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IQB Trends in Student Achievement 2016

The Second National Assessment of
German and Mathematics Proficiencies
at the End of Fourth Grade

Summary

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IQB Trends in Student Achievement 2016

In 2003 and 2004, the Standing Conference of the Ministers of Education and Cultural Affairs of the States in the Federal Republic of Germany (KMK) introduced educational standards for primary level and secondary level I detailing which competencies students are expected to have attained by the time they reach specific points in their school career in the subjects of German and mathematics (primary level and secondary level I), the foreign languages of English and French (secondary level I), and the natural sciences (secondary level I) (KMK, 2004a-c, 2005a-h). In accordance with the Standing Conference's (KMK, 2006, 2015a) long-term strategy for educational monitoring in Germany, the 16 federal states (*Länder*) also decided to implement regular studies assessing the extent to which educational standards are being met at the state level. The Institute for Educational Quality Improvement (IQB) at the Humboldt University of Berlin is responsible for conducting these assessments. The first cycle of surveys in the IQB's standards-based national assessments was completed with the studies of 2009 (secondary level I: German, English, and French), 2011 (primary level: German and mathematics), and 2012 (secondary level I: mathematics, biology, chemistry, and physics) (c.f. Köller, Knigge & Tesch, 2010; Pant et al., 2013; Stanat, Pant, Böhme & Richter, 2012). The IQB study conducted in 2015 (secondary level I: German, English, and French) marked the beginning of the second cycle. Its findings make it possible, for the first time, to analyze educational trends in relation to the attainment of educational standards (c.f. Stanat, Böhme, Schipolowski & Haag, 2016). The IQB Trends in Student Achievement 2016, whose results are summarized in the following, now also presents an analysis for the fourth grade in terms of changes in key areas of proficiency that have occurred within a period of five years. The findings reported for the IQB Trends in Student Achievement 2016 not only describe the extent to which fourth-graders were able to attain the assessed proficiencies in 2016, they also consider the extent to which the pattern of results has changed since 2011 on the basis of trend analyses.

The test items used in the surveys were developed by teachers in close consultation with experts in subject didactics. Their work was based on the educational standards of the Standing Conference and was conducted under the oversight of the IQB. The 2016 IQB study surveyed students' proficiency levels in German in the domains of *reading*, *listening*, and *orthography*. In the subject of mathematics, the five areas of proficiency (core themes) described in the educational standards were assessed: *numbers and operations*, *space and shape*, *patterns and structures*, *sizes and measurements*, as well as *data, frequency and probability*. In addition, a global scale of mathematic proficiency was created that summarizes all core themes.

To assist in interpreting students' results in the tests, the IQB worked closely with experts in subject didactics to develop proficiency level models based on the Standing Conference's educational standards. These models enable us to describe the demands that students with a specific test score will generally be capable of meeting. They also allow us to determine the extent to which students are meeting the Standing Conference's educational standards in the subject and domain at hand (attainment of the "normative" standard), and whether they have met the respective "minimum" or "optimal" standards. Minimum standards refer to a defined minimum level of proficiency that all students are expected to have achieved by the time they have reached a certain level of education. This minimum lies below the proficiency expectations of normative standards stipulated in the Standing Conference's publications. In contrast, optimal standards refer to proficiencies that can be attained with very good or excellent individual learning conditions and suitable learning opportunities. They exceed the expectations of the Standing Conference's educational standards by far.

Besides analyses on which level of proficiency fourth-graders have achieved as a whole, the 2016 IQB study also addresses the question to what extent differences in the proficiencies attained by students correlate with certain background characteristics. The study investigates differences in proficiency between girls and boys (gender disparities), correlations between social background characteristics and the proficiencies attained (social disparities), and differences in achievement between children from immigrant families and children without any immigration background (immigration-related disparities). Even if the expectation that an educational system can completely reconcile differences in initial conditions is unrealistic, it remains a generally accepted aim of education policy to reduce the disparities associated with the aforementioned background characteristics of students to the greatest extent possible.

Moreover, the report on the 2016 IQB study considers individual issues in a range of additional chapters that concern the key *conditions* of teaching and learning processes in addition to their *outcomes*. The analyses set out on the basis of the Standing Conference's long-term strategy for educational monitoring (KMK, 2015a), according to which educational achievement studies are to be used to examine key practical questions regarding school and teaching development. The focus theme chosen for the 2016 IQB study is primarily related to the issue of "dealing with heterogeneity", which the Standing Conference considers particularly relevant. Here, the analyses focus on students with special educational needs (SEN). However, the study also covers high-achieving students whose learning situation likewise calls for further research. The analyses of teachers' qualifications already conducted since the 2011 IQB national assessment are continued in another supplementary chapter. Furthermore, this supplementary chapter also considers aspects pertaining to the focus theme of "dealing with heterogeneity" and presents the results of the teachers' survey that relate to the joint instruction in regular schools of children with SEN and children without SEN.

Comparative perspectives in IQB Trends in Student Achievement 2016

In IQB Trends in Student Achievement 2016, we report findings on student proficiencies from three comparative perspectives:

From a *critical* comparative perspective, we explore the question of how the fourth-graders in the various states were distributed across the various levels of the proficiency models in 2016. We look in particular at what percentage of students achieved at least the normative standards, and what percentage failed to meet the minimum standards. Beyond that, we analyze the students' achievement of optimal standards.

From an *ipsative* or *temporal* comparative perspective, we are also able to describe changes over time (trend estimates) in IQB Trends in Student Achievement 2016. By linking temporal and critical perspectives, we can draw conclusions about the extent to which the distributions of students across proficiency levels in the various states changed between 2011 and 2016 – for instance, whether the percentage of children who fail to meet the minimum standards has declined over time, and whether the percentage who meet at least the normative standards has increased.

Thirdly, we analyze the results from a *social* comparative perspective. This allows us to see, for instance, which states have higher percentages of students meeting the normative standards, and which states have lower percentages of students meeting these standards.

After briefly describing important aspects of the population definition, sample, and reporting metrics used in IQB Trends in Student Achievement 2016, as well as the participation rates in the surveys, we summarize the key results of our analyses in the subjects of German and mathematics. This, of course, requires us to reduce the complexity of the highly differentiated picture obtained for each individual state to a certain extent. To draw robust conclusions from the results reported in IQB Trends in Student Achievement 2016, the pattern of findings in each state should be examined in more detail within the context of that state's educational system.

Population definition, sample, and reporting metrics

The target population of the 2016 IQB study encompasses fourth-grade students in Germany at all types of schools and thus includes students with special educational needs.¹ A representative sample of fourth-grade students from all 16 states of the Federal Republic of Germany was selected from this target population by means of a random selection process. A total of 29,259 fourth-grade students from regular schools and special education schools took part in the study.² On the basis of the data collected in IQB Trends in Student Achievement 2016, it is possible to draw conclusions for individual states and for Germany as a whole.

1 Only students with special educational needs in the domain of “mental development” as well as students who were taught in the German language for less than one year were excluded from the target population.

2 For practicality reasons under the given test conditions, only special education schools focusing on the domains of “learning”, “language”, and “emotional and social development” were considered in the sampling procedure.

Participation in the proficiency tests administered as part of IQB Trends in Student Achievement 2016 was mandatory at public schools in all states, both for the schools and students. The overall sample of 29,259 fourth-grade students corresponds to a weighted participation rate of 94 percent of the student population. This is at approximately the same level as in the assessments most recently conducted in the primary level in Germany: PIRLS/IGLU 2011 and TIMSS 2015. In the individual states, too, the rate of participation in the proficiency tests as part of the 2016 IQB study was high overall at 92 to 96 percent.

Along with the results of the proficiency tests, the information from the student and parent questionnaires is also significant for the data analyses as part of the 2016 IQB study. At an overall rate of 83 percent, the participation rate was lower for the student questionnaires than for the proficiency tests. In addition, the rate of participation in the student questionnaires differed considerably between states, which is due to the fact that only some states mandated questionnaire completion. For participation in the parent questionnaire, which was voluntary in all states, the rate of participation was 74 percent throughout Germany.

Information about the professional background, education, and country of birth of the participating students' parents is necessary to provide a basis for the analyses of social and immigration-related disparities. Since the profession and education of parents cannot be reliably obtained from the fourth-grade students, this information is only available for those parents who completed the parent questionnaire. However, entries from the student questionnaire can be used to determine the parents' country of birth.

As the reliability of analyses can be significantly impaired with a high degree of missing information, the findings for social and immigration-related disparities in IQB Trends in Student Achievement 2016 should be interpreted with caution if the necessary information is missing for 20 to 30 percent of the students. If there is no information for more than 30 percent of the children, no findings are reported. As a result of this rule, the findings reported on the social disparities for the states of Baden-Württemberg, Bavaria, Brandenburg, Hessen, Lower Saxony, North Rhine-Westphalia, Rhineland Palatinate, Saxony, Saxony-Anhalt, and Schleswig-Holstein can be presented only with reservation. No findings on social disparities can be reported for the states of Berlin, Bremen, Hamburg, and Saarland. Although the immigration-related disparities are reported for all states due to fewer cases of missing information on immigration background, the findings are presented with reservation for Hamburg and Saarland.

In order to present trends, it is necessary to depict the findings from various surveys on a common scale (metric). For this reason, the data obtained by IQB Trends in Student Achievement 2016 was carried over to the reporting metric of the IQB National Assessment 2011. This metric was defined in the individual domain such that the distribution of test values exhibited a mean value of $M = 500$ points and a standard deviation of $SD = 100$ points in the overall population of fourth-grade students in 2011. An exception was made only for the domain of *orthography*, for which the metric was set with a mean value of $M = 500$ points and the standard deviation of $SD = 100$ points for the population in 2016.

Proficiency level distributions in 2016 and trend analysis

The main findings of the analyses conducted as part of IQB Trends in Student Achievement 2016 on the achievement of educational standards for the subjects of German (*reading, listening, and orthography*) and mathematics (*global scale*) are summarized and categorized in the following. The salient trends are also outlined, and particular successes and challenges highlighted.

The summary of the findings for the proficiency level distributions explores three questions for each domain of proficiency: Which percentage of students achieve at least the normative standards, which percentage fails to meet the minimum standards and which percentage fulfils the optimal standards? After depicting the findings for 2016, we describe the findings of the trend analyses which show the extent to which the aforementioned percentages changed in comparison with 2011. The analyses of the achievement of educational standards in 2016 and in the trend refer to all fourth-grade students including children with special educational needs. However, we needed to exclude students following an alternative curriculum not leading to a regular school leaving certificate, since the Standing Conference's proficiency goals defined in the educational standards are not generally applicable for children who are educated with an alternative curriculum.

The domain of *orthography* is a special case: Since the survey for this domain was conducted in the IQB National Assessment 2011 such that no national analyses were possible and no students were included from special education schools, the trend analyses can only be performed for this domain for Germany as a whole and only for children without special educational needs.

Comparing proficiency level distributions in German in 2016

In the subject of German, around 66 percent of fourth-graders across Germany met or exceeded normative standards for *reading* in 2016. This was true of a good 68 percent for *listening* and around 54 percent for the domain of *orthography*. The percentage of students who failed to meet the minimum standard in these proficiency domains was around 13 percent, almost 11 percent and approximately 22 percent of students respectively. In Germany as a whole, around 10 percent of students achieved optimal-standard proficiency in both *reading* and *listening*, and almost 9 percent in *orthography*. Yet as Figures 1-3 show, the percentages vary widely between states.

In the domain of *reading*, approximately 26 percentage points separate the states with the highest and lowest percentages of students achieving at least the normative standard³ (74 percent in Bavaria and Saxony – 48 percent in Bremen). The top and bottom-scoring states were separated by 23 percentage points in the domain of *listening* (77 percent in Bavaria – 54 percent in Bremen) and by around 36 percentage points in the domain of *orthography* (68 percent in Bavaria – 32 percent in Bremen). The states of Bavaria, Saxony, and Schleswig-Holstein had significantly higher percentages of students who achieved at least the normative standard, both in *reading* and *listening*, compared to the national average. Moreover, the percentages of fourth-grade students who met or exceeded the normative standard in *orthography* in Bavaria and Saarland were far higher than the national average.

³ The differences indicated in the following are based on rounded percentages.

By contrast, the states of Berlin and Bremen had much lower percentages of students who achieved at least the normative standard, in all three proficiency domains, than Germany as a whole. Furthermore, a considerably lower percentage of fourth-graders met the normative standard in *reading* in North Rhine-Westphalia, in *listening* in Saxony-Anhalt, and in *orthography* in Hamburg and Lower Saxony compared with the national average.

With respect to the percentages of students who failed to achieve the minimum standards in German, results also vary widely by state. States with the highest and lowest percentages were separated by around 19 percentage points in *reading* (26 percent in Bremen – 7 percent in Saxony), around 14 percent in *listening* (21 percent in Bremen – 7 percent in Bavaria) and around 27 percentage points in *orthography* (40 percent in Bremen – 13 percent in Bavaria). When comparing the state data to the national averages, the results for the minimum standards present a similar picture to those for the normative standards. Again, Bavaria had a smaller percentage of students who performed below the minimum standard compared to Germany as a whole in all three proficiency domains. The percentage of students who failed to achieve the minimum standard was also significantly lower for *reading* in Saxony and Schleswig-Holstein than the national average, as well as for *listening* in Schleswig-Holstein and *orthography* in Saarland. However, outcomes were particularly poor relative to the national average for Berlin and Bremen across the board, as well as for Hamburg and Lower Saxony specifically in *orthography*.

The results of the states vary less significantly in relation to the percentage of students who achieved the optimal standards in German. The states with the highest and lowest percentages were separated by 8 percentage points in *reading* (13 percent in Bavaria – 5 percent in Bremen), around 9 percentage points in *listening* (14 percent in Hamburg and Saxony – 5 percent in Saxony-Anhalt), and 13 percentage points in *orthography* (16 percent in Saarland – 3 percent in Bremen). In Bavaria, a significantly higher percentage of students achieved the optimal standards in *reading* and *orthography* than the national average. The states of Hamburg and Saxony had a significantly higher percentage of fourth-graders who achieved the optimal standard than the national average in the domain of *listening*, whereas Saarland excelled in the domain of *orthography* in this respect. In contrast, a considerably lower percentage of students achieved the optimal standards in all three proficiency domains in Bremen, in *reading* in Thuringia, in *listening* in Rhineland-Palatinate and Saxony-Anhalt, and in *orthography* in Berlin, Brandenburg, Hamburg, Lower Saxony, and Thuringia compared to the national average.

Figure 1: Percentage of Fourth-Grade Students in Each State Who Fail to Meet the Minimum Standard in the Domain of *Reading* in German, or Who Meet or Exceed the Normative Standard, or Achieve the Optimal Standard in this Domain

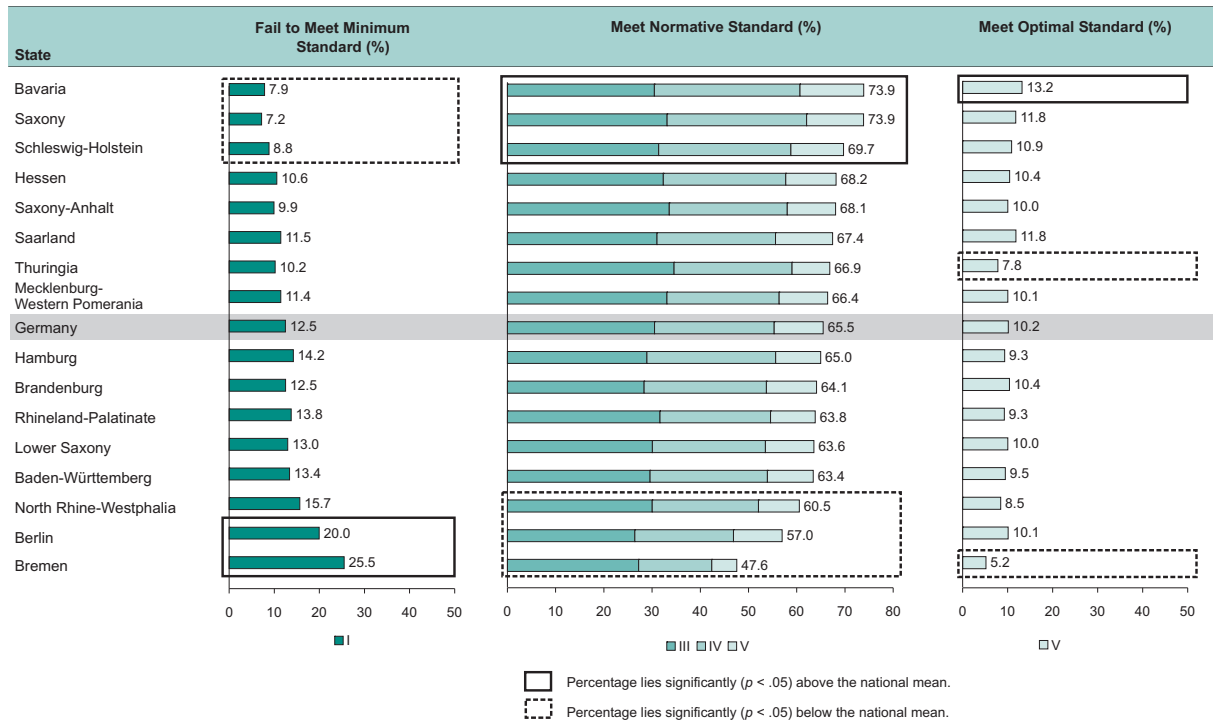


Figure 2: Percentage of Fourth-Grade Students in Each State Who Fail to Meet the Minimum Standard in the Domain of *Listening* in German, or Who Meet or Exceed the Normative Standard, or Achieve the Optimal Standard in this Domain

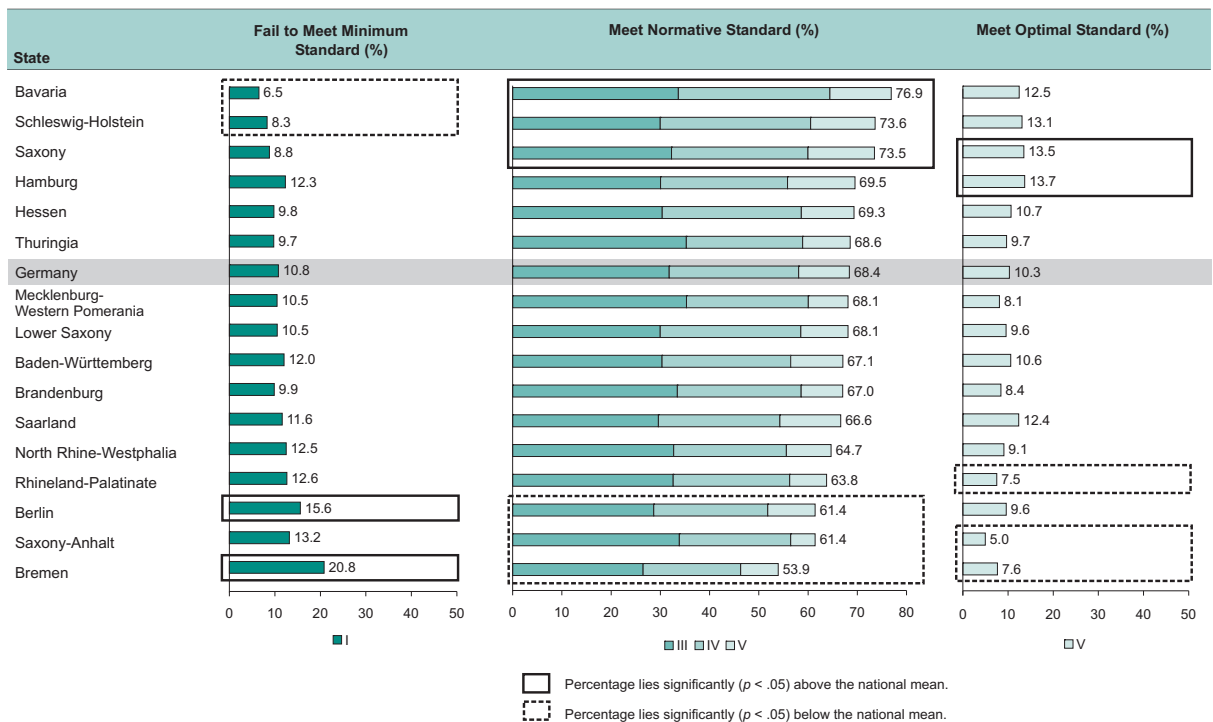
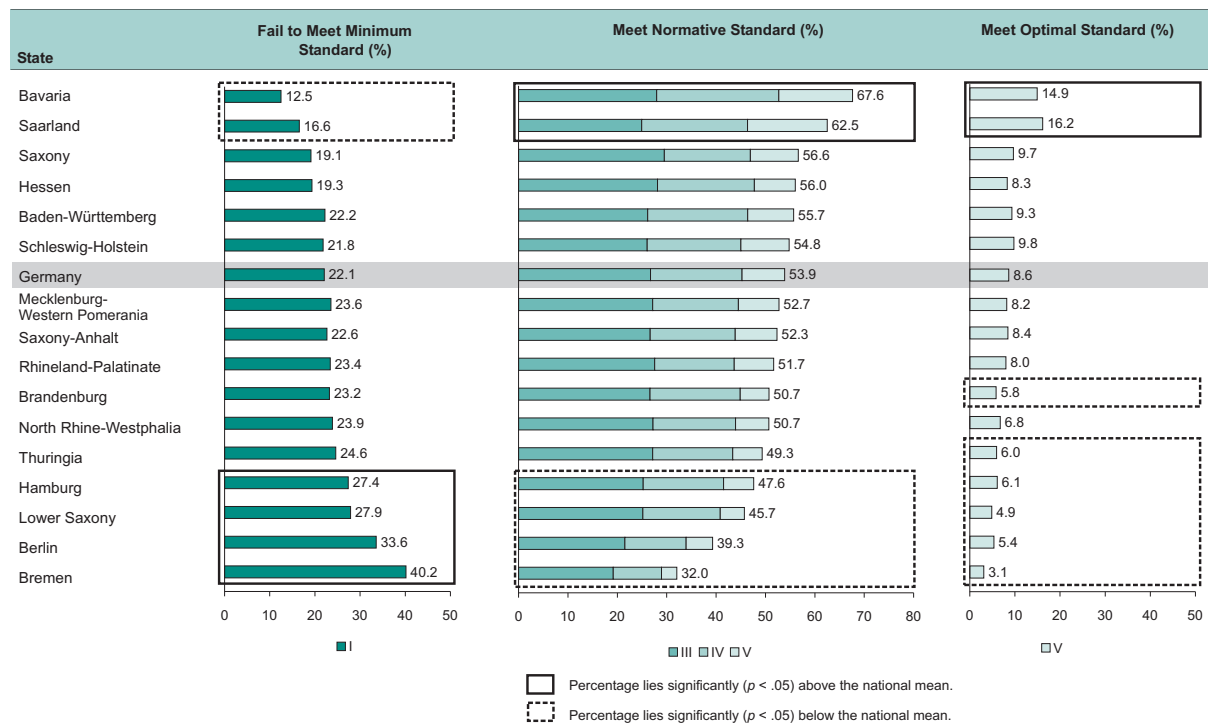


Figure 3: Percentage of Fourth-Grade Students in Each State Who Fail to Meet the Minimum Standard in the Domain of *Orthography* in German, or Who Meet or Exceed the Normative Standard, or Achieve the Optimal Standard in this Domain



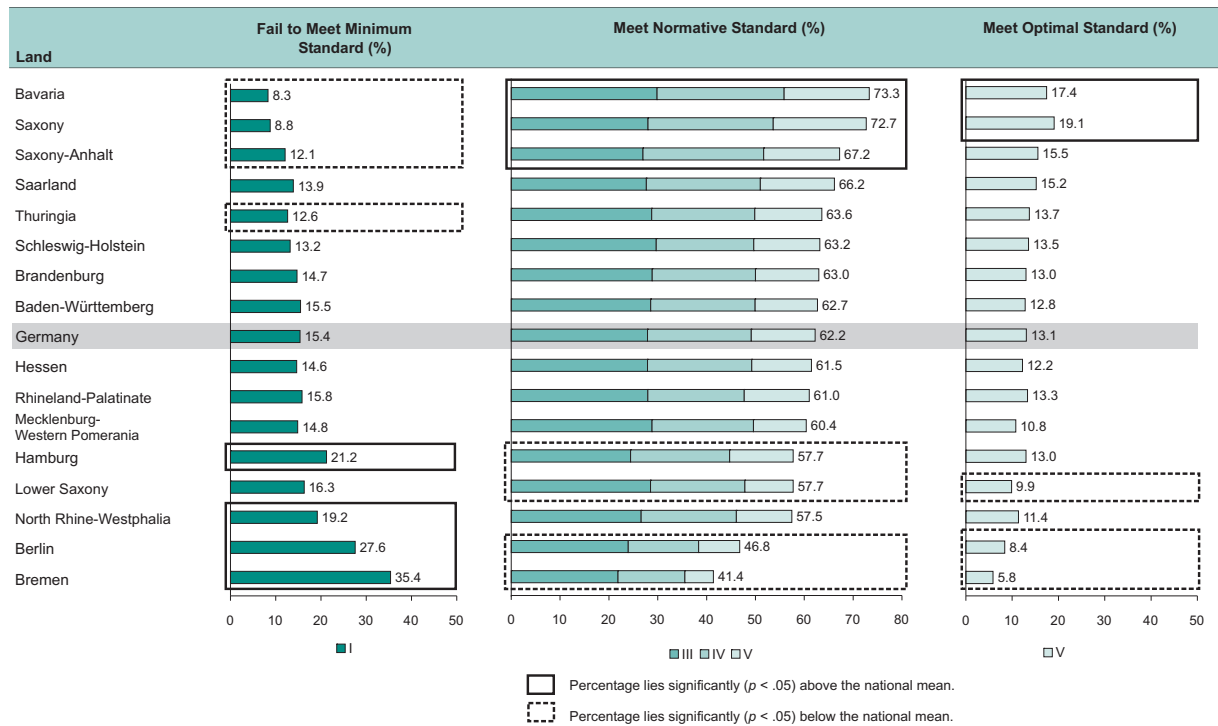
Comparing proficiency level distributions in mathematics in 2016

In the subject of mathematics (*global scale*), a good 62 percent of students in Germany met or exceeded the Standing Conference’s normative standard overall, while around 15 percent failed to meet the minimum standard. Around 13 percent of fourth-graders were able to demonstrate proficiency in mathematics that corresponds with the optimal standard. Figure 4 shows that these percentages also vary substantially between states in the subject of mathematics.

There are around 32 percentage points (73 percent in Bavaria and Saxony – 41 percent in Bremen) that separate the highest and lowest percentages of students who were able to achieve at least the normative standard on the global scale of mathematic proficiency. The states of Bavaria, Saxony, and Saxony-Anhalt had significantly higher percentages of students who achieved at least the normative standard compared to the national average. The percentage of children who achieved the normative standard was much lower than the national average in Berlin, Bremen, Hamburg, and Lower Saxony.

With respect to the percentages of students who failed to achieve the minimum standard in mathematics, results also vary widely by state. In mathematics, the state with the highest percentage is separated from the state with the lowest percentage by 27 percentage points (35 percent in Bremen – 8 percent in Bavaria). A particularly favorable pattern of results for achieving the minimum standards in mathematics can be seen in Bavaria, Saxony, Saxony-Anhalt, and Thuringia. Whereas in Berlin, Bremen, Hamburg, and North Rhine-Westphalia, the percentage of fourth-grade students who failed to achieve the minimum standard in mathematics is significantly higher than the national average.

Figure 4: Percentage of Fourth-Grade Students in Each State Who Fail to Meet the Minimum Standard in the Subject of Mathematics (*Global Scale*), or Who Meet or Exceed the Normative Standard, or Achieve the Optimal Standard in this Subject



The results of the states also vary less significantly in mathematics in relation to the percentage of students who achieved the optimal standards. The states with the highest and lowest percentages are separated by around 13 percentage points (19 percent in Saxony – 6 percent in Bremen). The percentages of students who achieved the optimal standard are significantly higher than the national average in Bavaria and Saxony, and significantly lower in Berlin, Bremen, and Lower Saxony.

Comparing proficiency level distributions in the subjects of German and mathematics in 2011 and 2016

Comparing the proficiency level distributions over the period of five years as depicted in Figures 5 to 7 also presents a differentiated picture. The bars projected towards the right in the figures show that the percentages of children in each state who achieved at least the normative standard, failed to meet the minimum standard, or achieved the optimal standard were higher in 2016 than in 2011; bars projected towards the left indicate that the relevant percentage has declined from 2011 to 2016.

In the subject of German, the findings for Germany as a whole in the domain of *reading* remained largely stable between 2011 and 2016. Only the percentage of students who achieved the optimal standard in *reading* has reduced significantly, although this change is small at just 2 percentage points. The domains of *listening* and *orthography* however, present significantly negative trends that have undergone a larger change. The percentage of fourth-graders who achieved at least the normative standard declined by around 5 percentage points in

listening, and even by around 10 percentage points in *orthography*. At the same time, the percentage of those who failed to meet the minimum standard rose by a good 3 percentage points or almost 8 percentage points respectively. Moreover, the percentage of students who achieved the optimal standard in *orthography* fell by around 4 percentage points.

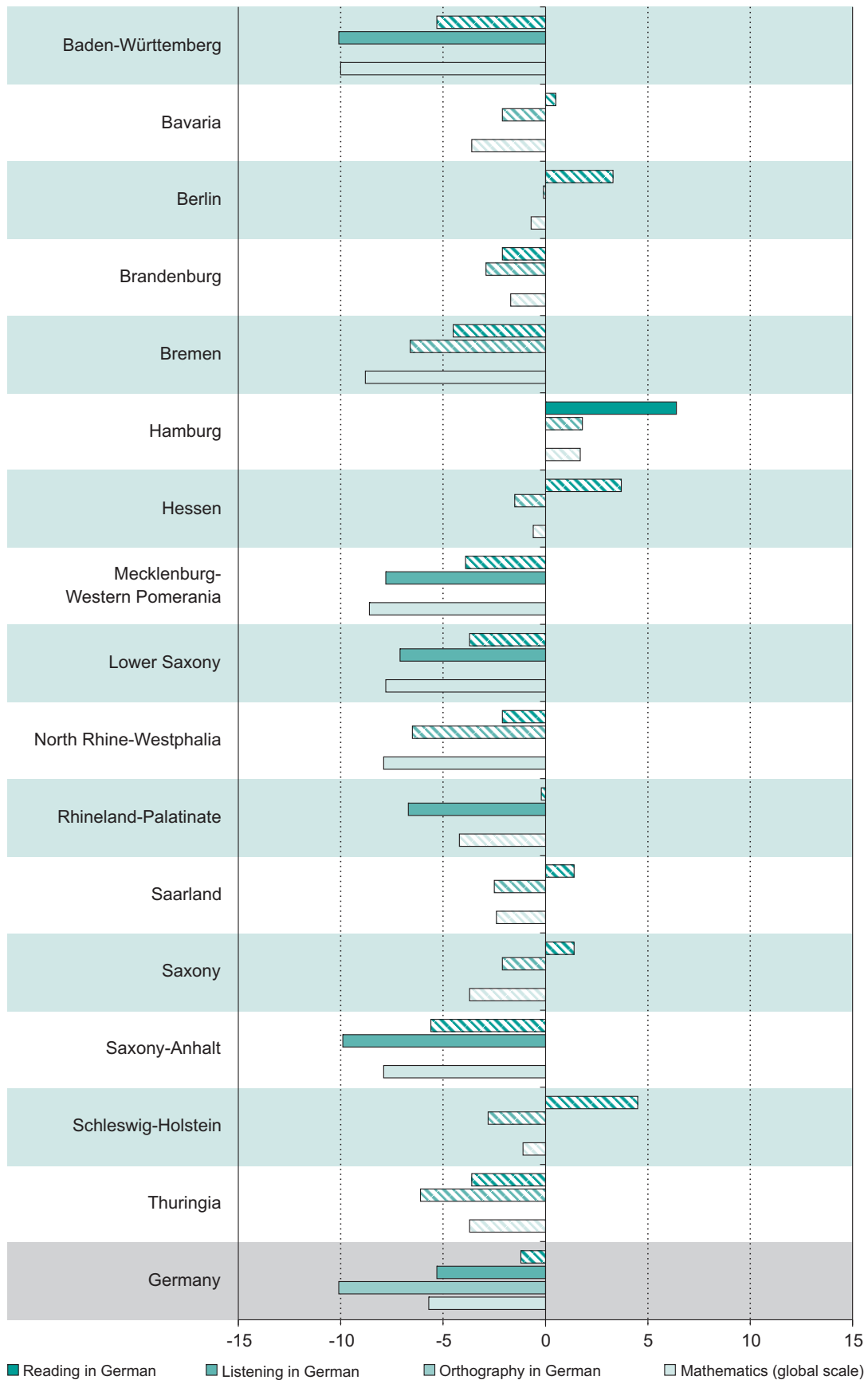
A significantly negative trend can likewise be observed for Germany as a whole in the subject of mathematics. Here, the percentage of fourth-grade students who met or exceeded the normative standard dropped by around 6 percentage points, and the percentage of students who failed to meet the minimum standard increased by almost 4 percentage points. In 2016, the percentage of students who achieved the optimal standard was 3 percentage points lower than in 2011.

In the individual states, too, a number of adverse trends are presented particularly for the proficiency domain of *listening* and the subject of mathematics. As no trends could be identified for *orthography* at the state level, Figures 5 to 7 are unable to present the findings for the states in this proficiency domain.

The states of Baden-Württemberg, Mecklenburg-Western Pomerania, Lower Saxony, and Saxony-Anhalt exhibit significantly negative trends for the achievement of the normative standards in both *listening* as well as mathematics. In the subject of mathematics, the percentage of students who achieved the normative standard in Bremen and North Rhine-Westphalia also declined significantly between 2011 and 2016. The trends in these states (including Bremen and North Rhine-Westphalia) for *listening* and mathematics are also adverse with respect to the minimum standard. In addition, a significantly negative trend can be observed in Rhineland-Palatinate in the domain of *listening*, both in terms of the normative standard as well as the minimum standard. Significantly positive trends are shown in only two cases: In Hamburg, the percentage of students who met or exceeded the normative standard in *reading* increased, while the percentage of students in Schleswig-Holstein who failed to meet the minimum standard in *reading* decreased.

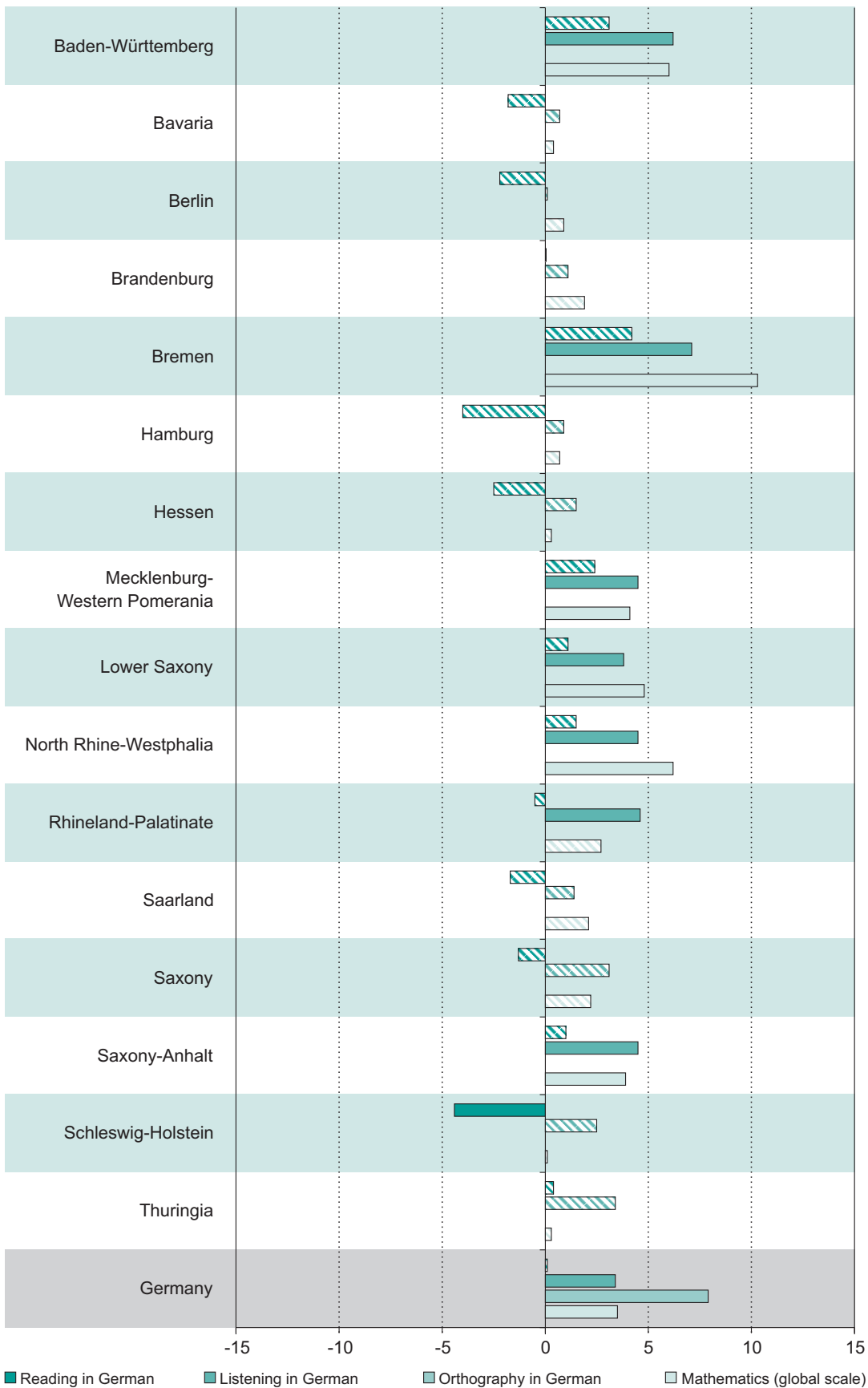
In relation to the optimal standards, a number of statistically significant trends can be observed at the state level, which were exclusively negative. The percentage of students who met the optimal standard in Saxony-Anhalt in *reading*, *listening*, and mathematics, in Lower Saxony in *listening* and mathematics, in Thuringia in *reading*, and in Baden-Württemberg and Mecklenburg-Western Pomerania in mathematics dropped significantly.

Figure 5: Changes in the Percentages of Fourth-Grade Students Who Meet or Exceed the Normative Standard Between 2011 and 2016 (in Percentage Points)



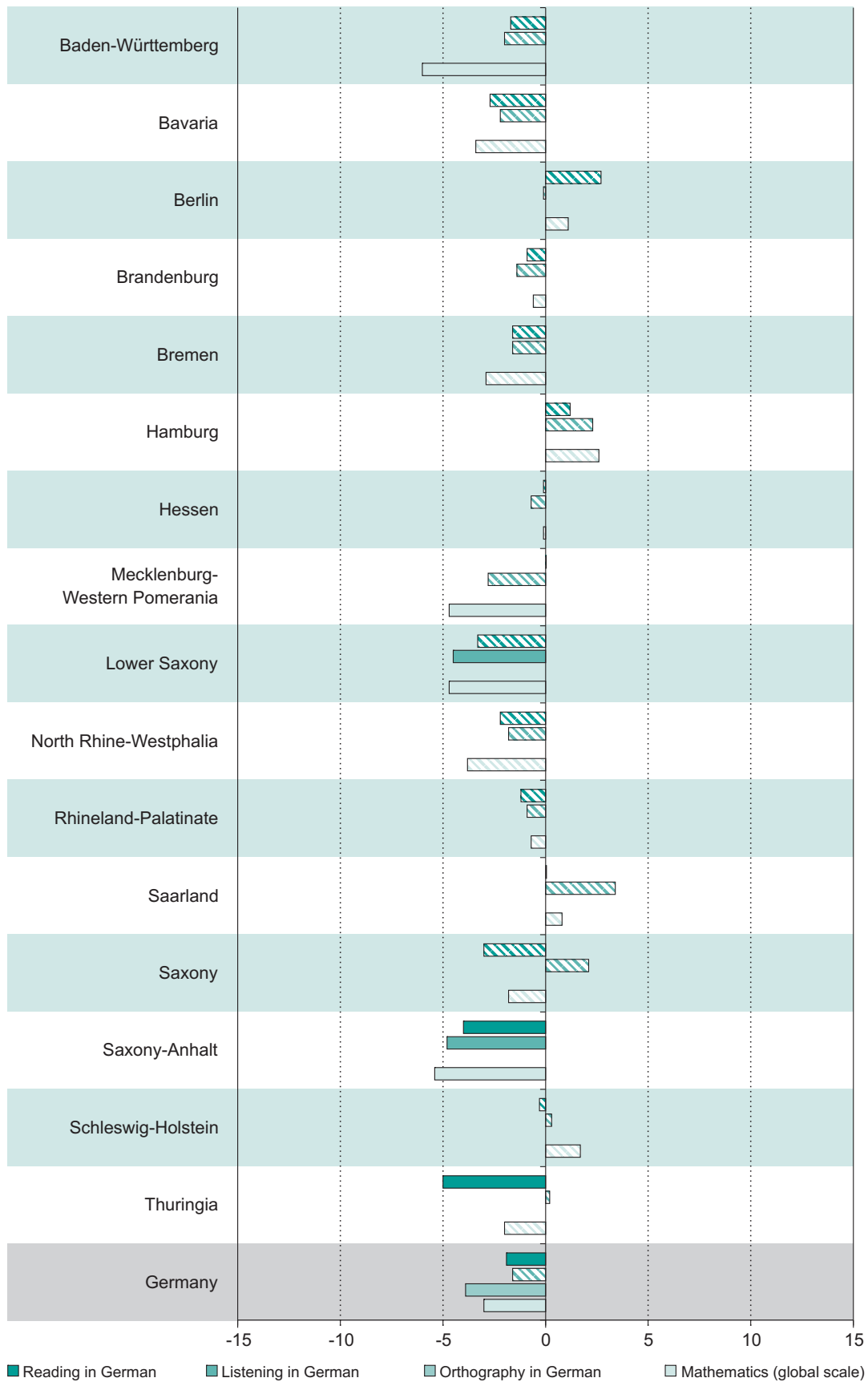
Notes. Hatched bars indicate statistically non-significant differences. For the proficiency domain of *orthography*, no trend analyses could be conducted at the state level.

Figure 6: Changes in the Percentages of Fourth-Grade Students Who Fail to Meet the Minimum Standard Between 2011 and 2016 (in Percentage Points)



Notes. Hatched bars indicate statistically non-significant differences. For the proficiency domain of *orthography*, no trend analyses could be conducted at the state level.

Figure 7: Changes in the Percentages of Fourth-Grade Students Who Meet the Optimal Standard Between 2011 and 2016 (in Percentage Points)



Notes. Hatched bars indicate statistically non-significant differences. For the proficiency domain of *orthography*, no trend analyses could be conducted at the state level.

Comparing mean proficiency levels in 2016 and in the trend

In addition to the distributions of students across proficiency levels, IQB Trends in Student Achievement 2016 also examined the average of achieved proficiencies across the various states. An overview is presented in Figure 8 for 2016; it shows the extent to which the mean proficiency score of students in each state deviates from the national average.

Mean proficiency levels in German and mathematics in 2016

The pattern of findings on the mean proficiency levels are very similar to the pattern of findings for the achievement of educational standards, as could be expected (c.f. Fig. 8). Significantly positive deviations from the mean levels for Germany as a whole can be observed for Bavaria on a consistent basis. In Saxony, too, the mean proficiency levels of students were significantly higher than the national average in almost all proficiency domains (*reading, listening, and mathematics*). Positive deviations can also be seen in individual proficiency domains for Saarland (*orthography and mathematics*), for Saxony-Anhalt (*mathematics*), and for Schleswig-Holstein (*reading and listening*). In contrast, the mean values for Berlin and Bremen consistently lie significantly below the national average. A number of significantly negative trends are likewise evident for Hamburg and Lower Saxony (*orthography and mathematics*), North Rhine-Westphalia (*reading and mathematics*), Rhineland-Palatinate and Saxony-Anhalt (*listening*), as well as Thuringia (*orthography*).

The highest and lowest mean proficiency levels achieved in the states for German are separated by 70 points in *reading*, 61 points in *listening* and 91 points in *orthography*. If these differences were considered in relation to rough estimates for the increase in proficiency that would be expected within a school year at the end of the primary level, the mean differences would correspond to around one school year of learning time in all three domains. In the subject of mathematics, the highest and lowest mean value for the states are separated by 90 points, which likewise equates to a difference of approximately one school year.

Figure 8: Deviations of Fourth-Grade Students' Mean Proficiency Scores in Each State from the German National Mean in 2016



Note. Hatched bars indicate statistically non-significant differences.

Figure 9: Changes in the Mean Proficiency Levels of Fourth-Grade Students Between 2011 and 2016



Notes. Hatched bars indicate statistically non-significant differences. For the proficiency domain of *orthography*, no trend analyses could be conducted at the state level.

Comparing mean proficiency levels in German and mathematics in 2011 and 2016

The trend estimates for the mean values largely replicate the pattern of findings produced by the trend estimates for the achievement of educational standards, although the changes in the mean values are more frequently significant (c.f. Fig. 9). In Germany as a whole, the mean proficiencies achieved in both subjects in 2016 are significantly lower in 2011. In the domain of *reading*, the reduction amounts to just 7 points, whereas the decline is much larger in the other domains examined. In 2016, the mean proficiency level achieved in Germany for *listening* fell 16 points short of the national average for 2011; over the same period, *orthography* declined by 24 points and mathematics by 17 points. At the state level, too, no significantly positive trends were observed either for German or mathematics. In contrast, significantly negative trends can be seen for the two proficiency domains in German that could be included in the trend analysis across states (*reading* and *listening*) as well as for mathematics in Bremen, Saxony-Anhalt, and Thuringia, for *listening* and mathematics in Baden-Württemberg, Mecklenburg-Western Pomerania, Lower Saxony, and North Rhine-Westphalia, and for *listening* in Rhineland-Palatinate. In all other states (Bavaria, Berlin, Brandenburg, Hamburg, Hamburg, Saarland, Saxony, and Schleswig-Holstein), the mean proficiencies in the three domains examined in the trend have remained stable between 2011 and 2016.

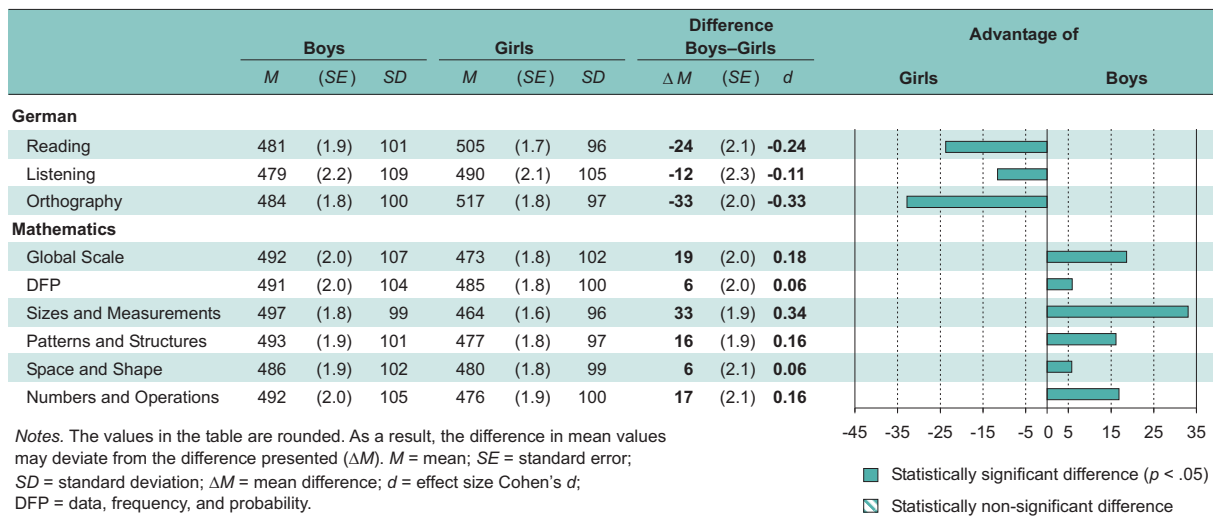
Gender, social and immigration-related disparities

In the intense discussions on educational equality, the question to what extent the promotion of proficiency development in various groups of children and youths is successful is ascribed particular importance. The educational systems of all states aim to reduce existing inequalities. For this reason, IQB Trends in Student Achievement 2016 includes analyses of gender, social and immigration-related disparities.

Gender disparities

The findings of the analyses of gender disparities show that there are significant differences in the achieved level of proficiencies between boys and girls in all proficiency domains examined in German and mathematics in 2016 (c.f. Fig. 10). The differences correspond with common expectations: In German, girls achieved higher proficiencies than boys on average; here, the difference in *orthography* is greatest (33 points), followed by the differences in *reading* (24 points), and in *listening* (12 points). However, in mathematics, boys attained higher levels of proficiency than girls on average, both on the global scale (19 points), as well as in all substantive domains of proficiency (from 6 points in the domain of *data, frequency, and probability*, as well as *space and shape*, up to 33 points in *sizes and measurements*). Gender disparities are evident in both the lower as well as median and upper area of proficiency distributions.

Figure 10: Proficiency Differences Between Boys and Girls in German and Mathematics for Germany Overall



The pattern of findings for the individual states is very similar to that for Germany as a whole. In all states, girls exhibit a significant proficiency advantage in *reading* and in *orthography* in German, while boys demonstrate a significant proficiency advantage in mathematics. An exception can only be seen in the proficiency domain of *listening* in German; here, no significant gender disparities are presented in the majority of states. In the state of Bremen, the gender disparities are particularly small in all examined domains in the subject of German. On the other hand, girls demonstrate a significant advantage in all three domains in German in the states of Brandenburg and North Rhine-Westphalia, and the tendency in each case is more distinct than in Germany overall. On the global scale in mathematics, the lowest gender disparities can be found in Schleswig-Holstein, while these disparities are particularly wide in Berlin, Bremen, Hamburg, and Thuringia.

Between 2011 and 2016, gender differences in the examined proficiency domains have not undergone any significant change, either in Germany as a whole or in each of the states. The only exception can be seen in the domain of *listening* in German, where the difference between the mean proficiencies of boys and girls in Germany overall has increased significantly, by 9 points. At the state level however, this trend is only statistically significant in one state (North Rhine-Westphalia).

On average, both boys and girls indicate that they have a high interest in the subjects of German and mathematics. A large majority of both sub-populations also consider their own level of proficiency to be high. Overall, the motivation of students towards the respective subjects appears to be highly positive at the end of primary-level education. At the same time, however, differences exist between boys and girls in the examined motivational aspects which reflect the same direction as the gender disparities in the examined domains of proficiency. The pattern of findings for the subject of mathematics can be taken as an indicator that girls perceive their own mathematical proficiency to be lower than equally proficient boys. Since students' self-perception of their own proficiencies can have an effect on the progression of interest and proficiency development, and on subsequent course and career choice, it may contribute to the solidification or even strengthening of gender disparities in the subject of mathematics.

Social disparities

The question to what extent students' acquisition of proficiency correlates with aspects of their social background, and to what extent this correlation can be reduced, constitutes one of the main issues of educational monitoring. For this reason, the IQB Trends in Student Achievement 2016 study examines social disparities and investigates the extent to which they have changed since 2011. Due to the high degree of missing data pertaining to the students' socioeconomic background, no findings regarding the relationship between social background and proficiency can be reported for the city states of Berlin, Bremen, and Hamburg, nor for Saarland. The findings of these analyses therefore provide an incomplete picture of social disparities in Germany.

In line with the findings of earlier studies, the results of IQB Trends in Student Achievement 2016 show that the social composition of students varies only marginally between the states that could be included in the analyses.⁴ Compared to 2011, the mean socioeconomic background in 2016 has remained largely stable. Social heterogeneity – measured by the variation of socioeconomic status – has, however, increased significantly both in Germany as a whole and in the individual states (Lower Saxony, Rhineland-Palatinate, Saxony, and Schleswig-Holstein), although the change is not very large. Analyses of the distribution of students' social heterogeneity show that the differences in fourth-graders' socioeconomic background lie around 85 percent within schools nationally, and around 15 percent between schools. This distribution differs neither between the states, nor between 2011 and 2016. In primary level education, the social composition of students taught by teachers in their classes is therefore highly heterogeneous.

In 2016, the correlation between social background and the proficiencies achieved by fourth-graders is substantial for all examined domains of proficiencies, both for Germany as a whole and in all federal states: A higher social status is accompanied by higher scores in the proficiency tests (for an exemplary representation of the social gradients⁵ and their changes over time, see Figure 11 for the domain of *reading* in German and Figure 12 for the global scale in mathematics). However, the social gradients in the domain of *orthography* lie at 30 points, somewhat lower than in the domains of *reading* and *listening*, and in mathematics (each around 40 points). Accordingly, the orthographic proficiencies appear to depend less strongly on the family's social status than the other proficiencies. Between the states that could be included in the analyses, there were no substantial differences in the degree of correlation between social background and proficiency in 2016.

Likewise, there were scarcely any differences in the social gradients between 2011 and 2016. In the domain of *listening* and in mathematics, the disparities in Germany have actually increased slightly overall. However, the changes are quite small and in the two other domains of proficiency – *reading* and *orthography* – no significant changes could be observed nationally. Only two states exhibit a significantly higher correlation in 2016 between social background and proficiency in one domain respectively than in 2011: Baden-Württemberg in *reading* and Saxony in *listening*.

4 In earlier studies in which all states could be included in the analyses, the variance of socioeconomic status tended to be higher in the city states than in the regional states.

5 Social gradients describe the linear relationship between the socioeconomic status of the family and the proficiencies achieved by the students. They indicate how many points on the reporting metric students would achieve on average, if the value for the socioeconomic status of their family were one standard deviation higher.

Figure 11: Comparing Social Gradients in the Domain of Reading in German Between 2011 and 2016

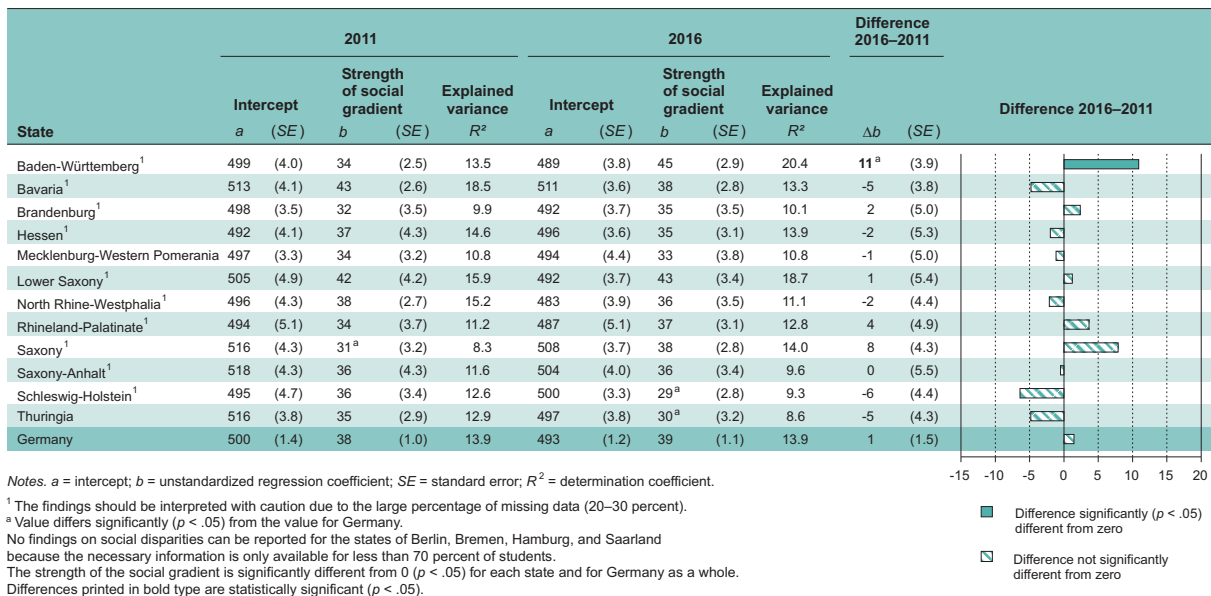
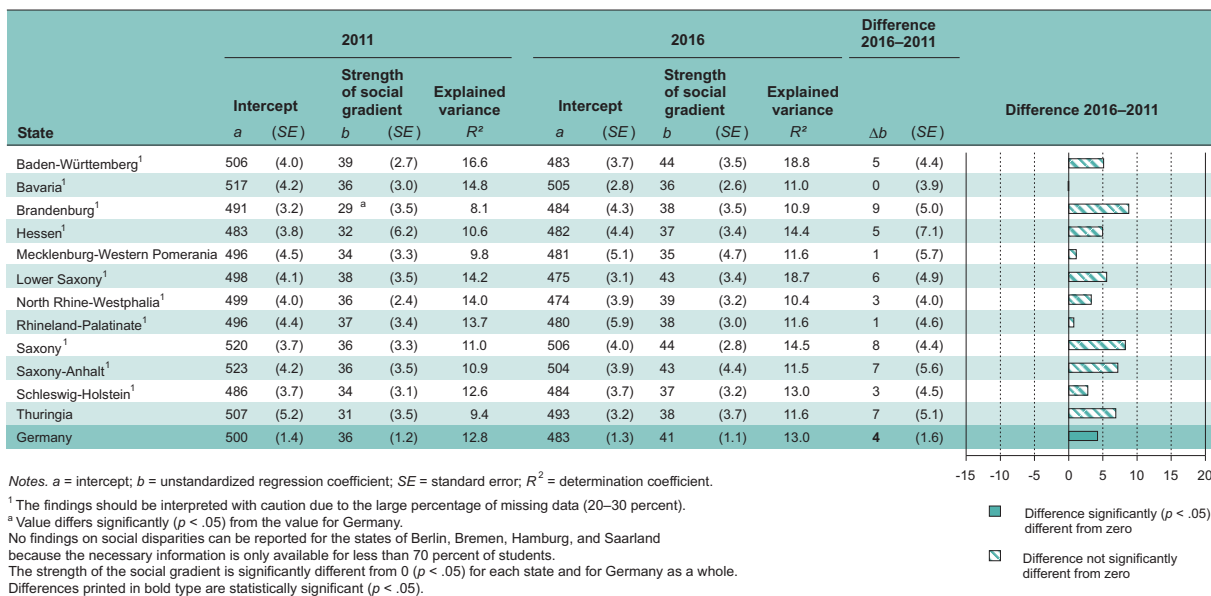


Figure 12: Comparing Social Gradients in Mathematics (Global Scale) Between 2011 and 2016



Immigration-related disparities

The extent to which there are immigration-related disparities in school education is likewise one of the key questions of educational monitoring; it has therefore been examined once again in IQB Trends in Student Achievement 2016. The findings show that the percentage of fourth-graders with an immigration background (at least one parent born abroad) in Germany overall has increased by 9 percentage points since 2011, lying at around 34 percent in 2016. An increase – albeit to varying degrees – can be observed in almost every state and is primarily due to the higher percentage of children with a parent born abroad as well as second-generation children (children born in Germany with immigrant parents). However, the percentage of children who were themselves born abroad and im-

migrated to Germany with their families (first generation) has risen much less sharply between 2011 and 2016; it increased by only around 2 percentage points for Germany as a whole.⁶

Analyses of the distribution of children with an immigration background exemplify that primary-level schools vary widely in their immigration-related composition. While less than 5 percent of children had an immigration background in around 13 percent of schools in Germany, the percentage of children from immigrant families amounts to at least 40 percent in around a quarter of schools. This distribution has changed in comparison with 2011: The percentage of school with particularly few children with an immigration background has fallen, while the percentage of schools with a higher proportion of children with an immigration background has risen.

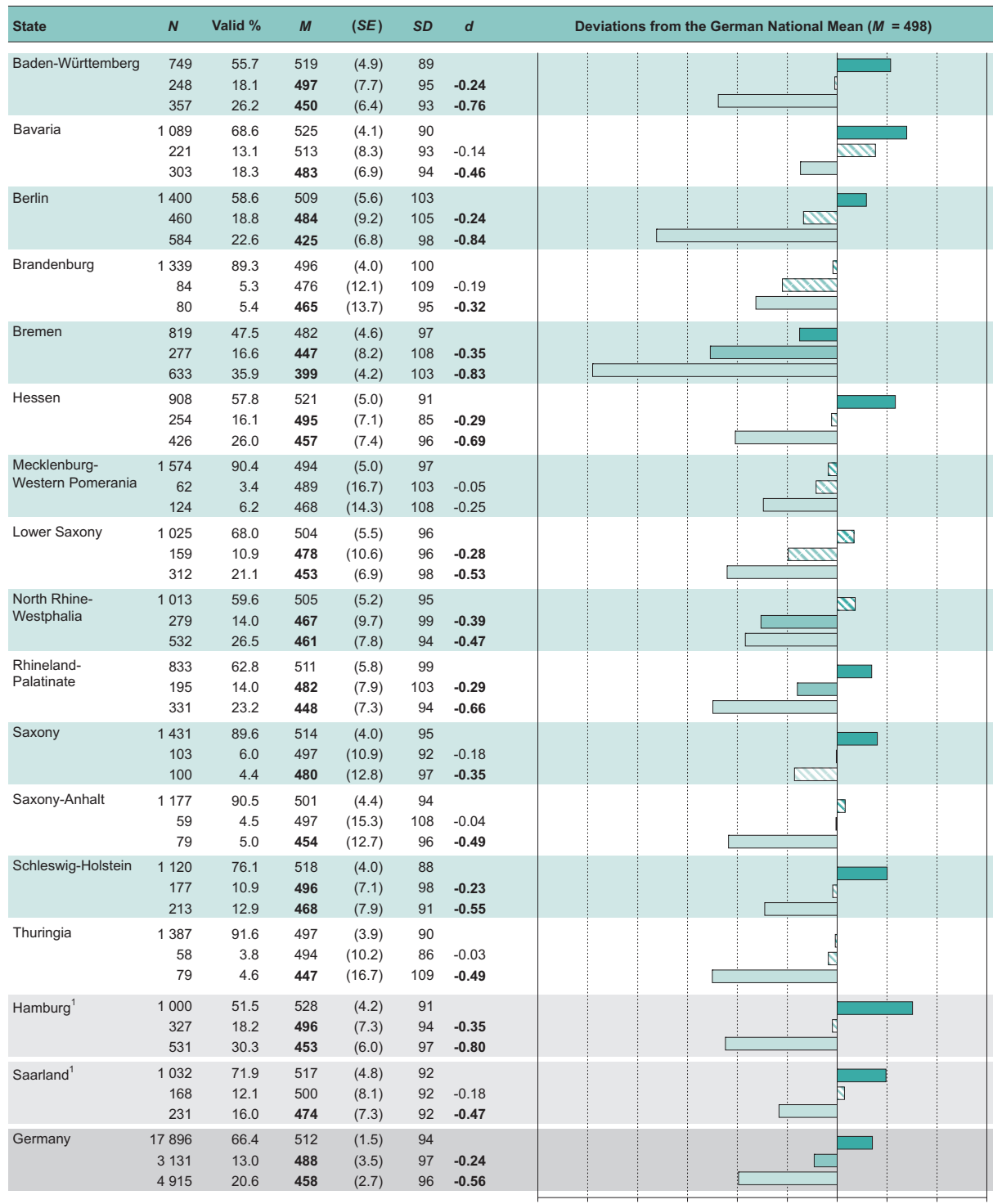
In the subject of German in 2016, children from immigrant families had significant disadvantages in all examined domains of proficiencies; these disadvantages were greatest in *listening* and smallest in *orthography*. An illustrative example is offered in Figure 13 for the immigration-related disparities in the domain of *reading* in German. In mathematics in 2016, there were likewise proficiency differences to the disadvantage of children with an immigration background; these differences were similar in scale to the disparities in *reading* (c.f. Fig. 14). At the national level, the disparities for children from the first generation of immigrants were the greatest, as could be expected, while they were much lower for children from the second generation of immigrants. This could indicate that integration through schooling is increasingly more successful with each successive generation.

Moreover, the proficiency disadvantages of students with two foreign-born parents are significant in almost every state, while the proficiency disadvantages of students with one foreign-born parent are only statistically significant in some states. However, the extent of the disparities varies widely between states. Particularly large disparities can be found in the city states of Berlin, Bremen, and Hamburg, although the findings for Hamburg should be interpreted with caution due to the significant percentage of missing data. In some of the regional states in eastern Germany, the proficiency disadvantages are particularly low. However, the percentage of students from immigrant families is relatively low in these states.

Trend analyses were also conducted for immigration-related disparities in 2016. Besides changes in the mean proficiency levels achieved within individual groups, it is interesting to note whether the immigration-related disparities have changed. This would be the case, for instance, if the mean levels of proficiency achieved by children from immigrant families had increased more sharply than the proficiency of children without an immigration background. Significant changes in the immigration-related disparities can only be seen to a limited extent for the domain of *listening* in German and for mathematics; here, the disadvantages in the proficiency levels of children with an immigration background have increased.

6 The significant rise in immigration that began during 2015 is not yet reflected in the data of IQB Trends in Student Achievement 2016. Newly immigrated students who do not speak German as a native language, who have been taught in German for less than one year, and who were not able to read or speak in German did not take part in the tests. Thus, children who began a German school after the spring of 2015 were not typically included in the survey.

Figure 13: Means and Standard Deviations of Proficiency Scores, as well as Group Differences and Deviations from the German National Mean in the Domain of *Reading* in German by Immigration Status and State in 2016



Notes. The values in the table are rounded. As a result, the sum of percentages per state may differ marginally from 100.

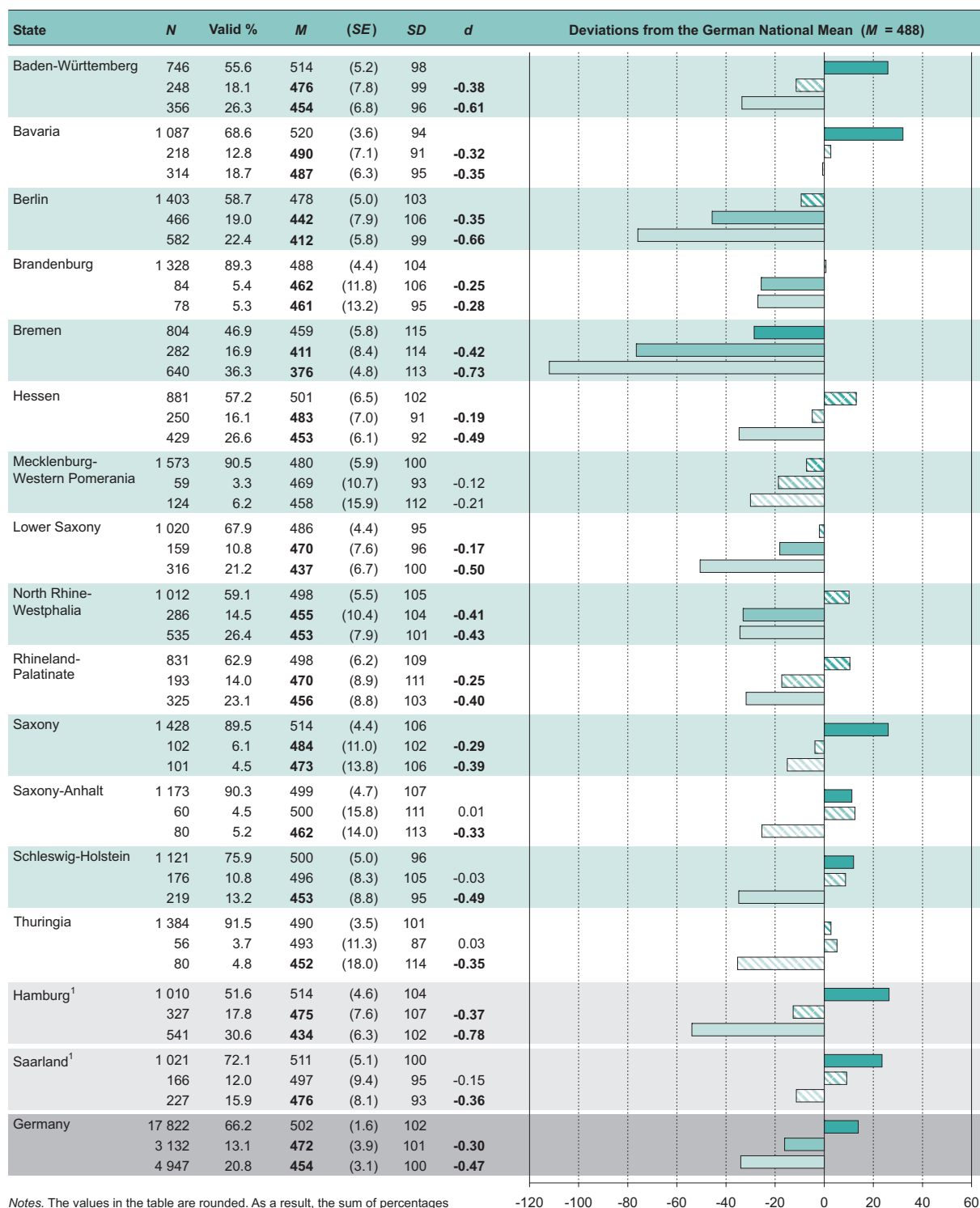
- 1. line: Students without an immigration background (both parents born in Germany)
 - 2. line: Students with one foreign-born parent
 - 3. line: Students with two foreign-born parents
- N = sample size of students; M = mean; SE = standard error; SD = standard deviation; d = effect size Cohen's d.

¹ The findings should be interpreted with caution due to the large percentage of missing data. Mean values printed in bold indicate a statistically significant deviation ($p < .05$) from the means for children without an immigration background.

Hatched bars indicate statistically non-significant differences from the German national mean (M = 498).

- No immigration background
- ▨ One foreign-born parent
- Two foreign-born parents

Figure 14: Means and Standard Deviations of Proficiency Scores, as well as Group Differences and Deviations from the German National Mean in the Subject of Mathematics (*Global Scale*) by Immigration Status and State in 2016



Notes. The values in the table are rounded. As a result, the sum of percentages per state may differ marginally from 100.
 1. line: Students without an immigration background (both parents born in Germany)
 2. line: Students with one foreign-born parent
 3. line: Students with two foreign-born parents
 N = sample size of students; M = mean; SE = standard error;
 SD = standard deviation; d = effect size Cohen's d.

¹ The findings should be interpreted with caution due to the large percentage of missing data. Mean values printed in bold indicate a statistically significant deviation ($p < .05$) from the means for children without an immigration background. Hatched bars indicate statistically non-significant differences from the German national mean ($M = 488$).

■ No immigration background
 ▨ One foreign-born parent
 ▩ Two foreign-born parents

Figure 15 presents the trend analyses for the subject of mathematics as an example. In this figure, statistically significant changes in the disparities over time are marked with a superscript “a” in the column ΔM .⁷

Overall, the trend analyses indicate that the differences in proficiency levels associated with immigration background have remained largely stable in both of the subjects examined between 2011 and 2016. In addition, it is evident that, in 2016, both children with an immigration background as well as children without an immigration background achieved lower levels of proficiency on average in the domains of *listening* and *orthography* in German as well as in mathematics than in 2011. The negative trends observed for the overall population of fourth-graders are therefore not limited to individual groups of students.

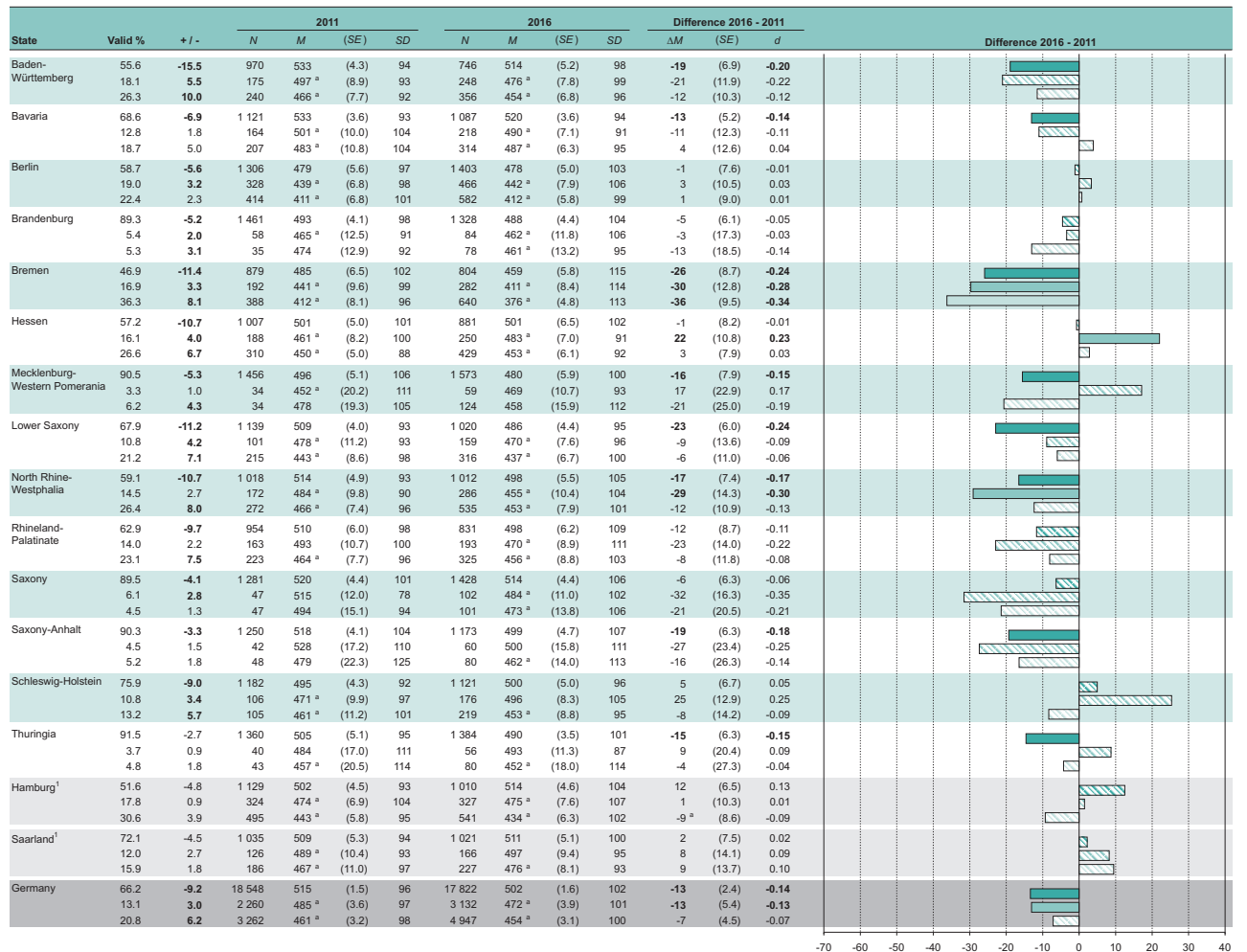
The immigration-related disparities can partly be attributed to the social backgrounds of students: In cases of the same socioeconomic background, the proficiency differences between children with and children without an immigration background are much lower. Moreover, the language spoken in the family is clearly significant: Taking into account the socioeconomic status of the family, the level of education, and the parents’ country of birth, the proficiency scores for German and mathematics achieved by students whose families speak German “sometimes” or “never” are significantly lower than for students whose family language is exclusively German.

These findings re-emphasize how important it is to provide suitable learning opportunities for acquiring and continually developing educational proficiencies in German, the language in which teaching is conducted – particularly for children whose language of origin is not German.

In addition to disparities in acquiring proficiencies, the report on IQB Trends in Student Achievement 2016 also presents analyses on indicators for the social integration and school motivation (subject-specific learning enjoyment) of students for the first time for the primary level. The findings show that children feel well-integrated in their schools – regardless of their immigration status – and that children with an immigration background sometimes even feel more satisfied with their school than children without an immigration background. School motivation among students from immigrant families is at least as high as for students without an immigration background. This could be used as a resource for the ongoing learning process.

7 Further national analyses in the report of IQB Trends in Student Achievement 2016, which distinguish between the first generation of immigrants (both parents and child born abroad) and the second generation of immigrants (both parents born abroad and the child born in Germany) or between groups of different ethnic origin, also indicate cases of reduced immigration-related disparities in some domains of proficiency in German and mathematics.

Figure 15: Comparing Means and Standard Deviations of Proficiency Scores as well as Group Differences in Mathematics (*Global Scale*) by Immigration Status Between 2011 and 2016



Notes. The values in the table are rounded. As a result, the difference in mean values may deviate from the difference presented ΔM and the sum of percentages per state may differ marginally from 100.
 1. line: Students without an immigration background (both parents born in Germany)
 2. line: Students with one foreign-born parent
 3. line: Students with two foreign-born parents
 +/- = Change compared to the IQB National Assessment 2011; N = sample size of students; M = mean; SE = standard error; SD = standard deviation;
 ΔM = mean difference; d = effect size Cohen's d.
¹ The findings should be interpreted with caution due to the large percentage of missing data.
^a Significant difference (p < .05) from children without an immigration background.

Dealing with heterogeneity

Besides the detailed description of the proficiency scores achieved by fourth-graders and disparities in acquiring proficiencies, additional analyses were conducted as part of IQB Trends in Student Achievement 2016 on dealing with heterogeneity. According to the Standing Conference’s long-term strategy on educational monitoring, this issue is of key importance for education policy (KMK, 2015a). The focus of the analyses lies on the one hand on children with special educational needs who play a central role in the current efforts for implementing inclusion. On the other hand, descriptive analyses are presented for particularly high-achieving students who have likewise become the subject of increased attention of education policy in recent years. For instance, the Standing Conference developed a strategy to promote high-achieving students (KMK, 2015b) and introduced an initiative “to promote high-achieving and potentially particularly high-achieving students” together with the federal government (KMK, 2016).

Students with special educational needs

Students with special educational needs at regular schools and special education schools also took part in IQB Trends in Student Achievement 2016; the publication offers a nationally representative basis of data for fourth-graders with special educational needs in the areas of “learning”, “language”, and “emotional and social development”. Descriptive analyses were conducted on three issues on the basis of this data: (1) congruence between officially determined special educational needs and special education needs provision, (2) correlations between the background characteristics of students with a determined special educational need and the type of school attended, and (3) correlations between the type of school attended by students with special educational needs and their proficiency scores and motivational characteristics.

In practice, students with special educational needs were included in the survey in each of the states on the basis of various criteria, whereby the officially determined special educational need played a role in some cases, while special education needs provision was applied in others. As it is unclear to what extent the groups of students identified using the two criteria match, this question was pursued on the basis of the data of IQB Trends in Student Achievement 2016. The findings show that there are significant overlaps between the criteria, but the corresponding groups of students are not fully congruent. The heterogeneity of the approaches in allocating special needs status should therefore be taken into consideration when collecting data on students with special educational needs in national surveys.

The analyses of correlations between various background characteristics of fourth-graders (gender, social background, and immigration background) with a determined special educational need and the type of school attended (special education school or regular school) indicate that primarily gender and social background are significant: Boys and children from families with a low social status more frequently have a determined special educational need and more frequently attend a special education school than girls and children from families with a high socioeconomic status. However, no significant differences can be observed between children from immigrant families and children without an immigration background in IQB Trends in Student Achievement 2016 with regard to the diagnosis frequency for a special educational need overall, nor for the frequency of special school attendance.

In order to find out in which type of school students with special educational needs in the areas of “learning”, “language”, and “emotional and social development” achieve more favorable results, comparisons were drawn between special education schools and regular schools taking into account a range of children’s background characteristics. To fulfill this objective, the proficiency scores achieved as well as motivational characteristics (subject-specific academic self-concept and interest) were considered in the subjects of German and mathematics. The findings indicate reverse associations between the type of school attended with school proficiencies on the one hand and school motivation on the other hand: While children with special educational needs achieved higher proficiency scores on average in regular schools, children with special educational needs in special schools demonstrated a higher level of school motivation on the whole. The strength of these correlations, however, varies depending on the domain of proficiency and the area of special educational need. The proficiency differences in favor of regular schools are more distinct for children with a

special educational need in the area of “learning” than for children with a special educational need in the area of “language”, whereas the children with a special educational need in the area of “emotional and social development” demonstrate no significant proficiency differences depending on the type of school attended. In terms of school motivation, there are differences in favor of special education schools which tend to be stronger for children with a special educational need in the area of “learning” and “emotional and social development” than for children with special educational need in the area of “language”. Particularly in regular schools, a key challenge is also designing lessons such, that they not only meet the individual needs of children with special educational needs with respect to their development of proficiencies, but also in relation to their motivational development.

High-achieving students

High-achieving students were identified in IQB Trends in Student Achievement 2016 on the basis of proficiencies included in the study. In the subject of German, children were classified as high-achieving if they met the optimal standard in at least one of the three tested domains (*reading, listening, and orthography*) and also did not fail to meet the normative standard in any of the proficiency domains. In mathematics, students were deemed high-achieving if they achieved the optimal standard on the global scale. The findings of descriptive analyses show that overall around 23 percent of fourth-graders were high-achieving in at least one of the two subjects examined. Here, the percentage of children who were high-achieving in German only is around 10 percent, while the percentage in mathematics is approximately 6 percent. Around 7 percent of students proved themselves to be high-achieving in both subjects. The findings confirm the familiar gender differences; in the fourth grade, girls obtained particularly high achievements in German more frequently than boys. This relationship is reversed for the subject of mathematics. In the group of children who were high-achieving in both subjects however, boys and girls were represented in similar proportions.

Although high-achieving children primarily grow up in families with a high social status and education level, this is not always the case: A third of students who were high-achieving in either German or mathematics exclusively have parents who did not obtain an “Abitur” qualification; in the group of children who were high-achieving in both subjects, this proportion is around a quarter. The analyzed motivational characteristics (parents’ assessment of motivation, self-reported interest in the subject, and self-concept) are strongly pronounced overall for high-achieving students. It is also pleasing to note that they even have a reduced feeling of boredom in class than those students who did not exhibit a particularly high level of achievement in any of the examined subjects. On the whole, it seems that primary level schools are thus succeeding in designing lessons in a manner that is also motivationally stimulating for children who have already achieved the level of optimal standards.

Qualification of teachers and teachers' attitudes towards joint instruction of children with and without special educational needs

Since teachers play a central role in students' acquisition of proficiencies, the IQB studies on educational monitoring always include surveys of teachers, which are used for descriptive analyses. Besides a description of the teaching body using demographic characteristics, the reports examine teachers' professional qualifications in particular and address the question, to what extent do students achieve higher levels of proficiencies when they have teachers who have studied their taught subject during their teaching studies or have obtained a teaching qualification for the subject. These analyses were continued in IQB Trends in Student Achievement 2016.

Moreover, the teachers' survey in the 2016 IQB study also included questions for the first time that related to joint instruction for children with and without special educational needs, and thus likewise addressed the key topic of how heterogeneity is handled. In particular, it encompasses teachers' qualifications in special needs education, their perceived need for further training, as well as their attitude towards, and experience with, teaching classes including children both with and without special educational needs.

Overall, 1,784 teachers at regular schools throughout Germany participated in the teachers' survey in IQB Trends in Student Achievement 2016.⁸ The findings on their qualifications show that the percentage of teachers who have not studied their taught subject, either as their study subject or as a main focus within a larger study program, is higher in mathematics than it is for German; this is true for Germany as a whole as well as within the states. The national percentage of teachers who did not study their taught subject in the sample of IQB Trends in Student Achievement 2016 lies at around 19 percent in German and a good 31 percent in mathematics. The percentage of teachers in mathematics who do not have a subject-specific qualification is particularly high in the states of Baden-Württemberg, Rhineland-Palatinate, and Saarland. In contrast, this percentage is particularly low in the states of Mecklenburg-Western Pomerania, Saxony-Anhalt, and Thuringia. Moreover, the percentage of career changers who teach the participating classes without having studied teaching is very low, at one percent for both German and mathematics teachers respectively.

Analyses on whether the qualification of teachers in German and mathematics correlates with the proficiency scores of their students show that this is not the case. Neither in German nor in mathematics are the proficiency differences between students whose teachers have not studied their taught subject and students whose teachers have studied their taught subject statistically significant. This finding deviates from the results of corresponding analyses in secondary level I, which presented significant proficiency disadvantages among students taught by teachers who have not studied their taught subject, especially at non-grammar schools. Accordingly, teachers' subject-specific expertise, as attained by a subject-related university education, seems to be of greater importance for students' learning success in later schooling than during primary level education.

⁸ Since no teacher information was available for a high proportion of participating classes in Hamburg and Saarland, the findings for these states should be interpreted with caution. In Saarland, this particularly concerns information related to the demographic background characteristics and the qualifications of teachers.

In the analyses of the teachers' surveys on various aspects of teaching children with and without special educational needs together in one classroom, the focus was placed on those teachers at regular schools who teach at least one child with special educational needs in classes participating in IQB Trends in Student Achievement 2016. This is the case for a good half of surveyed teachers. Very few of these teachers obtained a qualification in special needs education or inclusive pedagogy as part of their teaching studies and many of them indicate a high need for further training in terms of giving lessons for children with and without special educational needs together. At the same time, the majority of these teachers have several years of experience in teaching children with and without special educational needs together. On average, the experience reported by teachers amounts to 7 years and only very few teachers (one percent) stated that they have less than one year of experience in giving lessons for children with and without special educational needs.

The teachers estimate their proficiencies related to the joined teaching of children with and without special educational needs to be at a moderate level: Most of them do not feel particularly well-prepared nor particularly poorly prepared by their education, training and professional experience. Likewise, the teachers' attitudes towards the question whether children with special educational needs develop better at regular schools than at special education schools are neither clearly positive nor clearly negative. Concurrently, the teachers who teach at least one student with special educational needs in classes participating in IQB Trends in Student Achievement 2016 are convinced that they are generally able to design lessons in these classes effectively.

Conclusions

Overall, IQB Trends in Student Achievement 2016 presents a picture of the proficiency scores achieved by fourth-graders in German and mathematics that is characterized to some degree by stability, but also by rather adverse changes over time. This concerns negative trends that are pronounced especially in the proficiency domains of *listening* and *orthography* in German and in mathematics throughout Germany. Also within the states, scarcely any significantly positive trends can be observed, although substantial differences are seen in which level of proficiency students achieved in 2016. When interpreting the trend results, it is also evident that the school systems in the states have undergone a number of changes in the period between 2011 and 2016. For instance, the heterogeneity of students has increased partly because the percentage of children with an immigration background has risen at primary level schools. As a result of implementing inclusive policies, more students with special educational needs also attend a regular school, which has led to an additional change in the composition of students in this type of school. Depending on the state, further changes had to be overcome in the school system during the period under review, such as the incipient generational change in teaching staff. In light of such changes, it may also be considered a success to some degree if school outcomes have remained stable.

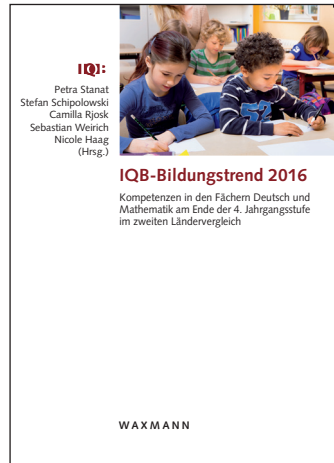
How the pattern of findings should be evaluated and which conclusions may thus be drawn will have to be discussed within the respective states. However, the key issue is how students can be better supported in subjects and domains that exhibit a need for improvement, and how the general conditions and processes should be designed in the educational system in order to facilitate this aim. One of the greatest challenges concerns the handling of heterogeneity among students, and this will also likely become increasingly important in the future. This challenge may only be overcome when all stakeholders in the educational system act in concert.

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