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SCHWERPUNKT

Academic achievement of refugee students at the end of primary school in Germany

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Abstract To date, little is known about refugee children's academic achievement in primary education in Germany. This study addressed this gap and examined achievement differences for refugee children compared to their peers with and without an immigrant background, as well as associated conditions at individual, family, and teacher levels. We analysed data from the "IQB Trends in Student Achievement 2021". Multilevel analyses indicated that refugee children face significant disadvantages in reading comprehension and mathematics, mitigated by student and family characteristics. Teaching-related characteristics (i.e., individual student support) showed little association with achievement gaps and exerted no differential effects for refugee children. The results highlight that more intensive efforts are needed to compensate for the less favourable starting conditions and resulting performance

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disadvantages of refugees, and call for further longitudinal research on effective teaching practices for this student group.

Keywords Academic achievement · Refugees · Primary education · Teaching quality

Die schulischen Leistungen geflüchteter Kinder am Ende der Grundschulzeit in Deutschland

Zusammenfassung Über die Schulleistungen von Grundschulkindern mit Fluchtbiografie in Deutschland ist bislang wenig bekannt. Die vorliegende Studie untersuchte das Ausmaß der Leistungsunterschiede von geflüchteten Kindern im Vergleich zu Gleichaltrigen mit und ohne Einwanderungsgeschichte sowie die damit verknüpften Bedingungen auf individueller, familiärer und Lehrkraftebene. Dazu wurden Daten des IQB-Bildungstrends 2021 analysiert. Mehrebenenanalysen zeigten, dass geflüchtete Kinder ausgeprägte Nachteile im Leseverständnis und in Mathematik aufweisen, die sich durch die Berücksichtigung von individuellen und familienbezogenen Merkmalen deutlich verringerten. Unterrichtsbezogene Merkmale (d. h. individualisierte Lernunterstützung) waren insgesamt unbedeutsam für die Leistungsunterschiede und es zeigten sich keine differenziellen Effekte für geflüchtete Kinder. Die Ergebnisse verdeutlichen, dass intensivere Bemühungen erforderlich sind, um die ungünstigeren Ausgangsbedingungen und die daraus resultierenden Leistungsnachteile von Geflüchteten auszugleichen, und dass es weiterer, längsschnittlicher Forschung zur Gestaltung des Unterrichts für diese Gruppe von Schüler:innen bedarf.

Schlüsselwörter Schulische Leistungen · Geflüchtete · Primarstufe · Unterrichtsqualität

1 Introduction

Between 2015 and 2021, around two million refugees arrived in Germany (BMI/BAMF 2023), one third of them being younger than 18 years (BAMF 2022; Destatis 2023). It is undisputed in research, practice, and policy that reading and mathematics skills are key prerequisites for the participation chances of young refugees in the receiving society. While previous studies have examined the academic achievement of refugees in secondary education (e.g., Höckel and Schilling 2022; Schipolowski et al. 2021), little is known on this matter for primary education. Research on school effectiveness has repeatedly shown that the skills acquired in the early stages of education have long-term effects for later educational opportunities and outcomes (e.g., Claessens and Engel 2013).

This article thus focuses on the academic achievement of young refugees at the end of primary education and factors at the individual, family, and classroom level associated with it. Specifically, our research questions are as follows: 1) *What level*

of competence do refugee students achieve in reading and mathematics? We assess their competence levels in comparison to non-refugee first- and second-generation immigrant students as well as non-immigrant students. 2) *To what extent do student, family, and classroom learning conditions contribute to refugee-specific achievement gaps?* Here, we examine how student characteristics, including language skills, and family characteristics are associated with student achievement. Additionally, our study explores whether teaching-related factors, specifically individualised student support from teachers, can help reduce these achievement gaps. Through these research questions, the article aims to provide insights into the specific needs and learning conditions that can enhance the academic achievement of refugee students.

Analyses are based on data from the German national assessment study at primary school level, the "IQB Trends in Student Achievement 2021" (Stanat et al. 2022). Refugee children in this study, predominantly originating from Syria, Afghanistan, and Iraq, arrived in Germany primarily between 2014 and 2017.

2 Refugee- and migration-specific achievement inequalities

Previous research has consistently demonstrated migration-specific inequalities in academic achievement, with students with an immigrant background typically performing below their peers without an immigrant background in achievement tests (for primary education, see, e.g., Henschel et al. 2022; Stubbe et al. 2023; Wendt et al. 2020 for secondary education, see, e.g., Henschel et al. 2023a; Winkler et al. 2022). The achievement gaps are usually particularly pronounced for first-generation students and smaller for second-generation students (e.g., Hunkler and Schotte 2023; Olczyk et al. 2016; Segeritz et al. 2010). Notably, achievement gaps for refugee students in secondary education are even more pronounced than for non-refugee first-generation students (Schipolowski et al. 2021). Yet, achievement levels of refugee students at the primary school level have not yet been subjected to a systematic study based on representative data.

In the following, we address potential explanations for these achievement inequalities. Based on ecological models of (immigrant-origin) student development (e.g., Bronfenbrenner 1994; Suárez-Orozco et al. 2018), we start with conditions at the student and family level (Sect. 2.1) and subsequently consider school-related learning conditions (Sect. 2.2).

2.1 Student and family characteristics

Migration-related achievement inequalities are often explained based on resource approaches or family investment models (e.g., Boudon 1974; Conger and Donnellan 2007; Erikson and Jonsson 1996): parental or family resources affect children's exposure to beneficial and stimulating learning environments, and contribute to differences in individual learning efficiency, engagement, and motivation (see, e.g., Erikson and Jonsson 1996; Baumert et al. 2006, for an overview). These resources entail economic resources such as household income, cultural resources like language skills, knowledge on the education system, educational qualifications and

certificates, as well as social resources such as support or shared norms and values (Bourdieu 1983; Coleman 1988; Lareau and Weininger 2003). Children and youth from privileged families are more likely to have access to resources that promote achievement gains. Since many immigrant groups are socioeconomically disadvantaged, migration-related achievement inequalities due to their lower socioeconomic status (SES) are to be expected (Heath et al. 2008).

However, the productivity of some resources depends on the respective context (Chiswick 1978; Friedberg 2000), which emphasises the specific situation of immigrants (Heath et al. 2008). For example, the productivity of language skills depends on the specific context, with proficiency in the language of instruction being crucial for acquiring school-related skills in predominantly monolingual school systems such as the German system (e.g., Kempert et al. 2016; Peng et al. 2020; Stanat and Edele 2015). Immigrant families in Germany often use their heritage language at home (Lorenz et al. 2024), creating conditions for their children to become competent multilinguals and supporting their development of a dual identity, which benefits immigrant children's adaptation (Baumert et al. 2024; Nguyen and Benet-Martínez 2013; Schotte et al. 2018). However, schools in Germany typically still practice a monolingual habitus (Gogolin 2008) and children rarely have the opportunity to use the resource of their family language there, particularly during lessons. At the same time, a frequent use of the heritage language is negatively related to competencies in German (Henschel et al. 2019; Kempert et al. 2016). Accordingly, family SES, the language spoken at home, and the related competencies in the language of instruction explain a large part of migration-related achievement gaps (for primary education, see, e.g., Henschel et al. 2022; for secondary education, see, e.g., Weis et al. 2019).

These processes should also apply to (recently arrived) refugees (Edele et al. 2021; Kogan and Kalter 2020). Despite variability, the average SES and educational level of refugees from Afghanistan, Syria, Iraq, Iran, or Eritrea are lower compared to the average educational level of the population in Germany (e.g., Hunkler et al. 2021; Liebau and Salikutluk 2016; Spörlein et al. 2020), so that refugee families tend to have fewer resources to support their children in school. This should impede the school achievement of refugee students compared to non-immigrant students, and also compared to other immigrant-origin students. Additionally, refugee children may have experienced discontinuous educational careers — in their country of origin, during migration, and in transition countries, and/or due to conditions in the host country (e.g., Saischek 2022; Will et al. 2022) — putting them at a higher risk to start their education in Germany at a lower achievement level compared to their non-refugee peers. These lower initial achievement levels could result in a decelerated learning growth (i.e., Matthew effect; e.g., Heckman 2006; Merton 1968). Moreover, refugee families typically have little knowledge of the language of instruction, as they could typically not prepare for the migration to the respective country of residence, including its language(s). With increasing periods of residence and/or children's attendance of kindergarten in Germany, and the accompanying access to language learning opportunities, the German language skills should improve (for evidence on language acquisition, see, e.g., Kosyakova et al. 2022; Seuring and Will 2022). Also, stress induced by traumatic experiences before, during, and

after migration, is more likely among refugees, and can impact the effectiveness of learning, whereby empirical evidence is mixed (e.g., Hunkler and Khourshed 2020; Kristen and Seuring 2021; Will and Homuth 2020). Finally, especially refugee children and youth often face unfavourable living and learning conditions (e.g., Tanis 2020).

In line with these considerations, we expect that, compared to majority students, refugee students will experience the greatest achievement disadvantages, followed by first- and second-generation students.

2.2 Teaching-related characteristics

In addition to student and family characteristics, learning conditions provided by schools and teachers are pivotal for students' learning progress and outcomes. Specifically, classroom instruction is considered key for student achievement (Praetorius et al. 2018; Seidel and Shavelson 2007).

Research on classroom instruction has identified individual student support as a crucial dimension of instructional quality (Praetorius et al. 2018; Seidel and Shavelson 2007). A broad conceptualisation of individual student support includes both, the quality of social relations in the classroom and teacher support for students' competence experience (for an overview, see Praetorius et al. 2018). The former refers to aspects of the classroom climate, such as friendly and respectful interactions among students as well as between students and teacher. The latter comprises teaching behaviour that is more directly linked to student learning, such as dealing constructively with errors, giving constructive feedback, and adapting teaching materials, pace of instruction, and classroom formats to students' needs and preferences (Decristan et al. 2015; Henschel et al. 2023b). Teaching strategies aimed at tailoring materials, tasks, and pace to individual students' needs are also often subsumed under the term "differentiated instruction" (Deunk et al. 2018; Gehrer and Nusser 2020; Langelaan et al. 2024). Along these lines, we conceive of differentiated instruction as a sub-dimension of individual student support (for a similar line of reasoning, see Praetorius et al. 2018).

Relations between individual student support and student achievement might be twofold. First, individual student support is assumed to increase students' socioemotional adjustment, learning motivation (e.g., Praetorius et al. 2018), and (academic) self-concept, and ultimately their achievement (e.g., Hardy et al. 2019; Roorda et al. 2011). Second, teaching behaviour such as providing adaptive feedback and differentiated instruction should support students in expanding their knowledge and skills, thus directly contributing to their achievement development (for an overview, see Hardy et al. 2019).

Research has corroborated the expected positive associations between broad measures of individual student support and socioemotional and motivational outcomes (e.g., Henschel et al. 2023b; Ohle-Peters et al. 2021; Ruzek et al. 2022), as well as between individual student support and student achievement (e.g., Decristan et al. 2015; Ruzek et al. 2022). As for the sub-dimension on differentiated instruction, prior work points to overall small positive effects on student achievement (Deunk et al. 2018; Gehrer and Nusser 2020). An inconsistent picture emerges for within-

class ability grouping, with research documenting very small (Lou et al. 1996) or even negative (Deunk et al. 2018) effects, with a small advantage of homogeneous grouping over heterogeneous grouping (Lou et al. 1996). Differentiated instruction using tailored materials and tasks, however, has been found to be associated with accelerated achievement compared to conventional teaching methods, typically yielding small to medium effect sizes (Gehrer and Nusser 2020; Hattie 2009; Lou et al. 1996). Against this background, we expect individual student support, comprising various aspects of differentiated instruction, to be conducive for students' academic achievement.

Building on the notion that instruction should be tailored to individual students' needs to support their learning progress, certain teaching strategies and learning environments may benefit some students more than others. Given the educational challenges of refugee students, and also of other students with an immigrant background, identifying characteristics of classroom instruction that are particularly beneficial for these vulnerable student groups is crucial: Many of these students grow up in disadvantaged families with limited resources which underlines the importance of high instructional quality for their learning progress. Moreover, fewer skills in the language of instruction of refugees and other immigrant background students can limit their participation in classroom interaction (Herrmann et al. 2021). Teaching strategies that promote active engagement of these students in class and that are well-aligned with their abilities and interests, i.e., individual student support, could enhance their learning outcomes.

In general, studies which examined the effectiveness of different aspects of classroom instruction, considering individual student characteristics (e.g., immigrant background, proficiency in the language of instruction, or family SES), have repeatedly, but not unequivocally (Jones and Byrnes 2006; Schmerse et al. 2018), shown that at-risk students particularly profit from high-quality classroom instruction (Decristan et al. 2016; for an overview, see Hardy et al. 2019). There is evidence that students of immigrant background particularly benefit from a high level of individual student support (for primary education, see Decristan et al. 2016; for secondary education, see Seiz et al. 2016; for evidence from a meta-analysis, see Roorda et al. 2011).

We expect that the overall positive effect of individual student support should be especially strong for refugee students, as this teaching strategy could effectively address their specific challenges, including limited command of the instruction language, experienced stress and traumatic events, and interrupted schooling.

3 Methods

3.1 Data

We used data from the study "IQB Trends in Student Achievement 2021", a nationally representative large-scale assessment study that is part of the national educational monitoring in Germany. The study assesses primary school students' attainment of specific learning goals as defined in the "National Educational Standards"

in the school subjects German and mathematics at the end of Grade 4 (Stanat et al. 2022). The test items were administered to students in a complex rotation design ("incomplete block design"; cf. Weirich et al. 2017) with each student answering a subset of items from both domains.

We used information from the achievement tests and questionnaires for students, parents, and teachers gathered between April and August 2021. Overall, 26,793 fourth-grade students from 1464 schools (one randomly selected class per school) participated in the achievement tests for at least one subject. We excluded students in special needs schools ($n = 1518$), students with missing information in achievement tests ($n_{mathematics} = 627$; $n_{German} = 549$), and students with missing teacher data ($n_{mathematics} = 6061$; $n_{German} = 6059$) from the analysis. The analysed sample consisted of data from 19,315 students and 1057 teachers for mathematics, and 19,326 students and 1057 teachers for German.

3.2 Instruments

3.2.1 Academic achievement

Mathematics achievement The math test covered the domains numbers and operations, space and shape, patterns and structures, sizes and measurements, and data, frequency, and probability, which were combined to a composite indicator of global math competence. Overall, the assessment comprised 406 items of different formats (e.g., multiple choice, arithmetic tasks were students had to fill in the correct answer).

Reading comprehension The reading comprehension test comprised narrative, expository, and discontinuous texts (e.g., tables) and respective items, aimed at assessing students' ability to retrieve information from written text, recognise connections, and draw conclusions (Bremerich-Vos et al. 2017). Overall, the assessment included 21 texts and 155 items, both in multiple choice and constructed response format.

For both mathematics achievement and reading comprehension, we used the person parameters ("Plausible Values") as established for reporting purposes for the "IQB Trends in Student Achievement 2021" (PV/EAP reliability for mathematics: 0.95; reading comprehension: 0.86). The reporting metric in each domain is standardised to $M = 500$ and $SD = 100$ points in the overall population of fourth-grade students in Germany in the year 2011 (for more details, see Sachse et al. 2022).

3.2.2 Immigrant background and refugee status

Refugee students were identified based on information provided by school officials, which was available for 95% of the students. Specifically, the schools indicated for each student whether they had "came to Germany as a refugee" (answer options: yes/no/do not know). For cases with missing information (5% of the initial sample; $n = 1412$), we used data on the country of birth and time of immigration to Germany, as provided by parents or students. In both cases, students were not considered as

refugees if they were born in the European Union or in a country which signed the Schengen Agreement (see Schipolowski et al. 2021, for a similar approach). Due to general sampling criteria (Sachse et al. 2022), students with German as a second language who had attended school in Germany for less than a year at the time of testing were excluded from the assessments; additionally, only students learning in regular classes were included in the data. Among refugee students with valid information on the country of birth, the majority was born in Syria (57%), followed by Afghanistan (14%) and Iraq (8%).

Based on parents' information about the country of birth, we further distinguished between first-generation (non-refugee) students (i.e., students born abroad), second-generation students (i.e., students born in Germany with both parents born abroad) and majority descent students (i.e., students and parents born in Germany). If information on the country of birth was missing, we used information gathered from the student.

3.2.3 Student and family characteristics

Educational family background Due to the limited transferability of refugees' occupations and income in the origin country to Germany, and due to the special importance of parents' cultural resources for their children's educational development, we used the highest number of parents' years of schooling, based on information on the highest level of parental education.

Duration of kindergarten attendance We used a 7-point scale, ranging from no kindergarten attendance (= 0), attendance for less than a year (= 1), to 5 years and longer (= 6). The information was provided by the parents.

Learning conditions at home Parents provided this information on six items (i.e., whether students had a designated space for uninterrupted learning, a personal desk, access to technological devices such as a PC or tablet, internet access, and a printer). We used the sum of the six items, with higher values indicating households possessing a greater number of characteristics that may foster learning.

Vocabulary in German As an indicator of students' German language proficiency, we used their vocabulary knowledge in German, assessed with the subscale V1 of the KFT 4–12+ R (Heller and Perleth 2000). For each item, the test required students to identify one out of five words that has the same or a very similar meaning as a given word. The scale consisted of 25 items ($\alpha = 0.87$).

3.2.4 Teaching-related characteristics

We used two indicators of individual student support: a student-report measure focusing on constructive feedback and perceived support, labelled as "perceived individual student support", and a teacher-report measure on "differentiated instruction". For *perceived individual student support*, students indicated whether their teacher in mathematics resp. German encouraged them, provided improvement suggestions, or

dedicated time to them, for instance (4-point scale ranging from 1 = *not at all true* to 4 = *absolutely true*). The scale included seven items and we calculated a mean score for further analyses (mathematics: $\alpha = 0.83$; German: $\alpha = 0.82$). Note that due to time restrictions, different versions of the student questionnaire were used in the assessment, with questions on instructional quality being presented in a randomly selected subset of schools.

Additionally, we used teachers' information on the implementation of *differentiated instruction* during mathematics resp. German classes. Teachers indicated how frequently they used methods such as providing students with differentiated tasks and material based on their ability or having them work at different pace (1 = *never* to 4 = *always*). We generated a mean score (five items; mathematics: $\alpha = 0.58$; German: $\alpha = 0.61$).

3.2.5 Control variables

Age Students' age was considered on a monthly basis. Information primarily originated from school records. If these data were unavailable, we used information provided by parents and students.

Gender We included student gender as a dichotomised variable (1 = *female*, 0 = *male*).

Amount of classroom teaching during COVID-19 pandemic As the examined student cohort experienced temporary school closures, distance learning, and alternating lessons during the pandemic, we considered information provided by the teachers on the share of classroom teaching during the school year 2020/2021 (10-point scale with 1 = *0 to 9%* to 10 = *90 to 100%*).

Descriptive statistics of the study variables are displayed in Table 1 (for correlations among the study variables at student level, see Table S.2 in the supplemental material).

3.3 Analytic strategy

We conducted multilevel regression models with random intercepts separately for German and mathematics in Stata, Version 17.0 (StataCorp 1985–2023). The models considered that students (Level 1) were nested in teachers (Level 2; note that L2 is identical with the school level). To assess the magnitude of refugee-specific disparities, we first regressed both outcome variables exclusively on immigrant background and refugee status (Model 1). Subsequently, we expanded the analyses by incorporating student and family characteristics of parental education, duration of kindergarten attendance, and the learning environment at home (Model 2), as well teaching-related characteristics (Model 3) to examine how each condition contributed to the refugee-specific achievement gaps. Next, to determine the extent to which disparities in mathematics and reading comprehension are language-based, we additionally controlled for language proficiency (i.e., vocabulary; Model 4). Finally, we considered interaction terms between immigrant background and refugee

Table 1 Descriptive statistics

	M/%	*SD*	*Min.*	*Max.*
Level 1 (student)				
Academic achievement				
Mathematics achievement	463.79	108.88	–36.72	847.15
Reading comprehension	474.24	105.03	–128.36	843.85
Immigrant background and refugee status				
Refugee	4.3	–	–	–
First-generation	6.5	–	–	–
Second-generation	13.4	–	–	–
Majority	75.7	–	–	–
Student and family characteristics				
Parental education	14.35	3.77	0.00	18.00
Duration of kindergarten attendance	4.19	1.54	0.00	6.00
Learning environment at home	4.31	0.90	0.00	5.00
Vocabulary in German	13.74	4.46	0.00	25.00
Teaching-related characteristics				
Perceived individual student support (mathematics)	3.23	0.59	1.00	4.00
Perceived individual student support (German)	3.26	0.55	1.00	4.00
Control variables				
Age	10.48	0.51	8.50	13.42
Female	50.1	–	0	1
Level 2 (teacher)[a]				
Teaching-related characteristics				
Differentiated instruction (mathematics)	2.94	0.41	1.60	4.00
Differentiated instruction (German)	2.91	0.42	1.60	4.00
Control variables				
Amount of classroom teaching (mathematics)	6.36	1.47	1.00	10.00
Amount of classroom teaching (German)	6.31	1.47	2.00	10.00

All descriptive statistics were calculated prior to grand-mean centring and were based on the first imputed data set. Unweighted values

N by construct: academic achievement and student-reported support: $N_{students} = 19{,}315$ (mathematics) and $N_{students} = 19{,}326$ (German); immigrant background and refugee status, student and family characteristics, controls (mathematics and German samples were combined due to negligible differences in descriptive statistics.): $N_{students} = 20{,}849$; differentiated instruction and amount of classroom teaching: $N_{teachers} = 1057$ (mathematics resp. German)

[a]Descriptive statistics at Level 2 (teacher)

Descriptive statistics by immigration group are summarised in Table S.1 in the supplemental material

Source. IQB Trends in Student Achievement 2021 (primary education)

status and teaching-related characteristics to test whether refugee students especially benefit from individual student support (Models 5 and 6). All continuous predictors were grand-mean centred at the student or teacher level, respectively, prior to the analyses.

All analyses are based on the original set of 15 *Plausible Values* estimated for reporting purposes following the procedures described by Sachse et al. (2022). This

approach considers various background characteristics of the students including immigrant and refugee status as well information given by teachers. To deal with missing data on background characteristics and all other variables besides school achievement, we used the 15 imputations provided with the data set. Following established procedures for educational large-scale assessments, multiple imputation of missing data was based on the *multivariate imputation by chained equations* approach (van Buuren 2018), taking into account a large number of variables such as sociodemographic characteristics of the students, teaching-related variables, students' general cognitive abilities, and characteristics of the assessment design (Sachse et al. 2022). At the student level, the proportion of missing data in the analysis samples ranged from 1 to 27%. As an exception, the share of missing values for students' information on individual student support was 63% (German) resp. 65% (mathematics). As this was due to the rotation design of the student questionnaire (i.e., questions about instructional quality in each subject were given to a random selection of 40% of the classes), these values were *missing completely at random* (MCAR; van Buuren 2018) and could be handled well using established imputation procedures (Graham 2009; Graham et al. 2006).

4 Results

Extent of achievement gaps On average, refugee children reached 373 points in mathematics and 372 points in reading comprehension (see Table S.1 in the supplemental material). Compared to non-immigrant students, they scored 107 points lower in mathematics and 121 points lower in reading comprehension. Multivariate results revealed, as expected, the largest achievement gaps for refugee students compared to majority students in both domains, followed by first-generation non-refugee and second-generation students (M1 and R1, Table 2).

Conditions at the student, family, and teacher level When considering student and family characteristics, there was a marked decrease in the observed refugee-specific gaps (M2 and R2, Table 2; for mathematics: $\Delta\beta_{M2\text{-}M1} = 65.9$; for reading comprehension: $\Delta\beta_{R2\text{-}R1} = 55.2$). Parental education, the duration of kindergarten attendance, as well as a well-equipped learning environment at home were positively associated with mathematics and reading achievement (for results from stepwise models, see Table S.3 in the supplemental material).

Considering teaching-related conditions barely changed refugee-specific gaps (M3 and R3, Table 2). Unexpectedly, perceived individual student support showed a negative association with mathematics achievement and no significant association with reading comprehension. Similarly, differentiated instruction was negatively associated with both achievement domains. This pattern indicates that, on average, students (regardless of immigrant background) with teachers who reported tailoring their teaching to individual needs tended to show lower performance in mathematics and reading comprehension.

When students' vocabulary knowledge was included, the coefficient for refugee students' mathematics achievement were no longer significant. For reading com-

Table 2 Student academic achievement predicted by student, family, and teaching-related conditions

	Mathematics achievement				Reading comprehension			
	M1	M2	M3	M4	R1	R2	R3	R4
Level 1 (student)								
Immigrant background and refugee status (Ref.: majority)								
Refugee	–84.38***	–18.46***	–18.01***	8.12	–100.38***	–45.20***	–45.40***	–17.76***
	(3.72)	(4.24)	(4.23)	(4.89)	(3.99)	(4.75)	(4.75)	(4.95)
First-generation	–52.47***	–16.50***	–16.30***	11.11*	–74.77***	–45.45***	–45.44***	–16.94***
	(3.48)	(3.67)	(3.66)	(4.47)	(3.26)	(3.22)	(3.22)	(3.30)
Second-generation	–34.18***	–17.64***	–17.58***	–0.53	–43.64***	–29.90***	–29.87***	–12.20***
	(2.46)	(2.36)	(2.36)	(3.40)	(2.50)	(2.38)	(2.39)	(2.96)
Student and family characteristics								
Parental education	–	6.41***	6.40***	4.39***	–	5.89***	5.89***	3.84***
		(0.25)	(0.25)	(0.25)		(0.23)	(0.23)	(0.28)
Duration of kindergarten attendance	–	5.89***	5.87***	3.69***	–	3.95***	3.94***	1.86**
		(0.63)	(0.63)	(0.56)		(0.60)	(0.60)	(0.59)
Learning environment at home	–	12.02***	12.03***	8.20***	–	11.49***	11.43***	7.50***
		(0.89)	(0.88)	(0.90)		(0.89)	(0.89)	(0.91)
Vocabulary in German	–	–	–	10.50***	–	–	–	10.66***
				(0.53)				(0.49)
Teaching-related characteristics								
Perceived individual student support	–	–	–5.21**	–4.03**	–	–	2.73	4.33**
			(1.56)	(1.51)			(1.52)	(1.34)
Control variables								
Age	–	–28.99***	–28.96***	–20.04***	–	–25.25***	–25.22***	–16.42***
		(1.51)	(1.52)	(1.59)		(1.39)	(1.38)	(1.40)
Female	–	–27.75***	–27.24***	–26.47***	–	18.63***	18.34***	18.60***
		(1.41)	(1.41)	(1.32)		(1.27)	(1.27)	(1.18)

Table 2 (Continued)

	Mathematics achievement				Reading comprehension			
	M1	M2	M3	M4	R1	R2	R3	R4
Level 2 (teacher)								
Teaching-related characteristics								
Differentiated instruction	–	–	–15.01***	–11.29***	–	–	–9.26**	–6.41*
			(3.24)	(2.80)			(3.09)	(2.57)
Control variable								
Amount of classroom teaching	–	4.93***	4.66***	3.21***	–	3.47***	3.26***	1.83*
		(0.91)	(0.90)	(0.76)		(0.86)	(0.86)	(0.72)
Intercept	475.15***	481.88***	481.49***	474.98***	488.04***	472.84***	472.96***	466.48***
	(1.61)	(1.61)	(1.61)	(1.77)	(1.57)	(1.55)	(1.55)	(1.79)
R-squared	0.079	0.220	0.223	0.385	0.118	0.242	0.243	0.422
$N_{students}$	19,315	19,315	19,315	19,315	19,326	19,326	19,326	19,326
$N_{teachers}$	1057	1057	1057	1057	1057	1057	1057	1057

*$p<0.05$, **$p<0.01$, ***$p<0.001$. Regression coefficients with standard errors in parentheses. Table S.3 in the supplemental material presents stepwise models in which parental education, duration of kindergarten attendance, and the learning environment at home were considered separately

Source. IQB Trends in Student Achievement 2021 (primary education)

Table 3 Results for student achievement by considering differential effects of teaching-related characteristics

	Mathematics achievement		Reading comprehension	
	M5	M6	R5	R6
Level 1 (student)				
Immigrant background and refugee status (Ref.: majority)				
Refugee	–18.46***	–18.52***	–45.92***	–46.19***
	(4.31)	(4.29)	(4.77)	(4.81)
First-generation	–16.36***	–16.36***	–45.56***	–44.99***
	(3.71)	(3.65)	(3.23)	(3.23)
Second-generation	–17.55***	–17.54***	–29.78***	–29.92***
	(2.36)	(2.35)	(2.39)	(2.37)
Student and family characteristics				
Parental education	6.40***	6.40***	5.89***	5.88***
	(0.25)	(0.25)	(0.23)	(0.23)
Duration of kindergarten attendance	5.87***	5.86***	3.95***	3.93***
	(0.63)	(0.63)	(0.60)	(0.60)
Learning environment at home	12.03***	12.01***	11.42***	11.41***
	(0.88)	(0.88)	(0.89)	(0.88)
Control variables				
Age	–28.96***	–28.93***	–25.20***	–25.21***
	(1.52)	(1.52)	(1.38)	(1.39)
Female	–27.24***	–27.26***	18.35***	18.29***
	(1.42)	(1.41)	(1.27)	(1.27)
Teaching-related characteristics				
Perceived individual student support	–5.65***	–5.21**	2.67	2.71
	(1.66)	(1.56)	(1.77)	(1.52)
Interaction: immigrant background × perceived individual student support				
Refugee × perceived individual student support	6.40	–	5.93	–
	(7.99)		(7.18)	
First-generation × perceived individual student support	2.76	–	3.52	–
	(5.95)		(5.48)	
Second-generation × perceived individual student support	–0.16	–	–3.17	–
	(4.11)		(5.07)	
Level 2 (teacher)				
Teaching-related characteristics				
Differentiated instruction[a]	–15.00***	–14.49***	–9.23**	–8.12*
	(3.24)	(3.46)	(3.09)	(3.24)
Cross-level interaction: immigrant background and refugee status × differentiated instruction				
Refugee × differentiated instruction	–	9.91	–	11.62
		(9.35)		(9.09)
First-generation × differentiated instruction	–	0.14	–	–14.12*
		(6.80)		(6.97)
Second-generation × differentiated instruction	–	–7.14	–	–4.96
		(5.97)		(5.91)

Table 3 (Continued)

	Mathematics achievement		Reading comprehension	
	M5	M6	R5	R6
Control variable				
Amount of classroom teaching	4.67***	4.67***	3.26***	3.24***
	(0.90)	(0.90)	(0.86)	(0.86)
Intercept	481.48***	481.52***	472.95***	473.04***
	(1.61)	(1.61)	(1.55)	(1.55)
R-squared	0.222	0.223	0.243	0.244
$N_{students}$	19,315	19,315	19,326	19,326
$N_{teachers}$	1057	1057	1057	1057

*$p<0.05$, **$p<0.01$, ***$p<0.001$. Regression coefficients with standard errors in parentheses
Source. IQB Trends in Student Achievement 2021 (primary education)

prehension, the refugee disadvantage remained, but it narrowed when considering students' vocabulary skills ($\beta=-17.76$, $p=0.001$; R4, Table 2).

Differential effects of teaching-related characteristics Regarding the interaction terms of teaching-related characteristics with students' immigrant background and refugee status, there was no evidence that refugee students particularly benefitted from individual student support, as indicated by findings for perceived individual student support (M5 and R5, Table 3) and differentiated instruction (M6 and R6, Table 3).

5 Discussion

This study focused on the academic achievement of refugee students at the end of primary education in Germany. This is the first examination of refugee students' achievement gaps at the level of primary school based on a large, representative data set such as the "IQB Trends in Student Achievement 2021"-study. It examined the extent of achievement gaps and the conditions at the student, family, and teacher levels that contributed to these gaps. We have shown that in this early stage of their educational career, refugee students face significant disparities in mathematics achievement and reading comprehension compared to other students of immigrant and non-immigrant descent. Based on the learning gains that can be expected to occur during one year of schooling (roughly 80 points in mathematics and roughly 60 points in reading comprehension; Stanat et al. 2022), the differences observed between refugee students and students without immigrant background accumulate to a gap of more than one school year in mathematics and of about two school years in reading comprehension. The present findings may even underestimate the gaps in the overall student body (cf. Henschel et al. 2022), since the data did not include recently arrived refugees who had attended school in Germany for less than one year. Overall, these findings corroborate our considerations regarding the particularly challenging situation of young refugee students and show that these challenges are not compensated for by the end of primary school.

When examining conditions contributing to refugee's achievement gaps, student and family characteristics play an important role. Refugee students' achievement gaps notably decreased when these factors were considered, even to a larger extent than in first-generation non-refugee students and second-generation students. A plausible explanation for this finding is the large variance of social and educational backgrounds among refugee families, particularly when compared to second generation students, ranging from very low educational levels, including attending school for less than four years, to university degrees (see Brücker et al. 2020; Hunkler et al. 2021). As expected, parental education, the duration of kindergarten attendance, and a favourable learning environment at home were positively associated with mathematics and reading achievement. Additionally, vocabulary skills in German proved to be important for the mathematics achievement as well as for reading comprehension of refugees (and also first-generation students in general): The gaps in reading comprehension diminished notably when vocabulary skills were considered, and the disadvantages of refugee students in mathematic even vanished completely, once again emphasising the pivotal role of proficiency in the language of instruction on refugee students' school achievement in Germany (see also Schipolowski et al. 2021). Teaching-related conditions contributed only little to refugee-specific achievement gaps. Furthermore, there was no evidence that refugee students, in particular, benefit from individual student support. Specifically, individual student support, as perceived by students, showed an unexpected negative association with mathematics achievement and no significant relationship with reading comprehension. Additionally, differentiated instruction was negatively associated with both mathematics achievement and reading comprehension.

Our analysis is not without limitations. First and foremost, we analysed cross-sectional data, which limits the explanatory power. This is particularly true as we could not rule out reverse causality, especially for the described results on teaching-related factors. Specifically, the unexpected findings regarding individual student support and differentiated instruction may be due to reverse causality, as teachers might be more likely to provide support and use differentiated instruction in classes they perceive as heterogeneous and/or underperforming. In line with this reasoning, there is initial empirical evidence highlighting that classroom composition is associated with the implementation of differentiated instruction. Thus, measures of differentiated instruction tend to occur more frequently in classrooms with a comparatively low average achievement (Gehrer and Nusser 2020) and in classrooms with a higher share of immigrant students (Lindner et al. 2021). Therefore, the negative associations may not reflect a negative impact of these teaching characteristics on student learning, but may instead indicate that the lower performance of these classes motivates teachers to adopt more supportive and individualised teaching approaches. Initial indications in this direction, at least for differentiated instruction, are provided by additional analyses that consider factors such as the average achievement level (see Tables S.4 and S.5 in the supplemental material). When controlling for the average achievement level, the significant negative effect of differentiated instruction was no longer evident (see M1 and R1 in Table S.5 in the supplemental material). This suggests that the observed negative effect of differentiated instruction may not stem from the practice itself but rather from the tendency of teachers to implement

differentiated instruction more frequently in classes with lower average achievement levels. These complexities highlight the need for longitudinal data to better understand the dynamic relation between teaching practices and student outcomes. Understanding these nuances will provide deeper insights into how individual student support may contribute to and moderate refugee-specific achievement gaps. A further limitation is the measurement of the construct of individual student support. Whereas the measure on differentiated instruction exhibits low reliability, suggesting that items do not form a homogeneous construct, the measure on perceived individual student support shows little variance, as students, particularly refugee students (see Table S.1 in the supplemental material), reported very high levels of individual student support. Finally, this study could not provide insights on the role of language learning opportunities at school in refugee students' achievement. Given the importance of language skills and language support in the acquisition of school competencies of newcomer students, it would be important to investigate the role of language support in school, including different models of language support for newly arrived students (e.g., Massumi et al. 2015). Research on language-supportive teaching in mathematics and science indicates that the systematic use of language-support strategies (e.g., engaging students in rich classroom discourse by having them justify their assumptions, providing adequate feedback by expanding students' utterances) contributes to students' conceptual understanding (e.g., Prediger and Wessel 2013; for an overview, see Höfler et al. 2024). Such teaching approaches have been proven effective to foster mathematics achievement in both monolingual students and second language learners (e.g., Prediger and Wessel 2018) and may, thus, inform interventions aimed at refugee students. However, given the tremendous achievement gaps among refugee students, but also among the first-generation in general, support measures that are implemented in regular classroom instruction are not sufficient for meetings these students' needs (see Henschel et al. 2023a, for a similar line of reasoning). As a potential remedy, the systematic use and improvement of extracurricular offerings seems of utmost importance, thus increasing students' overall learning time for the language of instruction and subject-specific content. This includes additional language classes for second language learners, ideally combining explicit and implicit support strategies (Stanat et al. 2012), and a stronger alignment between regular instruction and all-day programmes, providing opportunities for repeating and expanding newly acquired knowledge in different, typically more experience-based learning contexts (e.g., Paetsch et al. in press). Building on research on co-operations between schools and parents for promoting students' academic achievement (e.g., Ateş 2021), it seems promising to also actively involve parents (e.g., by regularly informing them about the lesson contents and accompanying vocabulary; Jones et al. 2019).

The reported achievement gaps of refugees at the end of primary school are particularly important in light of the transition to secondary education soon to follow on most states of Germany. In Germany, secondary education is highly differentiated, with various tracks that prepare students either for tertiary education or vocational training. These achievement disparities, if left unaddressed, could persist and potentially widen as refugee students move into secondary education, where academic performance at the end of primary school largely determines the type of secondary

school attended. Addressing the challenges faced by refugee students at this critical educational stage is essential, as the gaps could have long-term implications for their educational success.

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