learning. Additionally, mathematics teachers should be supportive and capable of providing appropriate mathematical challenges to help students perceive them as normal challenges that everyone faces. Furthermore, since classmates have a negative effect on the growth mindset, teachers and schools should consider the process of grouping students to prevent the development of a fixed mindset among peers.

This study has several limitations. Since it was conducted in cross-sectional settings, the result could not support the causality sufficiently. Therefore, longitudinal studies of the same model should be considered for further research to address the limitations of this study. Besides, unanticipated factors such as gender imbalance, mathematics self-concept, and failure experiences may affect study results. In addition, examining the specific types of support, including emotional and instrumental support, and accounting for between-class variance may explain the varying effects of classroom support. These points should be taken into account for further research to provide a deeper understanding of the relationship. Yet, this study provides a detailed picture of mathematical resilience development, emphasizing various facets and the significance of the mathematics classroom.

6 Conclusions

The results revealed varying relationships of classroom support on each facet of mathematical resilience, with some supporting previous studies while others seem to

contradict them. A more supportive mathematics teacher can lead to students having a more positive Value and Struggle in mathematics, but it was not related to students' Growth. Students' positive perception of classmates support tends to increase their understanding of the *Value* of mathematics but was not related to students' *Struggle*. Even, it decreases their Growth mindset.

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