



COVID-19-related differences in students' verbal achievements: Comparisons of different cohorts of students with SEN based on large-scale assessment data from Germany

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ABSTRACT

Background: Restrictions on schooling related to the COVID-19 pandemic resulted in learning deficits in primary and secondary education, but may have affected different groups of students in different ways.

Aim: We focus on the especially vulnerable group of students with special educational needs (SEN) in the domain of learning (SEN-L) and investigated changes in their verbal achievements by comparing different student cohorts. We also analyzed whether characteristics of the learning situation during the pandemic differed between students with and without SEN and whether these characteristics were associated with students' verbal achievements.

Sample: Analyses are based on representative data from large-scale assessments in Germany with achievement scores available for student cohorts prior to the COVID-19 pandemic and for student cohorts affected by the pandemic-related restrictions (Grade 4: 2016/2021, $N_{\text{non-SEN/SEN-L}} > 23.300/1.500$; Grade 9: 2015/2022, $N_{\text{non-SEN/SEN-L}} > 29.000/1.300$).

Results: Significant negative trends in student cohorts' average achievement emerged in reading, listening, and orthography for SEN-L students taught at regular schools and their peers without SEN. Negative cohort trends in achievement were also found for SEN-L students at special needs schools, but these were not statistically significant in all domains. Multilevel regressions revealed significant relations between students' learning conditions during the pandemic and their verbal achievement in 2021/2022, but did not differ between students without SEN and students with SEN-L.

Conclusion: The findings indicate negative trends in verbal achievements for students with SEN-L at regular schools and at special needs schools. These are likely in part due to the pandemic-related restrictions in schooling.

1. Introduction

Empirical findings indicate that the restrictions on schooling related to the COVID-19 pandemic impaired student learning in Germany and in other countries both in primary and secondary education (e.g., Betthäuser et al., 2023; Di Pietro, 2023). More specifically, trend results at the cohort level suggest that student cohorts affected by restrictions in schooling due to the COVID-19 pandemic reached lower levels of achievement than prior student cohorts that did not experience these

restrictions (also referred to as “cohort trends”; e.g., Ludewig et al., 2022; OECD, 2023a). While such cohort trends have already been analyzed for various groups of students (e.g., in terms of their socioeconomic status; Betthäuser et al., 2023; Stanat et al., 2022, 2023), evidence for the particularly vulnerable group of students with special educational needs (SEN) is limited. Achievement trends for this student group were investigated only in three studies so far, and their findings are mixed, identifying either no change in reading achievement for fourth and eighth-grade students (Chatzoglou et al., 2023) or substantial

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decreases in reading achievement for second and fourth-grade students (Fuchs et al., 2023; Ludewig et al., 2022). Moreover, all studies focused on academic achievement in the verbal domain of reading, with results for other verbal domains lacking.

The aim of our study was to examine potential cohort trends in academic achievement of students with SEN with representative data from large-scale assessments. Specifically, we investigated changes in achievement of students with SEN in the domain of learning (SEN-L) in fourth and ninth grade in the verbal domains of reading, listening, and orthography by comparing achievement scores of cohorts tested prior to the COVID-19 pandemic (T1; Grade 4: 2016, Grade 9: 2015) and of cohorts affected by the pandemic-related restrictions in schooling (T2; Grade 4: 2021, Grade 9: 2022). We further extend the results by analyzing characteristics of students' learning conditions during the pandemic-related restrictions. Specifically, we compare the learning conditions of students without SEN and those with SEN-L and analyze whether differences in these conditions during the pandemic are associated with differences in students' achievement in reading, listening, and orthography measured after the pandemic (T2). In the analyses, we examine two grade levels to determine if the achievement trends are comparable: Grade 4 (primary school, 10–11 years old students) and Grade 9 (secondary school, 15–16 years old students).¹ Moreover, we distinguish between SEN-L students taught at regular schools and those taught at special needs schools as these two learning environments differ considerably.

1.1. Learning environments of students with SEN in Germany

There is no internationally agreed definition of SEN (Rix et al., 2013). Nonetheless, the majority of definitions encompass a diverse array of conditions, spanning physical, psychological, cognitive, and educational impairments (Jordan & Prideaux, 2018). In Germany, SEN refers to impairments in children's and adolescents' educational, developmental, and learning abilities (KMK, 1994). Students with diagnosed SEN (approximately 8 % of primary and secondary level students in Germany; Schipolowski et al., 2022; 2023) need special educational support beyond what regular schools can provide. In Germany, students with SEN are taught either inclusively in regular schools (around 44 % in 2022; KMK, 2024) or separately in special needs schools (Biermann & Powell, 2014). Students with SEN in regular schools attend regular classrooms, adhering to a general curriculum that is reduced in terms of content and achievement expectations. Students in special needs schools also follow a special curriculum. They are taught by special education teachers in small learning groups of students with SEN (KMK, 1999, 2019; Kocaj et al., 2014, 2018).

Due to the heterogeneity of students with SEN, we focus on students with SEN in the domain of learning (SEN-L) which is the largest group of SEN students in Germany with 39 % (KMK, 2024). Students with SEN-L show sustained general learning difficulties across school subjects (Grünke & Grosche, 2014; Krämer et al., 2021). They typically struggle with acquiring fundamental skills like reading, writing, and mathematics (Görges et al., 2018) but also show difficulties in essential basic prerequisites of learning, such as endurance, memory, attention, and social-emotional dispositions (KMK, 2019; Núñez et al., 2024). Students with SEN-L typically reach substantially lower levels of achievement than students without SEN (e.g., Schwab et al., 2015). Yet, students with SEN-L attending regular schools perform better than their peers in special education schools (Kocaj et al., 2014; Krämer et al., 2021), underlining the importance of further differentiation between both school

types in our analyses.

1.2. Pandemic-related differences in students' competencies

In the years 2020–2022, educational institutions were temporarily closed to help contain the spread of COVID-19, resulting in periods of distance or alternate teaching and learning (i. e., partially at home; OECD, 2023b). However, the duration of these periods varied widely between and even within the federal states of Germany (Schneider et al., 2022; Schult et al., 2022). During the schooling restrictions (for an overview see Schult & Schneider, 2024), students depended on – among others – the learning environment at home, regular contact with their teachers (e.g., for the distribution of learning material and work assignments, feedback), and support from their parents (e.g., Lee et al., 2021; Schneider et al., 2021, 2022, 2023; Vincent et al., 2021). This was also the case for SEN-students. In fact, parents spent twice as much time per week supporting the learning of SEN children (11.5 h) than of children without SEN during the pandemic (5.1 h; Nusser, 2021; see also Gresch & Schmitt, 2021) as SEN students are less able to learn autonomously than their peers without SEN (Ribeiro et al., 2021). However, these studies included students with SEN in all domains and did not conduct separate analyses for students with SEN-L.

Empirical evidence on cohort differences in academic achievement for students with SEN, and more specifically for students with SEN-L, to determine effects of school closures is limited: Chatzoglou and colleagues (2023) analyzed large-scale data from the fourth and eighth-grade US National Center for Educational Statistics reading assessments. Whereas significant negative trends in reading emerged for students without SEN between the 2019 and 2022 cohorts in both grades, no substantial changes were found for students with SEN. In contrast, Fuchs and colleagues (2023) report decreases in reading achievement of second graders with learning difficulties in the US (student cohorts: 2019 vs. 2020 vs. 2021, each $N = 75$) that were approximately three times larger than for students without such difficulties. The only study carried out with German data found significant negative trends between 2016 and 2021 in reading for fourth-graders. These were comparable for students with and without SEN (Ludewig et al., 2022). As in the study by Chatzoglou and colleagues (2023), this analysis did not focus specifically on students with SEN-L.

Also, no research systematically investigated the pandemic-related changes in achievement of students with SEN-L depending on the type of schooling. Based on achievement differences (Kocaj et al., 2014), it could be assumed that students with SEN-L at special needs schools might have been less capable of coping with the restrictions in schooling during the pandemic than their peers at regular schools. Furthermore, results of a teacher survey (Robert Bosch Stiftung, 2021) indicate less favorable learning conditions for students with SEN at special needs school than at regular schools during the pandemic: Teachers at special needs schools reported greater needs for improvement regarding the technical equipment of their students and their own skills with digital learning formats than teachers of all school types. Moreover, they tended to prioritize compensating the social and psychosocial consequences rather than the learning deficits caused by the pandemic-related school restrictions. In contrast, it is also conceivable that teachers at special needs schools are more accustomed to responding to the individual needs of SEN students than their colleagues at regular schools and that they were therefore better able to adapt to the special learning situation of these students during the pandemic.

1.3. The present study

To complement current findings on trends in student achievement related to school restrictions due to the COVID-19 pandemic, we first examined (RQ1) cohort trends in students' verbal achievement in German as the language of instruction, both for Grade 4 (primary school, 10–11 year old students) and Grade 9 (secondary school, 15–16 year old

¹ In Germany, K-12 schooling differs slightly between federal states. While compulsory schooling includes primary and secondary school, the length of primary school (mostly 4 years), the number of compulsory school years, and types of secondary schools vary between states (for detailed information see Hennings et al., 2019).

students) and differentiated three groups: students with SEN-L in regular schools (inclusive education; SEN-L-R), students with SEN-L in special needs schools (SEN-L-S), and students without SEN in regular schools (non-SEN). For the three verbal domains included in the assessment (reading, listening, and orthography), we predicted substantial negative cohort trends for students in Grade 4 and Grade 9 that we expected to be more pronounced for students with SEN-L (SEN-L-R and SEN-L-S) than for non-SEN students. Due to a lack of theoretical and empirical foundations for predicting trend differences between SEN-L-R and SEN-L-S students, these analyses were exploratory.

The second research question (RQ2) focuses on differences in learning conditions during the pandemic for students without SEN and their peers with SEN-L. While it is not possible to directly link these conditions to the cohort trends in student achievement, regression analyses of school achievement at T2 (i. e., measured after the pandemic) can shed light on the extent to which the learning environment during the pandemic (e.g., learning environment at home, parental support) accounts for differences in school achievement. We pursued two sub-questions: (RQ 2a) Focusing on student cohorts affected by the pandemic in Grade 4 (2021) and Grade 9 (2022), we examined differences in selected characteristics of their pandemic-related learning conditions between the three student groups. (RQ 2b) Moreover, we analyzed the relations between the learning conditions during the pandemic and individual differences in students' verbal achievement in Grade 4 (2021) and Grade 9 (2022). Due to a lack of theoretical and empirical assumptions, these analyses were also exploratory.

2. Method

2.1. Sample and procedure

Our analyses are based on data from German large-scale educational assessment studies with achievement scores available for student cohorts prior to the COVID-19 pandemic (T1) and for student cohorts affected by the pandemic-related restrictions (T2). For fourth-grade primary school students, we used the *IQB Trends in Student Achievement 2021*-study (IQB-BT 2021; Stanat et al., 2022), which includes data for a student cohort tested in 2016 (T1) and a student cohort tested in

2021 (T2). For ninth-grade secondary school students, we used the *IQB Trends in Student Achievement 2022*-study (IQB-BT 2022; Stanat et al., 2023), which includes data for a student cohort tested in 2015 (T1) and a student cohort tested in 2022 (T2). For these studies, sampling was based on a stratified multi-stage random selection process (Rust, 2014; Sachse et al., 2022; Schofield, 2006; Weirich et al., 2023).

In regular schools, one class within each school was selected for participation in the studies. In special needs schools, the research design aimed at having all students participate in the assessment because the classes in these schools are typically small. However, some of the special need schools only have one class per grade. Only special needs schools with a focus on the domains of “learning”, “language” or “emotional and social development” were sampled. Using case weights, the data are representative for all students in the respective grades at regular schools and at special needs schools for SEN-L (students with SEN in the domain of learning or in the domain of learning and in other domains). For sample details, see Table 1.

Data collection was performed in a highly standardized manner by trained assistants in students' classrooms during typical school hours. Participation in the achievement tests was mandatory for schools and students whereas the student questionnaire was voluntary in some federal states, depending on state-specific regulations. In federal states with voluntary participation in the student questionnaire, parental consent was obtained beforehand. The parent questionnaire was voluntary in all federal states, whereas the extent to which teachers and principals were obliged to answer the questionnaires again varied between the federal states. Due to anonymity, all participants were de facto free not to answer individual questions and were informed that they could do so.

2.2. Variables

Prior to testing, teachers at regular and special needs schools indicated their students' SEN-L status based on school records. As is the case in other countries as well, defining SEN is complex and somewhat ambiguous (see Desforges & Lindsay, 2010; for Germany, see Galeano Weber et al., 2025; Gasterstädt et al., 2021). In line with the definition in Germany, students in our study were classified as having SEN-L if they

Table 1
Description of the analyzed samples.

		group	Grade 4		Grade 9	
			2016	2021	2015	2022
schools	regular: <i>n</i>		1395	1345	1423	1473
	special needs: <i>n</i>		85	83	71	91
students	<i>n</i>	non-SEN	25579	23335	29248	29880
		SEN-L-R	876	692	387	375
		SEN-L-S	668	827	992	1175
female: %		non-SEN	50.3	50.1	49.8	49.9
		SEN-L-R	47.1	51.1	46.7	37.5
		SEN-L-S	38.1	39.2	38.3	38.7
Age: <i>M (SD)</i>		non-SEN	10.4 (0.5)	10.3 (0.5)	15.5 (0.6)	15.5 (0.6)
		SEN-L-R	11.0 (0.7)	11.0 (0.6)	16.2 (0.7)	16.2 (0.7)
		SEN-L-S	11.0 (0.6)	11.2 (0.7)	15.9 (0.7)	16.0 (0.7)
HISEI: <i>M (SD)</i>		non-SEN	51.3 (20.7)	52.5 (21.0)	50.7 (20.3)	52.2 (20.9)
		SEN-L-R	38.7 (17.7)	37.4 (17.9)	38.4 (17.1)	37.3 (15.7)
		SEN-L-S	34.4 (15.6)	33.7 (15.2)	34.4 (16.0)	35.2 (15.9)
more than 100 books at home: %		non-SEN	49.1	43.1	53.3	45.9
		SEN-L-R	24.3	15.4	26.1	14.8
		SEN-L-S	19.2	16.8	20.2	14.6
immigration background: %		non-SEN	21.1	25.5	25.3	32.4
		SEN-L-R	27.7	41.4	38.5	50.5
		SEN-L-S	15.4	28.3	35.0	34.8
only German at home: %		non-SEN	71.2	61.1	78.2	66.9
		SEN-L-R	69.5	49.8	67.4	53.5
		SEN-L-S	75.7	62.5	86.3	72.0

Note. Non-SEN = students without special educational needs (SEN) at regular schools, SEN-L-R = students with SEN in the domain of learning at regular schools, SEN-L-S = students with SEN in the domain of learning at special needs schools, HISEI = Highest International Socio-Economic Index of Occupational Status in the family (scale from 16 = lowest socio-economic status to 90 = highest socio-economic status).

had been diagnosed in an official assessment procedure or if they received instruction at a modified level of difficulty or with an alternative educational goal as a result of a decision made by the school.

In both grades, the IQB-BT studies assessed competencies in reading, listening, and orthography with test items based on the national educational standards defined by the German Standing Conference of the Ministers of Education and Cultural Affairs (for sample items see Stanat et al., 2022, 2023). In order to obtain comprehensive and reliable information about students' competencies in each domain, a large number of test items is required across students. Applying a multiple matrix design (Frey et al., 2009; Gonzalez & Rutkowski, 2010), the items were bundled in different test booklets, making sure that all items are linked either directly within a test booklet or indirectly across several test booklets. This is the case when items in the various test booklets partly and systematically overlap (multiple matrix sampling design; Gonzalez & Rutkowski, 2010). This makes it possible to estimate students' achievement on the same scale, even though each student received only a subset of all items. The booklets for SEN-L-R and SEN-L-S students included predominantly easier tasks (Sachse et al., 2022; Weirich et al., 2023). To establish a common metric and comparable test scores, a common subset of linking items were completed by both non-SEN students (for whom they tend to be easy) and students with SEN-L (for whom they tend to be difficult). This represents a *Common-Item Nonequivalent Groups Design* (Kolen & Brennan, 2014) that is commonly applied to ensure that subgroups with different mean ability can be compared. The common items, then, were used for design-based linking. Within each grade level, the items were largely identical in both assessments to make sure trend analyses can be carried out. EAP reliability values, which can be interpreted as construct reliability (IQB-BT 2021 reading/listening/orthography: 0.747/0.723/0.868, IQB-BT 2022: 0.785/0.796/0.916), and WLE reliability values, which can be interpreted as reliability of individual person scores (IQB-BT 2021: 0.656/0.613/0.828, IQB-BT 2022: 0.785/0.768/0.902), were mostly at least acceptable.

Students and their parents, teachers, and principals also completed questionnaires which, among other things, included items assessing characteristics of the students' learning situation during the pandemic (Appendix A.1). The pandemic-related items were developed at the IQB. The items used in the IQB-BT 2022 study (Grade 9) differed from those in the study in 2021 (Grade 4) to enable comparisons with the PISA data also collected in secondary schools (Bertling et al., 2020). Moreover, relevant background characteristics (Appendix A.2) were assessed in the studies, taking into account that more students with SEN-L than students without SEN-L grow up in socially disadvantaged households and in families with an immigration background (e.g., Lenkeit et al., 2022; Werning et al., 2008). These background characteristics are also associated with lower achievements in reading, listening, and orthography (OECD, 2023a).

2.3. Analyses

For the analyses, we used data sets in which missing values had already been replaced in a multiple imputation procedure: Missing achievement values were treated as inherently missing and were imputed using plausible values (Mislevy, 1991). Missing values on the questionnaire variables were replaced by imputation in MICE (van Buuren, 2018).² For each case, 15 imputed data sets were generated.

For all analyses, replication procedures for dealing with clustered

samples were combined with pooling procedures for dealing with multiple imputed datasets (Rubin, 1987). For RQ 1, we computed point estimates for both times of measurement (T1: student cohorts prior to the COVID-19 pandemic; T2: student cohorts affected by the pandemic-related restrictions) for all groups (non-SEN, SEN-L-S, SEN-L-R) and all assessment domains (reading, listening, and orthography). Trend analyses refer to differences in point estimates between times of measurement (T2 – T1) for each group. The multilevel structure was taken into account by calculating all standard errors of the means and the standard errors of the mean differences using the jackknife-2 replication method (Rust, 2014; Wolter, 2007). The inference of trends for each group per verbal domain is based on the estimated standard error of the difference between the mean values at T1 and T2; the standard error includes the sampling error, measurement error, and linking error which are combined afterwards (Sachse & Haag, 2017). To examine trend differences between groups (e.g., $\Delta M_{\text{Non-SEN}}$ vs. $\Delta M_{\text{SEN-L-R}}$), we first computed difference scores between groups (based on a combination of replication methods for clustered samples and the delta method) and then the differences between assessments for this group difference. In determining standard errors and drawing statistical inferences, the clustered sample (Lumley, 2004; Wolter, 2007) and the missing values due to inherently unobserved latent competencies (Mislevy, 1991) were taken into account. The effect size d was computed as follows:

$$d = (M_1 - M_2) \cdot SD_{\text{pooled}}^{-1},$$

$$\text{where } SD_{\text{pooled}} = \sqrt{0.5 \cdot (SD_1^2 + SD_2^2)}.$$

For RQ 2a, we calculated differences in students' pandemic-related learning conditions between student groups (non-SEN, SEN-L-R, SEN-L-S) for fourth and ninth graders. The statistical inference is based on a combination of replication methods for clustered samples and the delta method (Wolter, 1985, 2007) which is used to determine statistical inference for derived parameters (the mean difference can be understood as such a derived statistic). For RQ 2b, we performed multilevel regression analyses (Hox et al., 2017) separately for the two grade levels and each verbal domain, with the SEN-L-R and SEN-L-S groups parameterized as predictors (main effects) and the differences in the effects between the groups parameterized as two-way interactions. We used grand mean centering for all metric and categorical independent variables (Enders & Tofighi, 2007; Yaremych et al., 2023). Student background variables were included in these regression models to account for potential confounds.

3. Results

3.1. Cohort trends in students' verbal achievement (RQ 1)

The trends in students' verbal achievements are presented in Table 2. In Grade 4, the results indicate significant negative trends in verbal achievements for non-SEN and SEN-L-R student cohorts in all three domains. For SEN-L-S students, mean values were also smaller at T2 than at T1, but significant group differences were only found for orthography. Moreover, the difference between T1 and T2 was larger for SEN-L-S than non-SEN students (indicated by the superscript letter; see Appendix B for statistical parameters).

Like in Grade 4, negative achievement trends emerged for non-SEN and SEN-L-R students in all domains in Grade 9 (Table 2). However, trends for ninth-grade SEN-L-R students were always significantly more pronounced than for their peers without SEN. Significant negative trends were also found for SEN-L-S students in Grade 9 in the domains of listening and orthography, but not in reading.

² If the missingness is not random (e.g., because participating in a study is mandatory and not answering questions is therefore the only way to refrain from doing so), results may be biased. However, missing not at random is not empirically testable. We therefore assume missing at random for the imputation procedure as used in large-scale educational assessments such as PISA and PIRLS.

Table 2
Achievement values of fourth and ninth grade students in the German verbal domains and trend results.

grade	domain	group	T1		T2		T2 – T1		
			M	SE	M	SE	ΔM	SE	d
4	reading	non-SEN	502	1.4	482	2.0	-20	2.9	-0.21
		SEN-L-R	341	7.1	314	6.1	-28	9.5	-0.30
		SEN-L-S	289	5.7	278	10.3	-11	11.8	-0.11
	listening	non-SEN	493	1.8	466	2.2	-27	3.6	-0.25
		SEN-L-R	351	8.2	310	7.0	-41	11.0	-0.37
		SEN-L-S	285	7.2	260	11.9	-25	14.0	-0.22
	orthography	non-SEN	508	1.5	485	1.9	-23	2.8	-0.24
		SEN-L-R	349	8.0	316	8.8	-33	12.0	-0.32
		SEN-L-S	326	8.3	270	8.1	-55^b	11.7	-0.52
9	reading	non-SEN	506	1.3	483	1.8	-23	4.8	-0.23
		SEN-L-R	370	8.8	319	8.7	-51^a	13.3	-0.62
		SEN-L-S	339	6.5	310	6.3	-29	30.0	-0.24
	listening	non-SEN	506	1.3	463	1.9	-43	4.5	-0.41
		SEN-L-R	384	14.6	308	8.5	-76^a	16.1	-0.87
		SEN-L-S	330	12.3	309	4.8	-21^c	13.8	-0.23
	orthography	non-SEN	506	1.2	480	1.5	-27	2.4	-0.26
		SEN-L-R	354	8.6	286	10.2	-68^a	13.4	-0.76
		SEN-L-S	319	10.0	253	5.2	-66^b	11.3	-0.71

Notes. Non-SEN = students without special educational needs (SEN) at regular schools, SEN-L-R = students with SEN in the domain of learning at regular schools, SEN-L-S = students with SEN in the domain of learning at special needs schools. Bold differences are significant at $p < .05$. For statistical parameters for trend comparisons between groups, see Appendix B.

^a $\Delta M_{\text{non-SEN}} \neq \Delta M_{\text{SEN-L-R}}, p < .05$.

^b $\Delta M_{\text{non-SEN}} \neq \Delta M_{\text{SEN-L-S}}, p < .05$.

^c $\Delta M_{\text{SEN-L-R}} \neq \Delta M_{\text{SEN-L-S}}, p < .05$.

Table 3
Group differences for aspects of students' learning conditions during the pandemic: students in 2021 (Grade 4) and 2022 (Grade 9).

grade	aspect	non-SEN		SEN-L-R		SEN-L-S	
		M	SD	M	SD	M	SD
4	extent of distance learning	15.17	5.68	14.62	6.20	14.66	6.80
	extent of alternate learning	17.18	11.40	18.27	11.66	15.99	12.71
	learning environment at home	0.87	0.18	0.76 ^a	0.21	0.76 ^b	0.22
	other children at home	0.48	0.31	0.54 ^a	0.33	0.49	0.34
	support by parents	3.10	0.75	2.80 ^a	0.79	3.04 ^c	0.76
	functioning of distance learning (parents)	3.06	0.67	2.99	0.72	3.27 ^{b,c}	0.66
	functioning of distance learning (teacher) ^d	3.03	0.42	2.94 ^a	0.41	2.69 ^{b,c}	0.50
	9	extent of distance learning	2.91	0.92	3.07	1.00	2.74
extent of alternate learning	2.50	1.00	2.56	0.99	2.29	0.89	
teacher-student contact	4.36	0.65	4.32	0.63	4.41	0.66	
problems during distance learning	2.16	0.66	2.12	0.66	2.01 ^b	0.67	
summer school attendance	0.10	0.30	0.09	0.28	0.10	0.31	

Notes. Information on scale construction can be found in Appendix A. Non-SEN = students without special educational needs (SEN) at regular schools, SEN-L-R = students with SEN in the domain of learning at regular schools, SEN-L-S = students with SEN in the domain of learning at special needs schools. For statistical parameters for mean comparisons between groups, see Appendix C.

^a $\Delta M_{\text{non-SEN}} \neq \Delta M_{\text{SEN-L-R}}, p < .05$.

^b $\Delta M_{\text{non-SEN}} \neq \Delta M_{\text{SEN-L-S}}, p < .05$.

^c $\Delta M_{\text{SEN-L-R}} \neq \Delta M_{\text{SEN-L-S}}, p < .05$.

^d The teachers rated the functioning of distance learning for the class as a whole.

3.2. Differences in learning conditions during the pandemic (RQ 2a)

Descriptives and group differences for students' learning conditions during the pandemic are depicted in Table 3. In Grade 4, the learning environment at home was significantly more unfavorable for SEN-L-R and SEN-L-S students than for non-SEN students (indicated by superscript letters; see Appendix C for statistical parameters). In addition, more SEN-L-R students lived together with other children in the same household than non-SEN students. Parents of non-SEN students reported that they were able to support their children significantly better than parents of both SEN-L groups. The evaluation of how well distance learning worked during the pandemic differed between parents and teachers for the student groups. While the distance learning was rated significantly more positively by parents of SEN-L-S children than by parents of non-SEN and SEN-L-R students, teachers at special needs

schools rated it significantly less positively than their colleagues at regular schools. Within regular schools, moreover, teacher ratings indicated that distance learning worked less well for SEN-L-S students than for non-SEN students. All other group differences were not statistically significant.

In contrast, group differences were not significant in Grade 9 with the exception of problems occurring during distance learning. Non-SEN students were more likely to face problems at home during distance learning than SEN-L-S students (Table 3).

3.3. Relations between the learning conditions and students' verbal achievement (RQ 2b)

For Grade 4, multilevel regression analyses revealed significant relations for some learning conditions during the pandemic and students'

Table 4
Results of the multilevel regressions for students' verbal achievements in 2021 (Grade 4).

	reading		listening		orthography	
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
<i>main effects: student level</i>						
intercept	471.7	1.5	455.8	1.6	474.6	1.5
SEN-L-R	-138.6	9.0	-118.2	8.9	-139.0	10.9
SEN-L-S	-194.1	12.5	-190.2	14.2	-211.2	12.2
learning environment at home	7.0	1.0	7.2	1.0	8.6	1.1
other kids at home	-4.6	1.0	-2.7	1.1	-4.4	1.0
support by parents	6.2	0.9	4.7	1.2	7.1	1.1
functioning of distance learning (parents)	1.7	1.1	-2.2	1.2	3.3	1.0
HISEI	21.8	1.0	23.3	1.1	20.0	1.0
books at home	19.8	1.0	24.5	1.2	15.3	1.1
immigration background ^a	-30.3	2.9	-49.4	3.5	-14.5	2.6
language spoken at home ^b						
sometimes German	-12.9	2.1	-26.3	2.5	0.5	2.1
never German	-38.7	6.3	-51.0	7.4	-37.1	6.8
<i>main effects: class level</i>						
extent of distance learning	1.0	1.3	1.2	1.4	1.1	1.4
extent of alternate learning	-1.3	1.2	-1.9	1.4	-3.3	1.4
functioning of distance learning (teacher)	6.6	1.4	7.4	1.6	4.2	1.5
<i>interaction effects</i>						
SEN-L-R × learning environment at home	2.4	5.2	4.0	6.2	4.5	5.7
SEN-L-R × other kids at home	1.6	6.2	1.9	6.7	-2.8	8.3
SEN-L-R × support by parents	-8.8	5.7	-8.7	6.7	-7.8	6.6
SEN-L-R × functioning of distance learning (parents)	4.5	6.0	2.2	7.8	4.8	7.8
SEN-L-R × HISEI	-12.5	6.7	-15.9	8.0	-10.8	7.2
SEN-L-R × books at home	-8.9	7.1	-10.3	7.4	-3.5	7.3
SEN-L-R × immigration background	11.5	13.4	4.5	15.7	14.0	17.9
SEN-L-R × sometimes German	-3.2	14.5	-11.0	14.9	-7.5	18.9
SEN-L-R × never German	17.9	33.9	2.8	35.9	2.7	35.4
SEN-L-R × extend of distance learning	11.2	6.0	7.7	5.8	6.4	9.1
SEN-L-R × extend of alternate learning	-0.3	6.1	-1.6	5.6	-6.8	7.9
SEN-L-R × functioning of distance learning (teacher)	-3.6	6.8	1.3	7.1	2.3	8.3
SEN-L-S × learning environment at home	6.6	6.0	7.3	5.7	4.1	5.8
SEN-L-S × other kids at home	1.4	5.9	3.6	6.1	-0.2	4.9
SEN-L-S × support by parents	-2.8	7.4	-3.4	8.4	-4.5	6.0
SEN-L-S × functioning of distance learning (parents)	-0.4	7.2	4.1	6.7	-2.4	6.7
SEN-L-S × HISEI	-22.6	6.9	-22.7	7.5	-21.1	6.7
SEN-L-S × books at home	-13.9	5.4	-14.4	6.3	-13.6	5.2
SEN-L-S × immigration background	-23.6	15.4	-22.4	13.7	-23.7	17.7
SEN-L-S × sometimes German	8.7	11.9	14.8	12.6	4.2	13.5
SEN-L-S × never German	64.9	22.3	58.0	28.0	50.0	18.3
SEN-L-S × extend of distance learning	-3.5	6.0	-0.9	7.2	-2.2	8.1
SEN-L-S × extend of alternate learning	1.4	8.0	-2.2	7.7	3.3	9.0
SEN-L-S × functioning of distance learning (teacher)	-14.3	6.3	-14.0	7.3	-15.2	7.1
<i>N</i>	24.854		24.854		24.854	
ICC (unconditional)	0.18		0.19		0.20	
<i>R</i> ² Level 1	0.41		0.46		0.32	
<i>R</i> ² Level 2	0.64		0.60		0.50	
<i>R</i> ² total	0.45		0.49		0.36	

Notes. Depended variables are the verbal achievements of students in reading, listening, and orthography in 2021. Information on scale construction can be found in [Appendix A](#). Non-SEN = students without special educational needs (SEN) at regular schools, SEN-L-R = students with SEN in the domain of learning at regular schools, SEN-L-S = students with SEN in the domain of learning at special needs schools. All metric and categorical independent variables are grand mean centered. Bold regression coefficients are significant at $p < .05$. Computation of R^2 is based on the proportional reduction in mean squared prediction error on Level 1 and Level 2 (Snijders & Bosker, 1994).

^a Reference group: students without immigration background.

^b Reference group: “always German” as the language spoken at home.

verbal achievements (main effects; [Table 4](#)). Better technical equipment and space for undisturbed learning at home was associated with higher achievement scores in reading, listening, and orthography. In addition, students from households with no other children and those with better parental support as well as students whose teachers rated the functioning of distance learning more positively showed better test results in all verbal domains. Significant negative interaction effects of student group (non-SEN vs. SEN-L-S) and learning conditions ([Table 5](#)) only emerged for the teacher-rated functioning of distance learning in reading and orthography. The better distance learning worked

according to the teachers, the higher was the achievement of students, but this positive relation was more pronounced for students without SEN than for SEN-L-S students.

For Grade 9, the multilevel regressions revealed significant relations for some learning conditions during the pandemic and students' verbal achievements (main effects; [Table 5](#)). Students with less pronounced problems during distance learning showed better test results in all domains. Moreover, summer school attendance in 2021 was associated with lower achievements in reading and listening. No significant differences between student groups in the relation between the pandemic-

Table 5
Results of the multilevel regressions for students' verbal achievements in 2022 (Grade 9).

	reading		listening		orthography	
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
<i>main effects: student level</i>						
intercept	467.2	2.6	449.1	2.4	461.9	2.4
SEN-L-R	-104.8	8.7	-89.8	9.3	-127.3	10.8
SEN-L-S	-158.1	10.7	-136.1	8.8	-214.9	9.7
problems during distance learning	-2.3	0.7	-4.7	0.8	-1.9	0.7
summer school attendance	-1.7	0.8	-1.8	0.8	-1.0	0.8
HISEI	6.3	0.9	8.6	1.0	5.7	1.0
books at home	20.1	1.0	23.5	0.9	16.8	0.9
immigration background ^a	-24.9	2.7	-28.5	2.6	-17.9	2.5
language spoken at home ^b						
sometimes German	-14.0	2.2	-20.8	2.2	-5.8	1.9
never German	-33.9	5.3	-49.7	5.6	-24.0	5.9
<i>main effects: class level</i>						
extent of distance learning	1.5	2.6	2.6	2.6	2.3	2.8
extent of alternate learning	-2.1	2.7	-2.4	2.7	-1.6	2.8
teacher-student contact	2.4	2.6	2.7	2.5	3.9	2.7
<i>interaction effects</i>						
SEN-L-R × problems during distance learning	5.9	5.8	8.0	6.3	9.0	6.8
SEN-L-R × summer school attendance	3.2	7.5	1.9	6.5	8.8	7.9
SEN-L-R × HISEI	-14.0	8.0	-13.0	8.0	-4.3	9.4
SEN-L-R × books at home	-9.3	8.0	-1.7	8.5	-6.0	9.5
SEN-L-R × immigration background	-17.4	21.2	-1.3	19.4	-16.8	19.7
SEN-L-R × sometimes German	6.6	18.7	3.6	17.4	-7.7	17.8
SEN-L-R × never German	-5.5	36.8	-20.8	50.4	8.5	48.0
SEN-L-R × extend of distance learning	1.2	8.3	-0.6	7.6	4.5	8.6
SEN-L-R × extend of alternate learning	2.3	7.0	1.8	6.3	6.7	6.2
SEN-L-R × teacher-student contact	5.0	9.4	4.4	8.2	0.3	9.9
SEN-L-S × problems during distance learning	3.9	5.4	5.8	4.4	1.1	5.5
SEN-L-S × summer school attendance	4.8	4.1	5.8	4.2	3.9	3.4
SEN-L-S × HISEI	-8.9	6.4	-7.3	5.5	-7.1	6.2
SEN-L-S × books at home	-9.9	4.5	-11.3	5.2	-11.6	5.7
SEN-L-S × immigration background	6.8	13.6	0.3	14.0	-5.6	15.8
SEN-L-S × sometimes German	-11.5	10.0	-5.8	11.1	-16.3	11.4
SEN-L-S × never German	-60.8	24.8	-31.9	23.5	-41.2	23.9
SEN-L-S × extend of distance learning	0.4	5.6	-0.2	6.2	-1.0	6.9
SEN-L-S × extend of alternate learning	4.7	5.9	3.9	5.9	9.9	6.6
SEN-L-S × teacher-student contact	2.8	6.7	-2.7	5.4	-1.4	6.2
<i>N</i>	31.427		31.427		31.427	
ICC (unconditional)	0.38		0.35		0.40	
<i>R</i> ² Level 1	0.24		0.29		0.17	
<i>R</i> ² Level 2	0.19		0.21		0.20	
<i>R</i> ² total	0.22		0.27		0.18	

Notes. Depended variables are the verbal achievements of students in reading, listening, and orthography in 2022. Information on scale construction can be found in Appendix A. Non-SEN = students without special educational needs (SEN) at regular schools, SEN-L-R = students with SEN in the domain of learning at regular schools, SEN-L-S = students with SEN in the domain of learning at special needs schools. All metric and categorical independent variables are grand mean centered. Bold regression coefficients are significant at $p < .05$. Computation of R^2 is based on the proportional reduction in mean squared prediction error on Level 1 and Level 2 (Snijders & Bosker, 1994).

^a Reference group: students without immigration background.

^b Reference group: "always German" as the language spoken at home.

related learning conditions and students' verbal achievements emerged (interaction effects; Table 5).³

4. Discussion

In our study, we first examined cohort trends in SEN-L students' verbal achievements. In both Grades 4 and 9, we found significant negative trends in student cohorts' average achievement in reading, listening, and orthography for students with SEN-L taught at regular schools and their peers without SEN. Most trends were also significantly negative for students with SEN-L at special needs schools. Thus, our results indicate that all students, independent of their SEN-L status, the respective school type SEN-L students attended, and Grade (i. e., Grade 4 vs. 9, regular schools vs. special needs schools), were likely affected by

the negative consequences of pandemic-related restrictions of schooling.

In Grade 4, there were no significant differences between student groups in these trends, with the exception that the negative trend in orthography was more pronounced for students with SEN-L at special needs school than for students without SEN. In Grade 9, more group differences in the negative trends were found, particularly between students without SEN and their peers with SEN-L at regular schools, with larger negative trends for the latter. Concretely, this meant that SEN-L-R and SEN-L-S students did not differ in their achievement in reading and listening in 2022 (unlike in 2015), while SEN-L-R students continued to show an achievement advantage in orthography (see Appendix B).

One reason for the differences in the achievement trends between students without SEN and their peers with SEN-L in regular schools in Grade 9 could be the (missing) support provided by others. Students without SEN should be used to learning more independently in secondary school than students with SEN-L who depend on and are used to additional support by teachers or additional personnel, such as special

³ For results of regression models without interaction effects, see Appendix D.

education teachers or school assistants. During distance learning, there were fewer opportunities for such targeted support for students with SEN-L at regular schools. Thus, students with SEN-L were even more dependent on their parents who may not have been used to provide intensive support to their children in higher grade levels and who may not have been able to provide effective support due to their background (cf. Domina, 2005). This, then, should have resulted in stronger negative trends for SEN-L students in regular schools. As support was not assessed in 2015, however, we were unable to analyze it over time.

The assumption that the negative achievement trends we found are at least in part associated with the restrictions in schooling due to the COVID-19 pandemic is supported by the results of the multilevel analyses. The results revealed significant relations between some learning conditions during the pandemic and students' verbal achievements in Grades 4 and 9. The small magnitude of the relations is not surprising as students' test scores reflect competencies they acquired over the course of many school years, not only during the pandemic. In interpreting these effects, however, one should keep in mind that especially deficits in the verbal domain can cause cumulating problems in students' further academic career and beyond, as verbal competencies and skills are prerequisites for knowledge acquisition in all other domains. Thus, even the small effects found in the regression analyses should not be underestimated in their importance.

4.1. Limitations and future research

Our analyses are based on cross-sectional large-scale assessment data. Yet, cohort trend analyses as those for RQ 1 provide descriptive knowledge about negative (or positive) developments overall. We cannot be completely sure that the negative cohort trends are attributable to restrictions in the school system. Negative cohort trends for students in Grade 4 in Germany already occurred in the verbal domains between 2011 and 2016 (Stanat et al., 2017), but these were considerably smaller than between 2016 and 2021. For Grade 9, no significant achievement differences were found between 2009 and 2015 (Stanat et al., 2016). This pattern suggests that something happened between 2016 and 2021 and between 2015 and 2022 respectively that resulted in learning losses for students in elementary and secondary education. In addition, we examined the trends in students' average verbal achievements controlling for family background variables to ensure that the cohort differences were not due to changes in student composition and the negative cohort trends continued to emerge (see Appendix E). As our findings are also consistent with the results of other studies, both nationally and internationally, we are quite confident that the restrictions in schooling have contributed substantially to the negative trends we found.

The comparability of our results may seem questionable in two respects. First, the time intervals between assessments differ between Grade 4 (five years) and Grade 9 (seven years). Yet, the trends were negative for students in both grades, suggesting that they were affected by the pandemic-related restrictions of schooling. Second, countries differ in their approaches to educating students with SEN (e.g., Powell, 2009; Schwab, 2020) and how they handled the COVID-19 pandemic (OECD, 2023b; Schnepf et al., 2024). However, the trends we found in our study for fourth-grade students with SEN-L are largely in line with the results of Fuchs et al. (2023) who reported negative cohort trends in reading achievement for US second graders with SEN-L. This suggests that the general pattern of our results are not unique to Germany.

Future large-scale assessments should also include students with SEN in other domains to allow for domain-specific analyses of cohort trends. In addition, school subject-specific differences should be explored (cf. Betthäuser et al., 2023; Di Pietro, 2023). Recent empirical results suggest that the learning loss was successfully compensated in some subjects (e.g., Gambi & De Witte, 2024; Haelermans & Smeets, 2024; Schult & Schneider, 2024). Future research should therefore also analyze long-term achievement development of SEN-L students and evaluate the effectiveness of compensatory measures (e.g., Helm & Huber, 2023).

4.2. Conclusion

Examining cohort trends in SEN-L students' verbal achievements separately for primary (Grade 4) and secondary school students (Grade 9), our findings indicate negative trends in verbal achievements of students with SEN-L in the time period of the pandemic. School achievement at the second measurement was related to some learning conditions during the pandemic, providing additional support for the assumption that the found trends are possibly related to pandemic-related restrictions in schooling. The aim should be to strengthen the support for SEN-L students affected by the pandemic to make up for resulting learning deficits as much as possible. Yet, many of them will have left the school system by now. Although we will hopefully not have to face another pandemic any time soon, this cannot be precluded. In this case, it would be important to keep schools open as much as possible and to provide targeted support to students with SEN-L if school closures cannot be avoided.

CRedit authorship contribution statement

Rebecca Schneider: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Sebastian Weirich:** Writing – original draft, Methodology, Formal analysis. **Poldi Kuhl:** Writing – review & editing, Writing – original draft. **Stefan Schipolowski:** Writing – review & editing, Project administration, Investigation, Conceptualization. **Petra Stanat:** Writing – review & editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.learninstruc.2025.102228>.

Data availability

The authors do not have permission to share data.

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