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# Supportive teachers, active students: Is teacher support a promising key to engaging students with and without migration backgrounds?

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Students with and without migration backgrounds differ in terms of their achievement. One approach to reducing the gap between the two groups may be through equal participation in classroom discourse. Here, supportive teaching behavior can be particularly important for promoting student participation. Especially teacher support after a student has made a mistake, the so-called error culture in the classroom, could pave the way for students to become active participants. In this study, we analyzed whether error culture as a facet of teacher support could be a promising key to engaging students with and without migration backgrounds. To investigate the generalizability of the process across different subjects, we examined video data from 20 eighth-grade classrooms of academic-track secondary schools in both German Language Arts and Mathematics ( $N = 387$  students). The results from nested hierarchical linear models indicate that error culture is related to student participation in German Language Arts but not in Mathematics. Interestingly, students with and without migration backgrounds did not differ in terms of their participation in classroom discourse. Furthermore, teachers' positive error culture supported students' participation irrespective of their migration background. Therefore, we encourage teachers to continue to pay attention to their error culture as this seems relevant for all students in the classroom.

## KEYWORDS

migration background, teacher support, error culture, participation, engagement

## 1 Introduction

Students with migration backgrounds have been an integral part of the student body for many years ([Federal Statistical Office of Germany, 2014](#); [Federal Statistical Office of Germany, 2023](#)). Despite this long-standing development, large-scale assessments such as PISA continue to show a gap in achievement between students with and without migration backgrounds (achievement gap; [Andon et al., 2014](#); [Weis et al., 2018](#); [Weis et al., 2019b](#)). So far, several studies have examined the reasons for the gap by looking at student characteristics. Differences in the socio-economic status ([Levels and Dronkers, 2008](#); [Lüdemann and Schwerdt, 2013](#)) and competence differences in language achievement of students with and without migration backgrounds ([Million-Fauré, 2019](#)) only partially explain the achievement gap. However, even when controlling for individual student characteristics, unexplained variance in the

achievement gap remains, suggesting migration-specific disadvantages (Hillmert, 2013). Against this background of unexplained differences in achievement, it seems promising to take a look at the processes in the classroom. Are students with and without migration backgrounds evenly engaged in classroom discourse? And do differences in teaching behavior account for possible differences in participation?

Student participation could be a promising key to closing the achievement gap, because active participation is regarded as one important indicator of student engagement (Böheim et al., 2020b) and, in turn, as being related to student learning and performance (Schnitzler et al., 2021). Thus, the question is whether student participation is equally distributed across students with different backgrounds. So far, studies looking at elementary schools have indicated that students with migration backgrounds participate less often in classroom discourse compared to their peers without migration backgrounds (Decristan et al., 2020). This is particularly concerning because students with migration backgrounds thus experience a double disadvantage: They start with unfavorable conditions and then experience additional differences regarding their participation—receiving less individual feedback, for example. As a result, teachers play an important role in overcoming these disparities.

Teachers can promote student participation by creating a supportive atmosphere (Böheim et al., 2020b; Denn et al., 2019; Fredricks et al., 2004). One facet of this supportive atmosphere is the way teachers and students deal with mistakes, commonly referred to as error culture (Spychiger et al., 2006; Steuer et al., 2013). When teachers show a positive and appreciative approach to mistakes, students may also become more willing to participate. In particular students with migration backgrounds, who might be more reluctant to participate due to fear of negative teacher and peer reactions after making mistakes or giving the wrong answer, could benefit from this.

With this paper, we wanted to build on this knowledge base and contribute to the discussion about how students with migration backgrounds can be promoted in the classroom and whether this process is context-specific (see Heitmann et al., 2017). In particular, we focused on one specific facet of teacher support—the error culture—and investigated whether the degree of a positive error culture can be promising for engaging students with and without migration backgrounds in the classroom discourse. Finally, we aimed to follow up on Praetorius and Gräsel's (2021) discussion of the subject-specificity of teaching behavior and to compare the processes of migration background, error culture, and student participation between German Language Arts and Mathematics.

## 2 Theoretical background

### 2.1 Differences between students with and without migration backgrounds

According to Weis et al. (2019b), a student has a migration background if at least one parent was born abroad. In addition to the already mentioned achievement gap, previous studies have found further differences between students with and without migration backgrounds: First, students with migration backgrounds are less likely to speak the official language at home (Weis et al., 2019b). A difference between the language spoken at home and at school can

result in language problems that are likely to hinder learning. Second, students with and without migration backgrounds differ regarding their peer relationships. Henschel et al. (2022) showed that students with migration backgrounds felt less socially accepted compared to their peers without migration backgrounds. Third, students with migration backgrounds might struggle with culture-specific norms. For example, different understandings of the roles of students and teachers can lead to misunderstandings in teacher–student interactions (Spychiger et al., 2006). As a result, students with migration backgrounds must overcome culture-specific obstacles in addition to the cognitive load that results from the learning process. Fourth, besides these differences regarding students' perceptions, the teachers' views might also differ. Lorenz and Gentrup (2017) found evidence that teachers less often expected a correct solution from elementary school children with Turkish migration backgrounds, even when their performance was equal to that of their peers. These four arguments can result in differences between students with and without migration backgrounds regarding student participation in classroom discourse.

### 2.2 Student participation in classroom discourse and the possible consequences of a migration background

Student engagement is recognized as a crucial component for improving students' academic outcomes (e.g., grades and graduation rates), social development (e.g., peer relationships), and emotional skills (e.g., conflict resolution; Appleton et al., 2006). Student engagement is frequently highlighted as a key factor in preventing student dropout (Archambault et al., 2022; Finn, 1989; Reschly and Christenson, 2006) and is positively related to students' mental health (Suldo and Parker, 2022). Models of student engagement (e.g., Fredricks et al., 2004; see overview in Reschly and Christenson, 2022) typically distinguish between cognitive engagement, emotional engagement, and behavioral engagement. Within this framework, student participation in classroom discourse (i.e., students' hand raising behavior or verbal contributions during teacher-centered interactions) has been shown to be a relevant indicator of students' current level of behavioral engagement (Appleton et al., 2006; Böheim et al., 2020b; Crombie et al., 2003). Some studies conceptualize student participation by recording the amount of time a student spends talking during classroom discourse (Sedlacek and Sedova, 2020; Sedova et al., 2019). Others observe visible behaviors such as hand-raising or verbal contributions as an operationalization of participation (Böheim et al., 2020a; Decristan et al., 2020). In the present study, we focused on a conceptualization by Decristan et al. (2020) and Sacher (1995), who divided student participation in classroom discourse into student-controlled and teacher-controlled participation. With regard to student-controlled behavior, hand-raising and calling-in can be distinguished. Teacher-controlled participation refers to whether the teacher calls on students. This distinction is valuable because we examined student participation on both sides: the side of the offer by the teacher (calling-on) and the side of the use by the students (hand-raising, calling-in; Decristan et al., 2020; Seidel, 2014). Previous studies have shown that student participation is associated with a higher use of instruction (Jansen et al., 2022) and with achievement (Böheim et al., 2020b; Sedova et al., 2019). Thus,

differences in student achievement (e.g., an achievement gap) may also be due to differences in student participation.

Based on the four identified differences between students with and without migration backgrounds (language issues, peer connections, cultural norms, and lower teacher expectations; see section 2.1), students may also differ in their participation in classroom discourse, as family characteristics are considered as important for student engagement (Appleton et al., 2006). First, since students with migration backgrounds are more likely to speak a different language at home, it might be more difficult for them to follow the classroom discourse and, thus, to contribute to the discussion. Students who speak a different language at home than at school can sometimes show lower oral proficiency in the school language (Droop and Verhoeven, 2003), possibly because they have fewer opportunities to practice the language at home (see time-on-task hypothesis; Rossell and Baker, 1996). These differences in oral proficiency may imply that students with migration backgrounds have to use more cognitive resources to speak the language at school (Wang and MacIntyre, 2021). Therefore, in addition to the effort related to content, they also have to make a greater linguistic effort to participate in classroom discourse.

Second, students with migration backgrounds might feel less comfortable due to concerns about public exposure and how their peers might react if they make mistakes. Previous research shows that students with migration backgrounds are less socially integrated than students without migration backgrounds (Henschel et al., 2022). This is shown, for example, by the observation that students with migration backgrounds are less frequently mentioned when peers are asked to name their preferred seating partners (Dicataldo et al., 2023; Plenty and Jonsson, 2017). Overall, students with migration backgrounds have fewer friendships and experience less acceptance (Hamel, 2022; Hamel et al., 2022). The authors again mention the language barrier as a possible reason for this, which sometimes leads to social isolation of students with migration backgrounds (Hamel et al., 2022). In this context of threatened or actual social exclusion, students with migration backgrounds may be more reluctant to participate in classroom discourse, because they are less connected to their peers (Henschel et al., 2022).

Third, students with migration backgrounds might understand classroom practices, such as hand-raising, differently, due to cultural norms and might not participate actively out of reticence and deference to the teacher. For example, cultural norms in Germany can differ significantly from those in countries like Russia or Turkey, which are common places of origin for many students with migration backgrounds in Germany. According to Hofstede et al. (2010), cultures in Russia and Turkey can be characterized by a high level of uncertainty avoidance, which for schools can mean that teachers are assumed to know all the answers (Hofstede, 2011). In contrast, Germany has a lower level of uncertainty avoidance, which means that teachers openly say in class that they do not know everything (Hofstede, 2011; Hofstede et al., 2010). When these two cultures come together in the classroom, misunderstandings can arise. For example, students from high uncertainty avoidance countries may have difficulty dealing with open-ended questions. Cultural differences can therefore play a role in participation.

Fourth, since teachers' expectations differ depending on whether students have migration backgrounds or not (Tenenbaum and Ruck, 2007; Tobisch and Dresel, 2017), and given the strong link between

expectations and behavior (Harris and Rosenthal, 1985), it can be assumed that teachers' behavior also varies accordingly between students with and without migration backgrounds. Since teachers are the gatekeepers to teacher-controlled participation, their expectations could play a role in the participation of students with migration backgrounds. If they expect less from these students, they might call on this group less because they would fear of disrupting classroom discourse. Alternatively, they could call on students with migration backgrounds more often to give them extra support and check that they have understood the content. Consequently, the difference in behavior is not necessarily negative. Adaptive teacher behavior can both mitigate and exacerbate heterogeneity (Denessen et al., 2020). Teachers can implement this adaptivity by varying the frequency or length of interactions between teacher and students with migration backgrounds.

In addition to these theoretical arguments, empirical findings from elementary schools have shown that students with and without migration backgrounds do indeed differ in their participation in classroom discourse. Students with migration backgrounds showed less student-controlled and teacher-controlled participation in classroom discourse (Decristan et al., 2020). Lorenz and Gentrup (2017) found a similar result in their study of elementary school students with migration backgrounds: Teachers called on students with migration backgrounds less often than students without migration backgrounds. Overall, interactions between teachers and students with migration backgrounds were shorter and less frequent. In contrast, Jansen et al. (2022) and Decristan et al. (2023) focused on students from different secondary school types and did not show a significant relationship between migration background and student participation in their results. Therefore, we built on these inconsistent findings across different school types and explicitly investigated students from academic-track secondary schools.

To sum up, previous studies have mainly looked at the relationship between student characteristics and student participation (see Decristan et al., 2020). However, due to the relevance of student participation, the question arises of how participation can be promoted.

## 2.3 Error culture as a teaching variable that fosters student participation

Hofkens and Pianta (2022) note that student engagement is not a student characteristic that students bring to school. Rather, student engagement emerges through interactions with teachers. Along with family and peers, school is an important predictor of student engagement (Appleton et al., 2006). Several studies have shown that a supportive teaching atmosphere is positively related to student participation (Böheim et al., 2020b; Fredricks et al., 2004; Reyes et al., 2012). For example, Denn et al. (2019) showed that in classes with a more positive classroom climate, student participation after a teacher question was higher. Supportive teacher behavior seems to be especially important after a student's mistake.

Error culture (sometimes called error climate; Soncini et al., 2021; Steuer et al., 2013) can be defined by teachers' and students' perceptions and activities in dealing with mistakes (Steuer et al., 2013). Error culture in a classroom can be seen, for example, in beliefs (e.g., whether students believe they are allowed to make mistakes in

class) and practices (e.g., whether an error is discussed in front of the whole class; Fischer and Freund, 2023). Fischer and Freund (2023) distinguish between a culture of error avoidance (in which errors are seen as a sign of failure and disruption and are avoided if possible; negative error culture) and a culture of error management (in which errors are seen as normal and important steps toward improvement; positive error culture).

It is worth focusing on how to deal with mistakes, as they are an integral part of the classroom (Heinze, 2004) and contribute to learning in two ways. First, errors have a content-related component. In order to structure the further learning process and to make individual progress, it is important to recognize the error. Negative knowledge, i.e., the knowledge of mistakes and “wrong ways”, supports, for example, certainty or increases the quality and depth of reflection processes (Gartmeier et al., 2008; Oser and Spychiger, 2005). Second, error culture always has a motivational component (see Tulis, 2013). If teachers have a positive error culture and treat students’ errors with appreciation, this can motivate students to think further. Otherwise, errors can lead to frustration and resignation. Recent studies empirically support these theoretical arguments and show the importance of (dealing with) mistakes for the learning process (e.g., Metcalfe et al., 2024; Soncini et al., 2021).

Narciss and Alemdag’s (2024) model defines key components of a supportive error culture. Factors such as the characteristics of students (e.g., demographics, emotions, motivational beliefs) and teachers (e.g., knowledge of errors, strategies for dealing with errors effectively) play an important role in a supportive error culture. However, the interactions and dialogues that learners have with teachers and peers are also crucial in dealing with mistakes. In this study, we focus on this aspect of interaction and examine the role of error culture for students’ participation in classroom discourse.

We hypothesize that error culture plays a role in students’ participation in the classroom discourse. If there is a positive error culture in a class, i.e., if errors are treated as necessary and important prerequisites for further learning, then students are more likely to participate in classroom discourse because they will not face negative consequences if they make an error. If, on the other hand, they are afraid of being exposed by the teacher and laughed at by the class, they may be reluctant to participate. This theoretical assumption is supported by the empirical result that error culture is positively related to the amount of effort a student puts into a subject (Steuer et al., 2013). One facet of this effort could be student participation in classroom discourse.

Thus, error culture could be a promising key to promoting participation. However, since the characteristics of students are important for a supportive error culture (Narciss and Alemdag, 2024), it remains unclear whether all students benefit equally from error culture or whether certain groups of students benefit in particular. Despite some criticism, Cronbach and Snow’s (1977) concept of an aptitude–treatment interaction could also be applied to the teaching context. A teaching variable (here, error culture) may be of different relevance to different students. As mentioned above, students with migration backgrounds may differ from their peers in a number of characteristics (e.g., language problems, connection to their peers, and misunderstandings of cultural norms). Consequently, students with migration backgrounds might be more dependant on a teacher’s positive error culture (Spychiger et al., 2006). Due to the lower achievement of students with migration backgrounds (see Henschel

et al., 2022), language problems (see Weis et al., 2019b), a weaker connection to their classmates (and thus, the fear of being laughed at; Henschel et al., 2022), or misunderstandings of cultural norms (Spychiger et al., 2006), making mistakes could be more in the foreground for students with migration backgrounds and thus, dealing with mistakes may be more important for them. To sum up, making mistakes and dealing with mistakes could play a stronger role for students with migration backgrounds. Therefore, error culture could be key to ensuring the participation of all students and, in turn, to reducing the achievement gap.

Seiz et al. (2016) showed that teaching characteristics could reduce the achievement gap between students with and without migration backgrounds. Students with migration backgrounds benefited more from supportive teaching (Seiz et al., 2016). Thus, students’ migration backgrounds emerged not only as directly related to student participation (Decristan et al., 2020; Lorenz and Gentrup, 2017), but also as important moderators influencing the role of teacher support (Seiz et al., 2016). In the present study, we extended this research by examining the interplay of migration background, error culture, and student participation. Therefore, we assumed that error culture is differentially important for students with and without migration backgrounds and investigated the moderating role for the relationship between error culture and student participation.

## 2.4 Investigation of the learning context

When investigating the relationship between students’ migration background, error culture, and student participation, the question is whether differences exist depending on the context (here, school subjects). According to the following arguments, a subject-specific role of migration background, classroom discourse, and error culture, can result in differences between German Language Arts and Mathematics. First, migration background may have subject-specific importance. Since German is not the only language spoken by many families of students with migration backgrounds (see Weis et al., 2019b), differences between students with and without migration backgrounds might be more pronounced in a language subject. Second, classroom discourse in German Language Arts and Mathematics differs: While students perceive discussions in STEM subjects as more fact-based, classroom discourse in German Language Arts seems to be shaped by opinions (Heitmann et al., 2017). Third, errors in Mathematics seem to be more clearly defined and less dependent on the teacher (Steuer et al., 2021). However, differences between subjects regarding the importance of making and dealing with errors are also evident (Spychiger et al., 1999; Tulis, 2013). Therefore, to control for subject-specific differences, we included both subjects, German Language Arts and Mathematics.

## 3 The present study

Our study examined students with and without migration backgrounds by looking at their participation in classroom discourse as a proximal predictor of achievement (see Böheim et al., 2020b; Sedova et al., 2019). In particular, we investigated whether or not error culture promotes student participation in classroom discourse and

whether students with migration backgrounds may benefit more from a positive error culture. As previous studies have investigated either student characteristics (e.g., self-concept, migration background; Böhmeim et al., 2020a; Decristan et al., 2020) or teacher behavior (e.g., positive classroom climate; Denn et al., 2019), in the present study, we examined the interplay of the two. Seiz et al. (2016) already showed that migration background can be a relevant moderator of the relationship between supportive teaching and achievement. We built on this by shedding light on the moderating role of migration background in the relationship between error culture and student participation as an outcome variable.

Moreover, this paper contributes to existing research in two ways. First, we shed light on the role of the context. Previous studies on the relationship between migration background and student participation have focused on elementary school students (Decristan et al., 2020; Lorenz and Gentrup, 2017). In our study, we extended the picture by an explicit look at academic-track secondary schools. In addition, we investigated the role of context by looking at two different subjects (German Language Arts and Mathematics).

In particular, we investigate the following research questions (RQs):

1. Are student migration background and error culture related to student participation in classroom discourse?
2. How does a migration background moderate the relationship between error culture and student participation in classroom discourse?

The originality of the study lies in the combination of behavioral (videotaped) data on student participation in classroom discourse with the students' perceptions of error culture, such as requested for example by Wang and Eccles (2013). Analogous to Decristan et al. (2020) and Sacher (1995), we subdivide student participation in classroom discourse into student-controlled participation (students raising their hand or calling-in without hand-raising) and teacher-controlled participation (teachers calling on students). Based on this distinction, we could infer who was an active and passive contributor to the interaction. This allowed for targeted conclusions for promoting student participation in classroom discourse.

## 4 Methods

### 4.1 Participants and procedure

The present study re-analyzed the data set from the Interaction I project (Jurik et al., 2015). Our analyses were restricted to eighth-grade students in German academic-track secondary schools.<sup>1</sup> The data set contains data for the subjects of German Language Arts (GLA) and Mathematics (M). A total of 501 students in 20 classes with a mean class size of 25.05 ( $SD = 3.52$ ) students and their 40 teachers

(65% female, on average 40.55 years old [ $SD = 10.51$ ], with 11.50 years of work experience [ $SD = 9.34$ ]) voluntarily participated in the study.

At the beginning and end of the 2013/14 school year, the students completed a questionnaire. In addition, one 45-minute lesson each in Mathematics and GLA was videotaped in the middle of the school year. The topics of the lessons were geometry or algebra in Mathematics and activities focusing on writing or presenting in GLA. No behavioral data were available for  $N = 114$  (GLA) and  $N = 120$  (M) respectively, because they refused permission or were absent. Their numbers varied widely, from one to 10 people per class ( $M = 5.70$ ,  $SD = 2.66$ ). These students were excluded from the analyses, leaving 381 students (59% female,  $M_{age} = 13.81$  [ $SD = 0.53$ ]) as the sample in Mathematics and 387 students (58% female,  $M_{age} = 13.83$  [ $SD = 0.54$ ]) in GLA.

### 4.2 Measuring student participation with video analyses

The videotaped lessons were rated by external observers to capture student and teacher controlled participation. For this purpose, two independent, previously trained coders coded the videos. They used the Interact software (Mangold, 2014) and a coding manual. In order to code the video material, each time there was a change between people speaking, a new turn was set.

As teacher–student interactions differ depending on the social form (e.g., classroom discourse vs. nonpublic work phases; Lipowsky et al., 2008), we focused on student and teacher behaviors in classroom discourse. With regard to student-controlled and teacher-controlled participation, the coders coded calling-in, self-initiated contribution, and hand-raising for student-controlled participation and calling-on for teacher-controlled participation. Here, “calling-on” means that a teacher gives a student permission to present his or her idea. This can be done non-verbally with a nod, or verbally with the student's name. A student's verbal contribution was rated as “calling-in” when a student answered a question without raising his or her hand or being called on. The category of self-initiated contributions was used when a student contributed without a teacher question or permission to talk (e.g., without being called on). Finally, the coders used the code “hand-raising” every time a student raised his or her hand. Overall, the interrater reliability of these variables was sufficient ( $\kappa = .72$ ; interrater agreement of 85.3%).

For each student, the number of behaviors (e.g., calling in, hand-raising, calling-on) in the videotaped lessons was added up separately for Mathematics and GLA. For the analyses carried out here, student-controlled participation was operationalized by adding up the number of hand-raising, calling-in, and self-initiated contributions. The number of events in which a student was called-on is used as teacher-controlled participation.

### 4.3 Questionnaire data

Error culture, migration background, and several covariates were assessed using student questionnaires.

#### 4.3.1 Migration background

Migration background was determined at the first measurement point prior to the videotaped lesson, at the beginning of the school year.

<sup>1</sup> In Germany (i.e., Bavaria), after the fourth grade of elementary school (at around the age of 10), children choose a secondary school. They have the choice between an academic-track secondary school and two types of non-academic-track secondary schools.

The student's country of birth as well as the mother's and father's were asked for. In line with Weis et al. (2019b), we described all students with at least one parent from abroad as children with migration backgrounds.

### 4.3.2 Error culture

To examine students' perceptions of the classroom teaching, the students were asked for their perception of error culture at the end of the school year. We expected the students to have a meaningful picture of the teacher and the teachers' error culture at this point. Two examples of questionnaire items are "The teacher is patient when a student makes a mistake in GLA" and "Our Mathematics teacher makes sure that nobody in our class is laughed at if they make a mistake" (adapted from Spychiger et al., 1998; Waldis et al., 2002). To ensure comparability between the subjects, the items had a parallel wording for both subjects. The answer categories were a four point Likert scale (1 = "exactly" to 4 = "not at all"). The values were recoded so that higher values also corresponded to a higher assessment of the error culture. The scale has a reliability of  $\alpha = .83$  (GLA) and  $\alpha = .80$  (Mathematics).

### 4.3.3 Covariates

Prior research has shown that students with and without migration backgrounds differ in their achievement (e.g., Henschel et al., 2022). To explicitly examine the relationship between migration background and student participation, we added course achievement as a covariate. Course achievement was operationalized by the students' grade in the mid-term report (best grade: 1, worst grade: 6, discrete scale), as this grade was closest to the time of the videography measurement. Teachers reported the grade on the teacher questionnaire. The variable was recoded so that a higher value corresponds to better performance. In addition, we included socioeconomic status (SES) as another covariate. SES is also assumed to be related to migration background (Weis et al., 2018). HISEI indicates the highest occupational status of parents (OECD, 2017) and has the highest predictive power in Germany compared to other variables that operationalize SES (e.g., educational level of parents, home possessions; Ehmke and Siegle, 2005). The values range from 16 (e.g., office cleaner) to 90 (e.g., judge; Ganzeboom and Treiman, 1996). As previous studies have shown differences in teaching behavior between female and male (e.g., Denn et al., 2015), we include the covariate 'gender' (1 = female, 2 = male).

## 4.4 Data analysis

All analyses were performed using the R-package *mitml* (Grund et al., 2021). The analysis script is published here: <https://osf.io/fx4bm/>.

Since the students were in 20 classes, the nested data structure had to be taken into account. Therefore, we decided to analyze nested hierarchical linear models. Using these random-intercept models, the standard errors for the classes can be taken into account. We assume that for individual student participation, personal perception of the error culture is more important than the perception of the whole class; therefore, we controlled for the class structure but did not generate any results at the class level.

All variables were standardized to obtain standardized regression coefficients. The interclass correlations (ICCs) were calculated with the package *performance* (Lüdtke et al., 2021). To calculate  $R^2$ , we used the formula of Snijders and Bosker (2012), which is the most accurate for random-intercept models (LaHuis et al., 2014). Separate

models were calculated for the two forms of participation as dependent variables as well as for both subjects. The interaction terms in the moderator analyses (RQ 2) were formed as products of the individual scale means of each student.

## 4.5 Missing data

To avoid estimating behavioral data, students for whom no behavioral data were available were excluded. Therefore, there are no missing values for student-controlled participation and teacher-controlled participation. To deal with missing values in the other questionnaire variables, we chose the R package *mdmb* (Grund et al., 2021). This package is suitable for considering interaction effects in nested hierarchical linear models. Here, the analysis model is already included in the imputation. In this way, the errors resulting from the estimation of the interaction term can be reduced. In addition to the analysis variables (e.g., error culture, course achievement, HISEI, gender), missing values were estimated with the auxiliary variables of age and further teaching variables. Twenty datasets were imputed, providing the basis for calculating the pooled results.

## 5 Results

### 5.1 Descriptive analyses

Table 1 shows the descriptive data from the questionnaire and video recordings. Overall, students assessed the error culture as rather positive, with no significant differences between the subjects. The descriptive values for student-controlled and teacher-controlled participation were a bit more difficult to interpret. For example, on average, each student showed 5.48 handraisings and calling-ins (student-controlled participation) in one GLA lesson. In addition, on average, a student was called-on (teacher-controlled participation) 2.31 times in a GLA lesson by the teacher. Overall, there was less teacher-controlled participation than student-controlled participation as well as a wide range between students in both subjects. With regard to the generalizability across subjects, we found significantly more teacher-controlled participation in GLA than in Mathematics [ $t(752.38) = 2.01$ ,  $p < .05$ ]. In contrast, slightly more student-controlled participation was evident in Mathematics, although the difference between the subjects in student-controlled participation was not significant [ $t(736.3) = -1.91$ ,  $p = .057$ ]. Looking at the ICCs, the differences between the classes were primarily visible in error culture and in the two forms of participation. This justified the inclusion of the class level in further analyses. Regarding the correlations, Table 2 shows bivariate correlations without controlling for covariates.

Approximately 34% (GLA)/35% (M) of the students reported having a migration background. While there are no descriptive differences between students with and without migration backgrounds in terms of error culture and student participation, there are clear differences between the groups regarding the socioeconomic status [HISEI;  $t(149.17) = 4.21$ ,  $p < .05$ ] and course achievement [ $t(199.37) = 2.97$ ,  $p < .05$ ]. Students with migration backgrounds show lower achievement and lower socioeconomic status. This highlights the need to include HISEI and course achievement as covariates in the analyses.

TABLE 1 Descriptive results.

	Min (GLA/M)	Max (GLA/M)	M (GLA/M)	SD (GLA/M)	ICC (GLA/M)	Missings (GLA/M)
1. Error culture	1/1	4/4	3.13/3.16	.75/.70	29.4%/15.5%	20/19
2. Migration background	0/0	1/1	–	–	9.7%/10.8%	23/24
3. HISEI	19.78/23.57	88.96/88.96	68.18/68.13	15.57/15.51	2.0%/2.5%	55/55
4. Course achievement	1/0	5/5	3.00/2.68	.86/1.19	5.5%/5.9%	73/42
5. Gender	1/1	2/2	–	–	20.7%/22.3%	4/3
6. Student-controlled participation	0/0	36/43	5.48/6.36	5.75/6.94	14.7%/13.4%	0/0
7. Teacher-controlled participation	0/0	12/14	2.31/2.03	2.04/1.76	7.6%/19.9%	0/0

The value before the slash indicates the result in German Language Arts (GLA;  $N = 387$ ); the value after the slash shows the result in Mathematics (M;  $N = 381$ ). Student-controlled participation means handraising and calling-in, teacher-controlled participation refers to calling-on.

TABLE 2 Correlations (GLA/M) between the analysis variables.

	1.	2.	3.	4.	5.	6.	7.
1. Error culture	–						
2. Migration background	.05/–.01	–					
3. HISEI	–.15/–.04	–.19*/–.18*	–				
4. Course achievement	.16*/.11	–.16/–.15	.21*/.17	–			
5. Gender	–.20*/–.05	.00/.02	.03/.06	–.13/.03	–		
6. Student-controlled participation (SCP)	.17*/.02	.03/.06	.06/.07	.02/.17*	–.10/.03	–	
7. Teacher-controlled participation (TCP)	.15/.05	–.05/–.02	.04/.09	.15/.16*	–.05/.00	.74*/.77*	–

\* $p < .05$ . The value before the slash indicates the result in German Language Arts (GLA); the value after the slash shows the result in Mathematics (M). For all correlations with migration background or gender, the method according to Spearman was used, otherwise according to Pearson. Coding of migration background: 0 = no migration background, 1 = migration background; Coding of gender: 1 = female, 2 = male.

TABLE 3 Results from nested hierarchical linear models on the relationship between error culture and migration background with student participation (RQ 1).

Dependent variable	German Language Arts				Mathematics			
	Student-controlled participation (SCP)		Teacher-controlled participation (TCP)		Student-controlled participation (SCP)		Teacher-controlled participation (TCP)	
	$\beta$ (SE)	$p$	$\beta$ (SE)	$p$	$\beta$ (SE)	$p$	$\beta$ (SE)	$p$
Intercept	.02 (.10)	.854	.02 (.07)	.833	.01 (.10)	.924	.02 (.12)	.872
Error culture	<b>.15 (.06)</b>	<b>&lt;.05</b>	.11 (.06)	.070	.05 (.05)	.319	.08 (.05)	.125
Migration background	.09 (.05)	.089	–.01 (.05)	.837	.08 (.05)	.150	.01 (.05)	.841
<b>Covariates</b>								
Course achievement	.02 (.06)	.737	.12 (.07)	.086	<b>.14 (.06)</b>	<b>&lt;.05</b>	<b>.13 (.05)</b>	<b>&lt;.05</b>
HISEI	.10 (.05)	.050	.03 (.06)	.551	.06 (.06)	.269	.07 (.06)	.231
Gender	–.00 (.05)	.962	.01 (.05)	.800	.08 (.05)	.139	.05 (.05)	.299
$R^2$	.02		.03		.02		.01	

Significant correlations are printed in bold. Coding of migration background: 0 = no migration background, 1 = migration background; Coding of gender: 1 = female, 2 = male.

## 5.2 Relationship between error culture and migration background with student participation in classroom discourse (RQ 1)

To answer the first research question, we examined the roles of error culture and migration background in predicting student participation in classroom discourse. Table 3 presents the results of these models (including covariates) separately for student- and teacher-controlled participation, and on the left for GLA and on the

right for Mathematics. Looking at GLA, there was a significant relationship between error culture and the frequency of student-controlled participation ( $\beta = 0.15, p < .05$ ). The relationship between error culture and the frequency of teacher-controlled participation did not reach significance ( $\beta = 0.11, p = .070$ ). Students' migration background ( $\beta_{SCP} = 0.09, p = .089; \beta_{TCP} = -0.01, p = .837$ ) did not make a significant contribution to predicting both forms of participation. Looking at Mathematics, there was no significant relationship between error culture and either form of participation

TABLE 4 Results from nested hierarchical linear moderator analyses: migration background as a moderator of the relationship between error culture and student participation (RQ 2).

Dependent variable	German Language Arts				Mathematics			
	Student-controlled participation (SCP)		Teacher-controlled participation (TCP)		Student-controlled participation (SCP)		Teacher-controlled participation (TCP)	
	$\beta$ (SE)	$p$	$\beta$ (SE)	$p$	$\beta$ (SE)	$p$	$\beta$ (SE)	$p$
Intercept	.02 (.10)	.856	.01 (.06)	.895	.01 (.10)	.913	.02 (.11)	.867
Error culture	<b>.15 (.06)</b>	<b>&lt;.05</b>	.09 (.06)	.120	.04 (.05)	.419	.07 (.05)	.166
Migration background	.07 (.05)	.157	.01 (.05)	.860	.09 (.05)	.079	.04 (.05)	.442
Error culture $\times$ Migration background	.02 (.05)	.640	.05 (.05)	.306	.07 (.05)	.169	.05 (.05)	.252
<b>Covariate</b>								
Course achievement	.20 (.06)	.812	<b>.19 (.09)</b>	<b>&lt;.05</b>	<b>.15 (.05)</b>	<b>&lt;.05</b>	<b>.15 (.05)</b>	<b>&lt;.05</b>
HISEI	<b>.11 (.05)</b>	<b>&lt;.05</b>	.03 (.06)	.671	.07 (.06)	.223	.07 (.06)	.251
Gender	-.00 (.05)	.937	.01 (.05)	.876	.08 (.05)	.149	.05 (.05)	.301
$R^2$	.02		.06		.02		.02	

Significant correlations are printed in bold. Coding of migration background: 0 = no migration background, 1 = migration background; Coding of gender: 1 = female, 2 = male.

( $\beta_{SCP} = 0.05$ ,  $p = .319$ ;  $\beta_{TCP} = 0.08$ ,  $p = .125$ ). As in GLA, migration background did not play a role here either ( $\beta_{SCP} = 0.08$ ,  $p = 0.150$ ;  $\beta_{TCP} = 0.01$ ,  $p = .841$ ). The covariate course achievement was only significant in Mathematics ( $\beta_{SCP} = 0.14$ ,  $p < .05$ ;  $\beta_{TCP} = 0.13$ ,  $p < 0.05$ ), but not in GLA ( $\beta_{SCP} = .02$ ,  $p = .737$ ;  $\beta_{TCP} = 0.12$ ,  $p = .086$ ).

### 5.3 Moderating role of migration background (RQ 2)

In addition, we examined whether students with and without migration backgrounds benefited differently from error culture regarding the frequency of their participation (RQ 2) (Table 4). The interaction term between error culture and migration background did not make a significant contribution in GLA ( $\beta_{SCP} = 0.02$ ,  $p = .640$ ;  $\beta_{TCP} = 0.05$ ,  $p = .306$ ) or Mathematics ( $\beta_{SCP} = 0.07$ ,  $p = .169$ ;  $\beta_{TCP} = 0.05$ ,  $p = .252$ ). On a descriptive level, Figures 1A,C show that for GLA, a positive error culture for students with and without migration backgrounds went hand in hand with increased participation.

In line with our expectations, this increase was greater for students with migration backgrounds. This descriptive trend also appears for Mathematics (Figures 1B,D). While students without migration backgrounds seemed to benefit little or not at all from a more positive error culture, a better error culture led to more participation among students with migration backgrounds.

## 6 Discussion

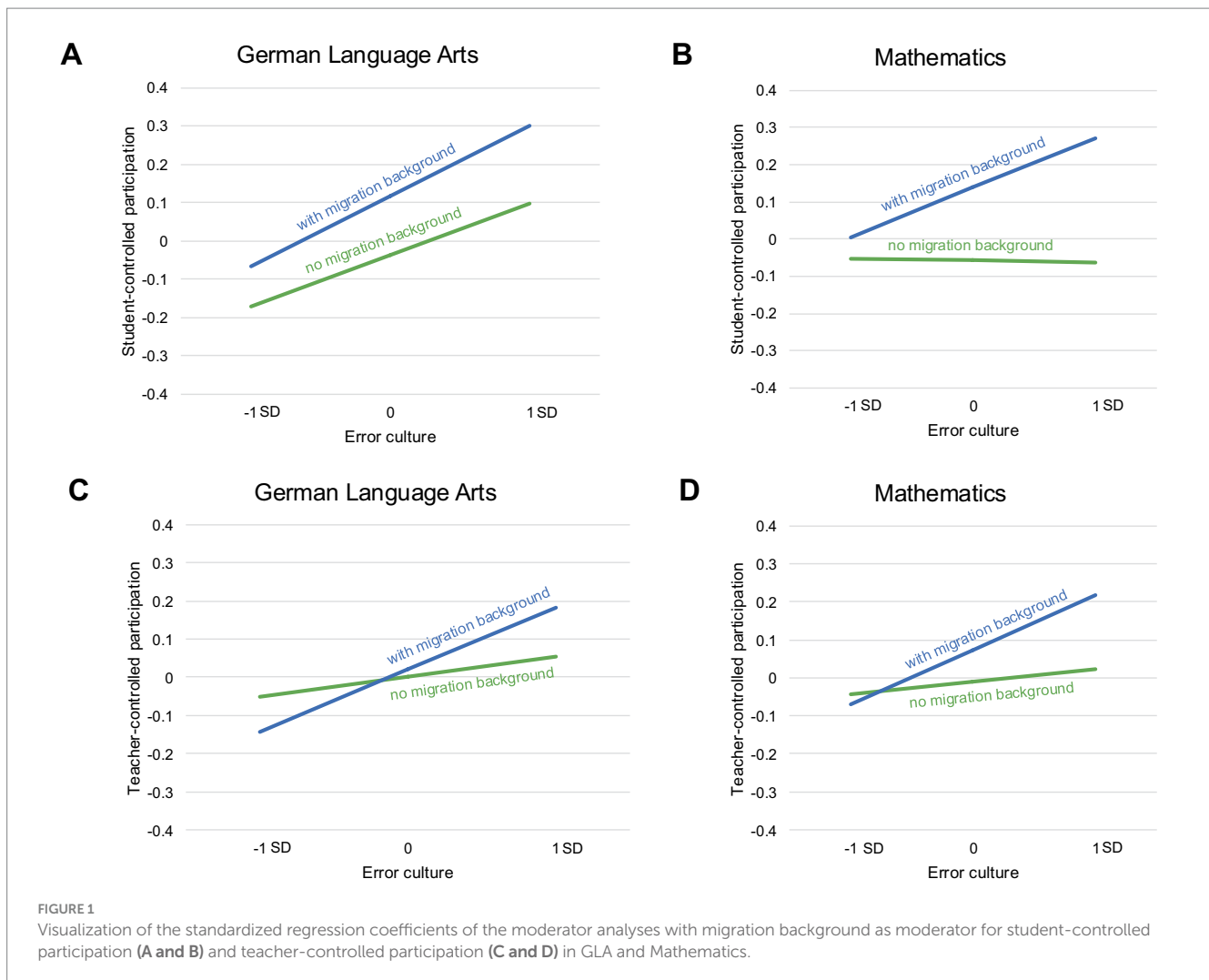
The aim of this study was to examine the relationship between migration background, error culture, and student participation in classroom discourse. Our study revealed subject-specific differences in the relationships that point to the (lack of) generalizability of findings from one subject. According to our results, students' perception of error culture was related to their participation in classroom discourse in German Language Arts, but not in Mathematics. In contrast, migration background did not play a significant role for students' participation in either subject. Contrary to our theoretical assumptions,

we did not find significantly different relationships between error culture and student participation, depending on whether students had or did not have migration backgrounds. Nevertheless, the results indicate nonsignificant trends that seem to highlight the important role of error culture for students with migration backgrounds.

### 6.1 Student participation seems to be independent from migration background in eighth-grade students

Since students with and without migration backgrounds differ in terms of their achievement (see, e.g., Andon et al., 2014) and student participation has been shown to predict student achievement (e.g., Böheim et al., 2020b; Sedova et al., 2019), we assumed that there would be differences in student participation depending on the students' migration status. However, in the present dataset, we found no significant relevance of migration background for student participation in classroom discourse (regardless of the subject). Prior research also showed inconsistent findings. While Decristan et al. (2020) and Lorenz and Gentrup (2017) found differences in student participation between students with and without migration backgrounds in their video analyses, the results of Jansen et al. (2022) and Decristan et al. (2023) were in line with our results and did not indicate differences. The reason for these different results may be the students' ages. While the analyses of Decristan et al. (2020) and Lorenz and Gentrup (2017) were restricted to younger students in elementary schools, we investigated exclusively and Jansen et al. (2022) and Decristan et al. (2023) mostly older students from academic-track secondary schools. While all children in Germany attend elementary schools, academic-track secondary schools are intended for students with the highest achievements (Reinhold et al., 2019; Schiepe-Tiska et al., 2019; Weis et al., 2019a). Also, there seem to be social disparities in the choice of a secondary school (i.e., non-academic-track or academic-track; Maaz et al., 2008). If students with migration backgrounds attend academic-track secondary schools, they may have adapted well to their classmates without migration backgrounds in classroom discourse;





thus, differences in student participation may not be apparent. This indicates that the role of migration background depends on a variety of context factors (see Heine and Stemmler, 2021). Future research should test whether these results also hold for other (non-academic-track secondary) school types.

## 6.2 Error culture partially predicts student participation

Since prior research has shown that teacher support is an important antecedent of classroom participation (Böheim et al., 2020b; Denn et al., 2019; Fredricks et al., 2004; Reyes et al., 2012), we assumed that the specific facet of error culture was relevant to student participation in classroom discourse. However, this assumption was only partially confirmed. While there was a significant relationship between error culture and student participation in GLA, the relationship was not evident in Mathematics. These differences are in line with existing studies on subject differences. As Mathematics is perceived as a more static, defined subject with less freedom (Grossman and Stodolsky, 1995; Stodolsky and Grossman, 2000) and discussions in languages are more open (Heitmann et al., 2017), there are also differences in the error culture. In Mathematics, errors are

more clearly defined and obvious, whereas in GLA they are more likely to be noticed only by the teacher (Steuer et al., 2021). In terms of dealing with errors, Mathematics teachers are more likely to react negatively to errors and are more likely to delegate error correction to classmates (Tulis, 2013).

Based on these differences, it is logical that error culture plays a greater role in GLA: In these open discussions, students are unsure whether their answer is correct and will only participate if they do not have to expect a negative reaction from their teacher or peers. The fact that the covariate course achievement only plays a significant role in Mathematics also supports this hypothesis. In Mathematics, students tend to know beforehand whether their answer is correct and only answer if it is. Since high achievers know the correct answer more often, they participate more often, whereas in GLA low achievers also try once.

Most importantly, the differential, subject-specific findings of the present study extend prior research by emphasizing the relevance of the context (here, subject). As such, our study also contributes to the discussion on the generalizability of a supportive teaching atmosphere (Praetorius and Gräsel, 2021), in particular with regard to the domain-specificity of error culture (Spychiger et al., 1999; Tulis, 2013), as well as with regard to the role that error culture plays in student participation.

### 6.3 The relationship between error culture and student participation seems to be independent of students' migration background

Based on four arguments (language problems, connection to peers, cultural norms, and teacher expectations), we assumed that error culture is particularly important for students with migration backgrounds. Contrary to our theoretical assumptions, our results indicate that, on average, the importance of error culture for student participation is not statistically different between students with and without migration backgrounds. This is in line with the results of a review that generally indicated difficulties in finding aptitude-treatment interactions (Tetzlaff et al., 2021). On the contrary, at least with regard to achievement there is little evidence to suggest that a positive teaching atmosphere is particularly important for students with migration backgrounds (Seiz et al., 2016). However, Seiz et al. (2016) also included non-academic-track secondary schools in their analyses. As mentioned above, in non-academic-track secondary schools, differences between students with and without migration backgrounds may be more pronounced, and thus a possible interaction effect might be more visible. Although not reflected in the regression analyses, the graphs may suggest a possible interaction. Therefore, we encourage future researchers to shed more light on differences within the group of students with migration backgrounds.

### 6.4 Limitations

Our research took advantage of the mixed-methods approach of the dataset (behavioral data for student participation and questionnaire data for students' perceptions of error culture) and the comparison of two different contexts (here, subjects). Nevertheless, with this secondary data analysis, we were bound by some methodological as well as conceptual restrictions. In particular, we discuss the time point of data collection, the school sample, the heterogeneity within the group of students with migration backgrounds, and the role of student participation as a dependent variable.

First, the data for this study were collected in 2013/14. Schools and teaching have changed in recent years, both in terms of the composition of students (e.g., slightly more students with migration backgrounds today; Federal Statistical Office of Germany, 2014; Federal Statistical Office of Germany, 2023) and teaching methods. Nevertheless, the processes examined in this paper are transferable to the present. First, the proportion of students with migration backgrounds per class already varied greatly in our sample, so classes with high proportions of students with migration backgrounds were already included in the sample. Second, the assessment of error culture and the participation of the students also differed among the students. Therefore, a large number of individually different processes were already considered for the analyses. In the spirit of much-requested multiple use of data, we therefore reanalyzed this dataset to fully exploit its potential.

Second, another limitation resulted from the school sample. We extended previous research on elementary schools by explicitly looking at academic-track secondary schools. Due to this focus, the results cannot be extended to other types of schools. Moreover, the fact that all students in the present study were relatively homogeneous regarding their achievement may mean that students with migration backgrounds adapted well to their classmates who did not have

migration backgrounds. Therefore, possible differences between students with and without migration backgrounds are less likely to be found in academic-track secondary schools compared to a school from before the separation (e.g., elementary schools).

Third, our sample did not allow us to look at the group of students with migration backgrounds in a differentiated way. Previous studies show that students with migration backgrounds differ depending on their country of origin (Bozick et al., 2016; Froehlich and Schulte, 2019; Schofield, 2006) and the length of stay in Germany (e.g., whether the students themselves or their parents migrated; Müller and Stanat, 2006; Segeritz et al., 2010). On this basis, it can be assumed that differences between students with and without migration backgrounds may be more pronounced when considering students from a culture that is different from the German culture (Hofstede, 2011; Hofstede et al., 2010) or students who have recently moved to Germany. However, such a contrast was not possible in our study due to the small sample size. Future studies should therefore take a differentiated look at this group of students.

Finally, our study considered student participation as a dependent variable and examined possible predictors (e.g., migration background and error culture). As in previous video studies (e.g., Pielmeier et al., 2018), we can only explain a small part of the variance in student participation. This highlights the fact that "classrooms are messy, unpredictable contexts" (Parsons et al., 2018, p. 206) and that many questions remain unanswered. Given the inconsistent findings of the present study, future research should further explore the mediating mechanisms between error culture (or teacher support in general) and achievement. Roorda et al. (2017) showed that student participation mediated the relationship between the teacher-student relationship and achievement. In order to draw further conclusions about the importance of error culture in narrowing the achievement gap, more research on possible mediating mechanisms is needed.

### 6.5 Implications for theory and practice and avenues for future research

First, students with migration backgrounds did not participate in classroom discourse significantly differently than their peers without migration backgrounds. Although this is surprising given the often-found differences in achievement, it is also reassuring: Teachers do not seem to treat students with migration backgrounds differently from students without migration backgrounds, and students with migration backgrounds do not seem to behave differently. Therefore, the ideal of equal participation seems to be achieved and students with migration backgrounds seem to be fully integrated in the classroom, which can also be seen as a success of integration measures. Nevertheless, the question of where differences in achievement come from if they are not due to classroom discourse, remains open. This brings the learning environment outside the classroom (e.g., parental support; Holzberger et al., 2023) to the fore. For example, special support and a quiet place to study while doing homework could be promising approaches for students with migration backgrounds. Therefore, future research should investigate whether aspects of the home learning environment can explain the achievement gap between students with and without migration backgrounds.

Second, students who perceive error culture more positively also participate more often in classroom discourse, at least in GLA. This finding now has two consequences for the practice: First, it seems important to sensitize teachers to error culture. Their behavior sets an

example for the students: Students notice how teachers deal with mistakes. Teachers should therefore pay attention to small daily events to signal to students that mistakes are a normal part of the learning process. Second, teachers should be trained to deal with mistakes. Appropriate responses to common student mistakes should therefore be part of teacher education. In addition, the subject-specific differences in the role of error culture for student participation underline the role of context. Therefore, future research should investigate the relationship between error culture and student participation in other subjects (e.g., Science) to further explore whether the role of error culture is more similar to GLA or Mathematics.

## 7 Conclusion

Our study contributes substantially to the current research by (a) explicitly looking at the role of migration background on student participation in academic-track secondary schools, (b) investigating the interplay of teaching behavior (i.e., error culture) and student characteristics (i.e., migration background) on student participation, and (c) contrasting occurring processes in two specific subjects, namely German Language Arts and Mathematics. Previous studies have found that students with and without migration backgrounds differ in their performance (e.g., Weis et al., 2018). Focusing on student participation, our results indicate that students with and without migration backgrounds in academic-track secondary schools do not seem to differ systematically in their participation in classroom discourse. Thus, student participation does not seem to be the crucial mediating process in explaining the often-revealed achievement gap.

Moreover, our findings indicate that a positive error culture may play a role in participation in classroom discourse; however, this finding may not be generalizable across subjects (with positive findings for German Language Arts, but not for Mathematics). In addition, although it may be reasonable to assume that a positive error culture is particularly necessary for students with migration backgrounds, our findings do not reveal differential relationships. Thus, in order to adequately support students with migration backgrounds, further aspects of teaching behavior need to be investigated. Who participates in classroom discourse is thus a multilayered process dominated by individual, classroom-specific, and subject-specific characteristics. Providing appropriate support for students with migration backgrounds is not simply a case of more of the same, but rather of targeted support that takes a close look at the challenges they face.

## Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The data set is not publicly accessible, as this does not include the participants' declaration of consent. Requests to access these datasets should be directed to [simon.munk@tum.de](mailto:simon.munk@tum.de).

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## Ethics statement

The studies involving humans were approved by Bayerisches Staatsministerium für Unterricht und Kultus. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

## Author contributions

SM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. DH: Conceptualization, Supervision, Writing – review & editing. RB: Conceptualization, Writing – review & editing, Investigation. TS: Funding acquisition, Supervision, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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