Past and projected trends in teacher demand and supply in Michigan

Appendix A. Methods

Appendix B. Other analyses

See https://go.usa.gov/xVxJf for the full report.

Appendix A. Methods

This appendix includes detailed information about the data used for this report as well as the methods used to complete the analyses.

Data sources

The study team used a combination of data supplied by the Michigan Department of Education (MDE) and publicly available data to address the study's research questions (table A1).

Data for addressing research question 1. To address research question 1, the study team used information from MDE's Registry of Educational Personnel, teacher certification files, substitute permit data, and publicly available data:

- *MDE's Registry of Educational Personnel.* The Registry of Educational Personnel data consist of annual snapshots of teachers who are working in Michigan public schools. The data show each teacher's employment status, demographic characteristics (such as race/ethnicity, gender), hire date, highest degree held, and assignment (that is, school, grade, subject area, and full-time equivalent assigned).
- *Teacher certification files.* Teacher certification data show each teacher's certificate number, certificate type (for example, standard teaching certificate, professional teaching certificate), endorsement areas, and date of issuance. For teachers who were certified in 2011 or later, information on the teacher preparation program they attended is also included. The certification data and Registry of Educational Personnel data could be linked by teachers' unique identification numbers.
- *Substitute permit data*. Substitute permits are formal temporary permissions granted by MDE to Michigan school districts that allow an individual without the necessary certification and endorsement to teach a subject area or grade level for which they are not certified (Michigan Department of Education, 2016a).[1] MDE provided counts of permits issued to each district each year, by subject area and by permit type (for example, Daily Substitute Permit, Full-Year Basic Substitute Permit).
- *Publicly accessible data.* The publicly accessible data include enrollment by grade level, race/ethnicity, and special populations from the MI School Data portal; district average teacher salary from various editions of the Michigan Department of Education's Bulletin 1014; district locale information from the National Center

[1] A certified teacher in Michigan can teach out of subject or grade level for up to 90 days without a permit.

for Education Statistics (NCES) Elementary/Secondary Information System; and data on individuals who completed a teacher preparation program from U.S. Department of Education (2018).

Data for addressing research question 2. To address research question 2, the study team built on the data sources used to address research question 1. The historical data on teachers from 2012/13–2017/18 were used to project teacher demand and active teacher supply for 2018/19–2022/23. Additional data were drawn from the following public sources:

- *The U.S. Census Bureau website.* The U.S. Census Bureau's Annual County Resident Population Estimates report (https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml) contains data on the population by county and age level. Of particular interest for this study was the number of women between the ages of 14 and 44 (which are widely considered to be the child-bearing years). The number of women was combined with historic fertility rates (numbers of births per 1,000 women; see next bullet) to project the number of children who will be born in the near future. For the current study, estimates for counties in Michigan were obtained for 2012, which were used to estimate the number of children born in 2017, which in turn was used to project the number of children who will enter kindergarten in 2022/23 (that is, five years after being born).
- *The Michigan Department of Health and Human Services website.* The agency's website provides data on the birth counts and fertility rates in Michigan by county (http://www.michigan.gov/mdhhs). The most recent data on birth counts are for 2016. Birth counts from 2008 to 2016 were used to calculate or project the number of children born each year who entered kindergarten five years later (see the discussions about birth-to-kindergarten ratios in the *Projections of enrollment* section below). Fertility rates represent the number of births per 1,000 women ages 15–44. Fertility rates from 2016 (the most recent year for which data were available) were used to estimate the number of births likely to occur in 2017, which in turn was used to project the number of children who will enter kindergarten in 2022/23.
- *Comparable Wage Index.* The Comparable Wage Index (CWI) is an NCES-developed measure of regional variation in the salaries of college graduates who are not educators (see Taylor & Glander, 2006). The CWI is used as an indicator of cost of teacher labor for a given a labor market, relative to other labor markets. Areas where college graduates who are not educators have higher salaries are expected to have to pay higher salaries to attract and retain teachers. The CWI has not been officially updated by NCES since 2005. However, Dr. Lori Taylor, its lead author, has updated it through 2013 using her original methodology. The unofficial updated CWI files are available on the website of the Bush School of Government and Public Service at Texas A&M University (http://bush.tamu.edu/research/faculty/Taylor_CWI/). The study team included the 2013 CWI in regression-based projection models to control for regional variations in teacher labor cost.

Table A1. Data used to answer research questions

Data element	Years of data used in analysis	Source
Research question 1. What were the trends in teacher demand, supply, and shortages in Michigan public schools between 2013/14 and 2017/18 overall and by subject area, region of the state, district locale (urban, suburban, town, and rural), and district average teacher salary?		
Personnel data: employment and assignment data for all teachers employed in the state's public education system. The main categories of information contained in these files include: • Characteristics of teachers (such as race/ethnicity, age, gender, hire date, and highest degree) • Employment status • Job assignment (for example, subject area or grade and full-time equivalent) • Site of the assignment (such as school, district, or county)	2012/13–2017/18	Registry of Educational Personnel, maintained by the Center for Educational Performance and Information (CEPI) in Michigan, obtained through a data request with the Michigan Department of Education (MDE)
Teacher certification data, including: • Certificate types (such as standard, professional, advanced, or interim) • Endorsement area (for example, elementary, special education, math, science, or language arts) • Date of issuance • Recommending institutions	2010/11–2016/17	Michigan Online Educator Certification System, obtained through a data request with MDE
Permit data	2013/14–2017/18	Maintained by MDE and obtained through a data request
Student enrollment data: enrollment at the district and school levels (by grade and racial/ethnic subgroups)	2012/13–2017/18	Publicly available from the MI School Data portal, maintained by CEPI (https://www.mischooldata.org)
District average teacher salary	2013/14–2016/17	Bulletin 1014, publicly available from the MDE website (https://www.michigan.gov/mde/0,4615,7-140-6605-21514--,00.html)
District locale	2013/14–2016/17	Common Core of Data, publicly available from the Elementary/Secondary Information System, maintained by the National Center for Education Statistics (U.S. Department of Education, 2018)
Individuals who completed teacher preparation programs, by subject area	2011/12–2015/16	Federal Title II website (https://title2.ed.gov/Public/Home.aspx)
Research question 2. What will Michigan's public school teacher demand and supply picture look like between 2018/19 and 2022/23?[a]		
Census data and population estimates between census years	2012	Publicly available from the U.S. Census Bureau (https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml)
Birth and fertility statistics for each year	2008–16	Publicly available from the Michigan Department of Health and Human Services website (http://www.michigan.gov/mdhhs)
Comparable Wage Index	2013	Publicly available from the Bush School of Government and Public Service at Texas A&M University (http://bush.tamu.edu/research/faculty/Taylor_CWI/)

a. All data elements used to address research question 1 except substitute permit data and teacher preparation program data were also used to address research question 2.
Source: Authors' compilation.

Data preparation

Personnel data. Each row of the Registry of Educational Personnel data represents a unique teaching assignment with information on the site of assignment (that is, district and school), grade, and assignment code (indicating subject area assignment as well as assignment full-time equivalent). Teachers with more than one assignment therefore have multiple rows in the data. The data also show each teacher's employment status, demographic characteristics (such as race/ethnicity, gender, and date of birth), hire date, and highest degree held. The study team conducted the following manipulations and calculations to prepare the data for analysis:

- Teacher age was calculated as the difference (in years) between June 30 of each school year and date of birth (for example, the age as of June 30, 2013, for teachers employed in the 2012/13 school year). Teacher age was further recoded into five age categories: under 30, 30–39, 40–49, 50–59, and 60 or above.
- Teachers' years of experience in the district were calculated as the difference (in years) between June 30 of each school year and teachers' date of hire. Teacher experience was further recoded into four categories: 0–5, 6–10, 11–20, and 21 or more.
- Race/ethnicity codes were recoded into a binary variable indicating whether the teacher was a racial/ethnic minority.
- Assignment codes were recoded to 17 broad subject areas (arts, bilingual education, business education, career and technical education, early childhood education, English language arts, health and physical education, humanities, math, miscellaneous, other grade-level education, science, social studies, special education, support services, technology, and world languages).

The assignment-level file was then collapsed to create three district-level files that contain:

- File D1: full-time equivalent teachers by subject area by district.
- File D2: teacher count by subject area by district. Teachers who have multiple assignments in the same subject area are counted only once for that subject area. Teachers who have assignments in more than one subject area are counted multiple times in this file.
- File D3: unique teacher count by district and district-level teacher characteristics (for example, percentage of racial/ethnic minority teachers, percentage of teachers in each age and experience category).

Finally, using file D3 and teacher unique identification numbers, the study team constructed a longitudinal teacher-level file (file D4) that allows tracking of an individual teacher's employment status (whether and where the teacher was employed each year) over time. Each row in file D4 represents a unique teacher. Information on the initial (first) certification issued to each teacher was added to this file. This file was used to track individual entry and exit into teaching between 2012/13 and 2017/18.

Teacher certification data. The certification data file contained information regarding the type, endorsement, recommending institution, issue date, and expiration date of teacher certifications. Each row represented a unique endorsement associated with a specific teaching certificate. Teachers with more than one certificate or more than one endorsement per certificate appeared in multiple rows in the data. To prepare the data for analysis of trends of newly certified teachers, the study team followed the following steps:

- Dropped rows that were missing teacher unique identification numbers, at MDE's recommendation.
- Generated school-year variables using the issue date variable in the data to show the academic year (September 1–August 31) in which a certificate was earned.

- Identified teachers who earned a beginning certificate (Standard Teaching Certificate, Standard Career and Technical Education Certificate, or Interim Teaching Certificate) after September 1, 2011, and kept only rows that contained one of those three beginning certificates.
- Generated a subject area variable, placing endorsements into one of the 17 subject area categories described in the *Substitute permit data* section below.
- Reshaped data to make each row a unique certificate, with separate variables for each endorsement associated with that certificate. Teachers still appear in multiple rows if they earned multiple certificates between 2011/12 and 2017/18.

Substitute permit data. The substitute permit data contain counts of substitute permits issued to each Michigan school district each year by subject area. To prepare the data, the subject areas were collapsed into 17 categories: arts, bilingual education, business education, career and technical education, early childhood education, English language arts, health and physical education, humanities, math, miscellaneous, other grade-level education (for example, general middle school), science, social studies, special education, support services, technology, and world languages. The majority (97 percent) of permits in the dataset were Daily Substitute Permits, which allow an individual without the necessary certification and endorsement to teach temporarily, on a day-to-day basis, for less than 90 days per school year (Michigan Department of Education, 2016b) and are not linked to a subject area. Most of the remaining types of permits, such as Annual Career and Technical Education Authorizations, Full-Year Basic Substitute Permits, and Expert Substitute Permits, were linked to a subject area and were classified as long-term substitution permits. The types of permits in this category vary slightly over the years, and they typically authorize an individual without the necessary certification and endorsement to teach in a regular or long-term substitute assignment.[2] The substitute permit data were merged with a version of Registry of Educational Personnel data that had been collapsed to the district level and contained overall counts of teachers by subject area, including those with permits, in each district (see file D2 described in the *Personnel data* section above).

Data on district characteristics. All the district characteristics used throughout this study were collected from multiple data sources. First, the following three files were merged into one data file using the district codes assigned by the state:

- District enrollment numbers by grade level and by special populations from the MI School Data portal.
- District average teacher salaries from the Bulletin 1014 data. Average teacher salaries were all converted to 2017 constant dollars using the consumer price index values from the U.S. Bureau of Labor Statistics. Each district was then assigned to a district compensation level based on percentiles. The 25 percent of districts with the lowest average teacher salaries were assigned a district compensation level of "low," the 50 percent of districts in the interquartile range were assigned "medium," and the 25 percent of districts with the highest average teacher salaries were assigned "high."
- District locales from the Common Core of Data (U.S. Department of Education, 2018). The 12 NCES locale types were collapsed into four categories: city, suburban, town, and rural.

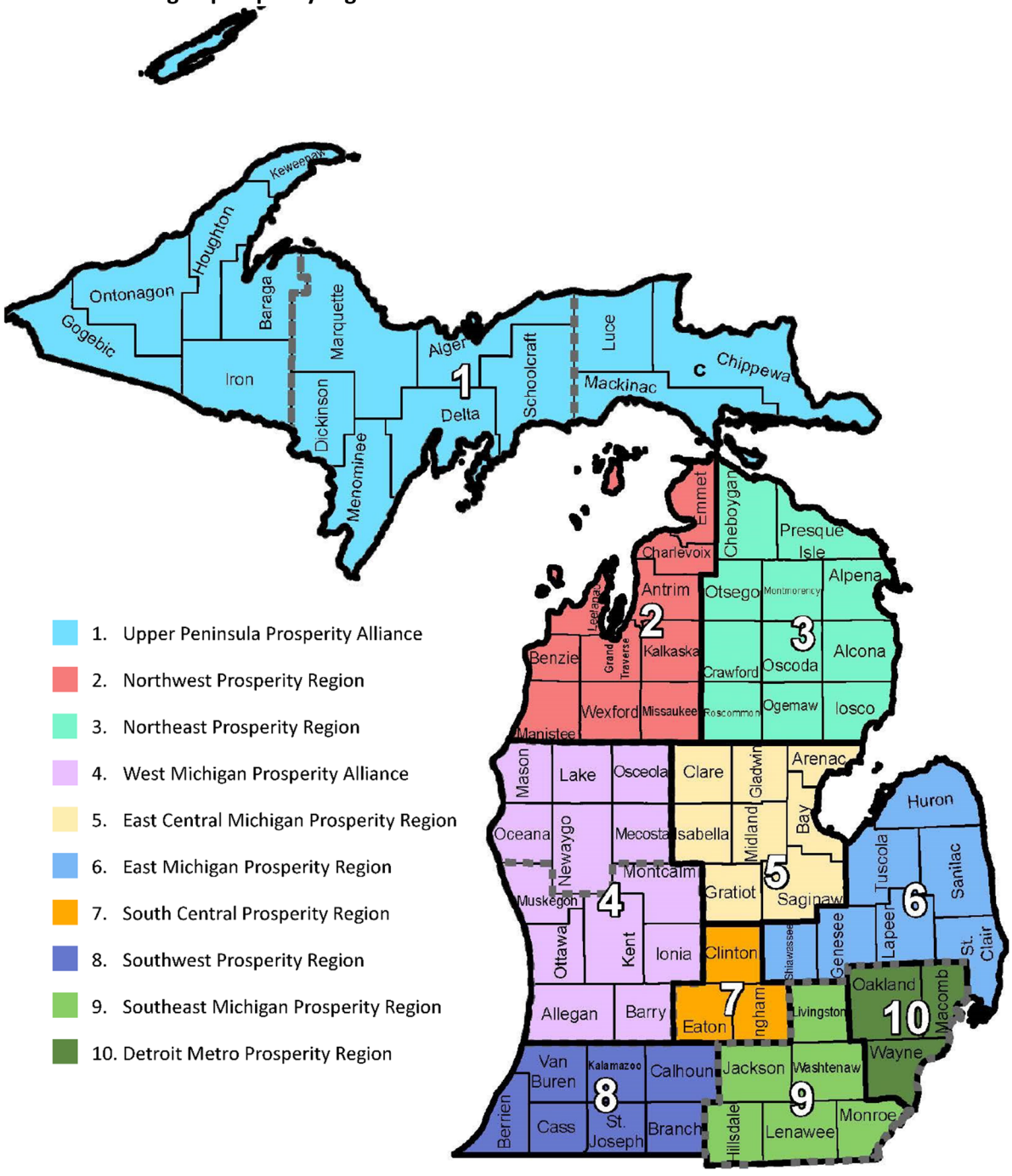
The next step involved assigning a geographic region to each school district based on its county. The data from Bulletin 1014 and the Common Core of Data listed a county for each district. In 106 instances, or 1.4 percent of districts, the two counties did not match. In these cases, the study team chose the county that also appeared in the MI School Data portal's independent school district variable, as many districts are named after the county in which they operate. In three cases the independent school district variable did not confirm the district. For these,

[2] These permits typically could be renewed to allow an individual to teach for up to a maximum of four years in the assigned area. There are different renewal requirements for different types of permits. Detailed guidance on permits can be found at https://www.michigan.gov/mde/0,4615,7-140-5683_14795_83467---,00.html).

the study team manually searched the location of the school district's main office and entered the county as such. Based on its county, each district was assigned to one of the 10 Prosperity Regions recognized by the Economic Development Collaborative (map A1): Upper Peninsula, Northwest, Northeast, West Michigan, East Central Michigan, East Michigan, South Central, Southwest, Southeast Michigan, and Detroit Metro. CWI data were merged into the data file using the school district codes assigned by NCES.

Finally, district characteristics were merged with the district-level staffing data (files D1–D3) to create one district-level analysis file.

Map A1. State of Michigan prosperity regions



Source: Adapted from Michigan Department of Technology, Management, and Budget (2013).

Data analysis for addressing research question 1

Substitute permit data. Substitute permits were used as rough indicators of teacher shortages. The study team calculated the number of substitute permits, overall and by permit type (Daily Substitute Permits and long-term substitute permits). For 2013/14–2017/18 the number of permits each year was aggregated by region of the state, district locale, and district average teacher salary. The number of long-term substitute permits associated with a specific subject area, expressed as a percentage of the total teacher count, was used as a measure of teacher shortages. The shortage for each subject area was calculated by dividing the number of permits in each subject area by the total number of teachers[3] (including those with regular certifications and special permits) in a given subject area for each year.

Teacher demand. The study team conducted analyses on two demand components for the past five years: enrollment and student–teacher ratios. Grade-level enrollment was summed across grades within districts to obtain total enrollment (grades K–12 and ungraded) and elementary (grades K–5), middle (grades 6–8), and high school (grades 9–12) enrollment for each district. District-level enrollments were then aggregated statewide and by region of the state, district locale, and district average teacher salary in each year to look at trends in total enrollment and enrollment in each grade span. District-level data on enrollment of English learner students, students in special education, and students eligible for the national school lunch program were aggregated to each of the above levels as well. The study team then calculated both raw and percentage changes for all enrollment values between 2013/14 and 2017/18. The study team used the total enrollment created by summing across grade levels in each district to calculate student–teacher ratios at each level of aggregation between 2013/14 and 2017/18. Total district enrollment was aggregated to the appropriate level and divided by total full-time equivalent teachers aggregated to the same level. Student–teacher ratios also were averaged across all five years, and raw and percentage changes in student–teacher ratios were calculated as they were with enrollment values.

Teacher supply. The study team conducted analyses on two sources of data related to teacher supply. First, the study team examined the active teacher supply by calculating the number and percentage of teachers from various supply sources. Second, the study team examined the new teacher pipeline by summarizing the number of individuals who completed an in-state teacher preparation program and the number of newly certified teachers in Michigan as well as the percentage of newly certified teachers who entered into teaching in Michigan public schools.

To determine the source of teachers employed in each year, the study team analyzed the individual-level longitudinal file (file D4) to classify the beginning-of-year employment status for each teacher, starting with the second year for which data were provided (that is, 2013/14). Each teacher was assigned to one of the following categories:

- *Retained teachers.* The district where a teacher worked was compared with the district where the teacher worked during the previous year. Those in the same district were assigned to this group. These teachers are often referred to as stayers (within districts) in the literature.
- *Transferred teachers.* A teacher working in a different Michigan district from the prior year was assigned to this group. These teachers are often referred to as movers (between districts) in the literature.
- *Newly certified teachers.* Teachers who appeared for the first time in the data and obtained an initial teaching certificate in any of the previous three years were assigned to this group. The study team further classified them into three subgroups based on the teacher preparation program they attended (prepared in a traditional

[3] This represents counts of unique teachers in each subject area.

teacher preparation program in Michigan, prepared through a state-approved alternative certification program in Michigan, or prepared in an out-of-state institution).

- *Other entrants.* All other teachers who were not in any of the three categories defined above were assigned to this group. It includes teachers who returned after a break in service (sometimes referred to as stop-outs in the literature) and teachers who appeared for the first time in the data but were not certified recently (that is, not newly certified as defined above).

The study team also conducted several analyses to examine the new teacher pipeline in Michigan. The study team first considered how many potential new teachers there were each year in Michigan by looking at individuals who completed teacher preparation programs and individuals who earned initial teacher certification. Counts of program completers from the Title II data were used to sum the number of people who completed teacher preparation programs in Michigan each year. The number of newly certified individuals each year was calculated using the teacher certification data. Those earning an initial teaching certificate in a given year, including a Standard Teaching Certificate, Standard Career and Technical Education Certificate, or an Interim Teaching Certificate, were counted as newly certified. To measure how many of the newly certified individuals were "captured" by Michigan's public schools, the study team tracked the employment status of newly certified individuals between 2013/14 and 2017/18 (using file D4 created above) and calculated the percentages of newly certified individuals who were actually teaching in Michigan public schools one and two years after they earned certification. The percentages of newly certified teachers each year who were teaching two years after earning their initial certification were presented in the main report.

Data analysis for addressing research question 2

The study team used the general approach of analyzing historical data (for 2012/13–2017/18) to identify trends and applying the estimated trends to future years to project teacher demand and active teacher supply for 2018/19–2012/23. To determine the magnitude of forecast errors, the study team calculated average percentage errors (APEs) and mean absolute percentage errors (MAPEs) by applying the estimates to historical data. APEs help determine whether models produce biased forecasts (that is, whether the forecasts are consistently above or below the actual value). MAPEs indicate the size of the errors in percentage terms. The study team tested different projection models and adopted the empirical strategy that yielded the smallest MAPEs. The projections were made at the district level. District-level projections were then aggregated to create statewide projections as well as projections for districts in each region of the state, district locale, or salary category. Projection methods for each teacher demand and supply element are described below.

Projections of enrollment

The team used grade progression ratios (GPRs) and birth-to-kindergarten ratios (BKRs) as the basis for forecasting enrollment. The GPR represents the proportion of students from one grade who progress to the next grade the following year. The BKR represents the proportion of children who were born in a given year who enter kindergarten five years later. Enrollment projections were made at the county level for two reasons: GPRs were calculated at the county level because some districts may not serve all grades, and BKRs were calculated at the county level because data on live births and population estimates are available at the county level (not the district level).

The study team calculated county-level GPRs for each district for each year from 2012/13 to 2017/18 by dividing the number of students in an advanced grade in one year by the number of students in the grade below in the prior year. For example, to calculate the ratio of students who progressed from kindergarten to grade 1 between 2012/13 and 2013/14, the formula is:

$$\text{Kindergarten to grade 1 GPR} = \frac{\text{Grade 1 enrollment in 2013}}{\text{Kindergarten enrollment in 2012}}.$$

County-level BKRs were calculated by dividing the number of kindergarteners in a county in a year by the number of live births in the same county five years prior. For example, to calculate the ratio of students who progressed from birth to kindergarten between 2008 and 2013, the formula is:

$$\text{BKR for 2013} = \frac{\text{Kindergarten enrollment in 2013}}{\text{All live births in 2008}}.$$

The study team then took the average GPR for each grade progression and the BKR for each county between 2012/13 and 2017/18 and applied them to create county-level enrollment projections using the following steps:

- Projected kindergarten enrollment from 2018/19 to 2021/22 by multiplying the number of live births in a county five years prior by the county's average BKR.
- Projected kindergarten enrollment projection in 2022/23 by multiplying the population of women ages 10–39 in a county in 2012 by the fertility rate in the county in 2016 by the average BKR. Because 2017 natality data were not yet available, the study team first needed to predict the number of live births in a county in 2017. The study team did so by multiplying the population of women who would be of child-bearing age in 2017 (women ages 10–39 in 2012, the latest year of available data) by the latest available fertility rate (2016 at the time of writing).[4]
- Calculated all other grade-level projections by multiplying prior-year, prior-grade enrollment[5] by the relevant grade's average GPR.

Finally, county-level enrollment projections were apportioned to the district level based on a district's share of its county's grade enrollment in 2017/18 (the last year of historical data).

Regression-based methods

The study team used regression-based methods to create projections for the other demand and supply elements presented in the main report. In essence, under regression-based methods the outcome of interest (for example, student–teacher ratio) was modeled as a function of a yearly time trend and a number of predictors that may be related to the outcome. The estimated regression coefficients were then used to predict the outcomes for future years by plugging in the values of projected student enrollment while holding all other predictors constant (at the historical mean for each district). For each outcome the study team tested a series of regression models (for example, by including different sets of predictors, interaction terms between predictors, or quadratic terms of some predictors). Predictors in the regression models included district-level student and teacher demographic and economic factors selected on the basis of both theoretical justification and statistical properties, such as overall model fit, the *t*-statistics of the coefficients, the Durbin-Watson statistic, and residual plots. The variables that were used in the final models are presented in table A2. The study team also examined models that included one additional set of financial variables (for example, the percentage of revenue from state, federal, or local sources; instructional expenditures per pupil; teacher average salaries). However, because such data were not available for 2017/18 and there also was a large degree of missing data among charter schools, the study team decided to exclude those variables from all models.[6] The projections were made at the district level and were aggregated to each level of reporting (that is, statewide and by subject area, region of the state, district locale, or district average teacher salary).

[4] This approach, however, may overestimate the counts of live births in 2017. The population of women of child-bearing age in 2017 possibly should have been smaller than that of the same cohort of women five years earlier due to out-migration or death. The actual fertility rate in 2017 could have been lower than the fertility rate in 2016 as the rate had been trending downward in Michigan in the past decade.

[5] For the 2018/19 projections the study team multiplied average GPRs by actual enrollment numbers from 2017/18. For all other projection years the prior year's enrollment numbers are themselves projections.

[6] Such data were missing for about 90 percent of charter districts and for 2–4 percent of local education agency districts in each year. These districts accounted for 10–12 percent of total enrollment in each year.

Table A2. Variables included in regression-based projection models

Variable	Student–teacher ratio	Proportion of demand by subject area	Total active teacher supply (full-time equivalent teachers)	Active teacher supply by subject area (full-time equivalent teachers)
Time (year)	√	√	√	√
Region[a]	√	√	√	√
Locale[a]	√		√	√
Comparable Wage Index	√	√	√	√
Public school academies (charter) indicator[a]	√		√	√
Detroit Public Schools Community District indicator[a]	√	√	√	√
Total enrollment[b]	√	√	√	√
Percentage of secondary enrollment	√	√	√	√
Percentage of racial/ethnic minority students	√	√		
Interaction of total enrollment and percentage of students eligible for the national school lunch program	√	√	√	√
Teacher average age[b]			√	√
Teacher average years of experience in district[b]			√	√
Interaction of teacher average age and teacher average experience			√	√
Percentage of racial/ethnic minority teachers			√	√
Percentage of female teachers			√	√

√ indicates that the variable was used in the model.
a. An interaction term between this variable and time also was included if the interaction term was significant at the .10 level.
b. A quadratic term of the variable also was included if the quadratic term was significant at the .10 level.
Source: Authors' compilation.

Projections of student–teacher ratios. Student–teacher ratios were modeled as a function of a yearly time trend and region, locale, CWI, an indicator for charter schools, an indicator for Detroit Public Schools Community District, total student enrollment, percentage of secondary enrollment, and percentage of minority students (see table A2). Enrollment squared was included to account for the possibility that the relationship between enrollment and student–teacher ratio is nonlinear. The interaction terms between some variables (for example, region, locale, or charter indicator) and time were included (when they were significant at the .10 level) to allow the time trend for those groups to vary over time.

Projections of total demand. The projected student–teacher ratios were applied to enrollment projections to produce projections of the total demand for each district (that is, projected demand = projected enrollment/ projected student–teacher ratio). The study team also considered an alternative method of setting a target pupil–teacher ratio for the entire forecast period at the average of the most recent three years observed (2015/16–

2017/18). Because the regression-based method produced smaller APEs and MAPEs, the demand projections presented in the main report were calculated using the student–teacher ratios produced through the regression-based method.

Projections of demand by subject area. A first-order projection of teacher demand for each subject area would be conducted by dividing the projected enrollment in a subject area by a target or projected student–teacher ratio for the subject area, which would require historical course enrollment and information on class size (that is, student–teacher ratios) by subject area. But those data were not readily available. Additional steps were needed to make the projections. The study team calculated demand projections by subject area by first projecting the estimated proportion of teachers in each subject area using a regression-based modeling approach, which modeled the proportion of teachers in each subject area as a function of a yearly time trend and other predictors (see table A2). The projected overall demand was then multiplied by the estimated proportion for each subject area to calculate the projected demand by subject area. Because the dependent variable in the regression model is proportions, which by definition are numbers between 0 and 1, a generalized linear model with a logit link and the binomial family were used to constrain the predicted outcomes to be between 0 and 1.

Projections of total active supply. The study team used total full-time equivalent teachers as the primary measure of total active supply. Full-time equivalent teachers were used rather than teacher count because the former takes into consideration the varying level of service (that is, full time or part time) that each teacher provides and is consistent with how demand was defined and calculated (student enrollment divided by student–teacher ratio). The projections were created using the regression-based method similar to what was described previously. Specifically, total full-time equivalent teachers were modeled as a function of a yearly time trend, region of the state, district locale, CWI, an indicator for charter schools, an indicator for Detroit Public Schools Community District, and a set of student and teacher demographic characteristics (see table A2). The set of variables included in the model was based on both theoretical justification as well as testing of competing models to improve model fit.

Projections of active teacher supply by subject area. The projected active teacher supply by subject area is defined as the projected number of full-time equivalent teachers in different subject areas. These projections also were created using the regression-based methods similar to those used in projecting the total active supply. Specifically, the full-time equivalent teacher count for each subject area was modeled as a function of a yearly time trend and a set of student and teacher demographic characteristics (see table A2).

Comparison of projected demand and projected active teacher supply

Finally, the study team compared the demand projections and the projected active teacher supply (both in full-time equivalent teachers) to identify potential shortages or surpluses. Specifically, the team calculated both the absolute and relative differences between projected demand and projected active supply to allow for comparisons across subject areas and regions. Relative difference was calculated as absolute difference divided by projected demand. For example, if a given region was projected to have 450 high school social studies teachers in 2018/19, and the projected demand for that subject area in the same year was 500, there would be a projected shortage of 50 teachers or a relative shortage of 10 percent (that is, [450–500]/500 = –0.1).

Limitations of projection methods

The projection methods used in this study have important limitations. A projection is a calculation showing what happens if particular assumptions are made. All the projections in this study were made based on historical trends (for example, in grade progression and birth and fertility rates in enrollment forecasts, in the relationship between predictors and outcomes in regression-based projections) with the assumption that these past trends will continue in the future; however, unexpected events (shocks) may lead to substantial changes in the trend. For example, state and local policies to expand prekindergarten and kindergarten programs could lead to higher enrollment at

the elementary school level. Projections cannot anticipate or reliably account for these shocks or changes in policies.

Many demographic, political, social, and economic factors influence teacher demand and supply, including state and local policies (for example, population migration, state or district education requirements, the availability of teaching positions relative to the availability of positions in other occupations, working conditions in teaching relative to conditions in other occupations). The relationships between the various factors and teacher demand and supply are complex and largely unknown and hence were not taken into account in the projection models.

Moreover, various assumptions can change the projections. For example, because demand is calculated as enrollment divided by student–teacher ratio, different assumptions about student–teacher ratios will change the results of demand projections.

The projected live births for 2017, on which the projection of kindergarten enrollment for 2022/23 was based, may be an overestimate. This may have contributed partially to the projected increase in total enrollment for 2022/23.

Many of the projections that this study produced were based on regressions that estimated an average linear trend based on historical data. However, if the available historical data are particularly volatile, the projected average trend will smooth out this volatility and thus will not be able to accurately reflect similar volatile patterns in future years.

The projected active supply represents the number of teachers projected to be employed in future years (based on historical trends in active supply and the estimated relationships between active supply and factors included in the projection models). However, such projections will not be able to answer the question of how many teachers are likely to be available and willing to enter the teaching force in the future.

Projections for areas with small populations (for example, subject areas such as bilingual education) tend to be less reliable. For that reason, projections by subject area for each region were not presented.

Finally, because the process of change is cumulative, the reliability of projections also decreases over time.

Projection errors

The study team used two measures to assess projection errors—APEs and MAPEs—which were calculated by comparing the predicted values (that is, predicted from the model) and actual values for historical years. APEs help determine whether models produce biased forecasts (that is, whether the predicted values are consistently above or below the actual value), while MAPEs are used to assess the magnitude of the discrepancy. APEs and MAPEs were calculated using the following equations:

$$APE = \frac{100}{n}\sum_{t=1}^{n}\frac{\text{predicted value}_t - \text{actual value}_t}{\text{actual value}_t}$$

$$MAPE = \frac{100}{n}\sum_{t=1}^{n}\left|\frac{\text{predicted value}_t - \text{actual value}_t}{\text{actual value}_t}\right|.$$

The MAPEs were calculated at the level of analysis and averaged across all historical years. To illustrate, for each historical year (for example, 2013/14), the study team first calculated a predicted outcome (for example, student–teacher ratio) using the regression equation and estimated regression coefficients (estimated based on all five years of historical data). It then calculated the difference between the predicted student–teacher ratio for 2013/14 and the actual student–teacher ratio for 2013/14 and expressed it as a percentage of the actual student–teacher ratio. It then averaged the error percentages across all five historical years to obtain APEs and MAPEs.

The APEs and MAPEs for each projection analysis are displayed in table A3. There are no benchmarks of forecast accuracy for education statistics at different levels of analysis. Hussar and Bailey (2016) reported a MAPE of 3 percent for projections of the number of public school teachers nationwide into the fifth year. For state-level projections, Berk and Hodgins (2008) suggest that future projections should be interpreted with caution if the MAPE is more than 10 percent. Levin, Berg-Jacobson, Atchison, Lee, and Vontsolos (2015) consider a MAPE of 7.5 percent high enough to warrant caution. All the MAPEs in table A3 that are higher than 10 percent are indicated.

Table A3. Average percentage errors and mean absolute percentage errors of projections produced in the study

Category	Student enrollment		Student–teacher ratio		Teacher demand		Active supply (full-time equivalent teachers)	
	Average percentage error	Mean absolute percentage error	Average percentage error	Mean absolute percentage error	Average percentage error	Mean absolute percentage error	Average percentage error	Mean absolute percentage error
Statewide	–0.40	0.41	–0.01	0.31	–1.01	1.01	0.01	0.56
Region								
Upper Peninsula	1.30	1.30	0.47	1.37	10.75	10.75[a]	0.00	0.56
Northwest	–0.02	0.50	0.26	1.54	7.90	7.90	0.01	0.99
Northeast	0.02	0.91	0.12	1.82	0.19	0.93	0.00	0.92
West Michigan	–0.52	0.57	0.07	1.14	0.43	0.82	0.00	0.53
East Central Michigan	0.98	0.98	–0.39	1.16	–1.42	1.42	0.01	0.74
East Michigan	–0.17	0.40	–0.08	1.43	0.95	0.96	0.01	0.55
South Central	–1.53	1.53	0.20	0.78	–5.12	5.12	0.00	0.42
Southwest	–0.98	0.98	–0.47	1.12	1.56	1.56	0.00	0.45
Southeast Michigan	–0.60	0.70	0.70	0.77	–2.23	2.23	0.01	0.86
Detroit Metro	–0.43	0.48	–0.18	1.53	–3.20	3.20	0.01	0.65
Locale								
City	0.96	1.02	–0.48	1.70	–6.52	6.52	0.02	0.87
Suburb	–1.27	1.27	0.17	0.23	–0.48	0.48	0.00	0.40
Town	–1.46	1.46	0.01	0.53	1.23	1.23	0.00	0.45
Rural	0.83	0.83	0.11	1.12	4.18	4.18	–0.01	0.60
Salary level								
Low	0.90	1.19	4.04	4.04	–2.38	2.83	–2.72	3.68
Medium	0.05	0.28	–2.10	2.10	–0.21	0.35	–0.02	0.43
High	–0.29	0.32	1.01	1.01	–1.59	1.59	0.40	0.90

Category	Student enrollment		Student–teacher ratio		Teacher demand		Active supply (full-time equivalent teachers)	
	Average percentage error	Mean absolute percentage error	Average percentage error	Mean absolute percentage error	Average percentage error	Mean absolute percentage error	Average percentage error	Mean absolute percentage error
Subject area								
Arts					–3.03	3.03	0.01	0.69
Bilingual education					–13.59	13.59[a]	0.65	8.20
Business education					3.24	3.40	0.02	1.15
Career and technical education					4.19	4.33	0.00	0.50
English language arts					0.69	1.05	0.00	0.52
General elementary					1.64	1.64	0.00	0.27
Health and physical education					–2.53	2.53	0.01	0.70
Math					–1.12	1.12	0.01	0.83
Science					–1.21	1.21	0.01	0.85
Social studies					–0.50	0.54	0.00	0.53
Special education					–2.19	2.19	0.00	0.24
Technology					–0.33	2.99	0.05	1.81
Health and physical education					–0.08	0.95	0.02	1.18
World languages					–3.03	3.03	0.01	0.69

Note: Early childhood education teachers were not included in the demand and supply projections because data on prekindergarten student enrollment were not available.
a. Mean absolute percentage error is higher than 10 percent.
Source: Authors' compilation.

References

Berk, B., & Hodgins, M. (2008). *K–12 school enrollment projections study: Final report.* Seattle, WA: Office of Superintendent of Public Instruction. Retrieved November 7, 2017, from http://www.k12.wa.us/schfacilities/publications/pubdocs/EnrollProjectionMethodologiesFinalReport2008.pdf.

Hussar, W. J., & Bailey, T. M. (2016). *Projections of education statistics to 2024* (NCES 2016-013). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. https://eric.ed.gov/?id=ED569143.

Levin, J., Berg-Jacobson, A., Atchison, D., Lee, K., & Vontsolos, E. (2015). *Massachusetts study of educator supply and demand: Trends and projections.* Washington, DC: American Institutes for Research. https://eric.ed.gov/?id=ED563815.

Michigan Department of Education. (2016a). *About Michigan substitute permits.* Lansing, MI: Author. Retrieved November 7, 2017, from https://www.michigan.gov/documents/mde/Permit_Overview_529841_7.pdf.

Michigan Department of Education. (2016b). *Michigan Department of Education strategic plan: Top 10 in 10 years.* Lansing, MI: Author. Retrieved November 7, 2017, from http://www.michigan.gov/documents/mde/10_in_10_Action_Plan_543856_7.pdf.

Michigan Department of Technology, Management, and Budget. (2013). *State of Michigan Prosperity Regions*. Retrieved November 7, 2017, from https://www.michigan.gov/documents/dmb/Prosperity_Map1_430346_7.pdf.

Taylor, L. L., & Glander, M. (2006). *Documentation for the NCES Comparable Wage Index files* (EFSC 2006-865). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. https://eric.ed.gov/?id=ED492607.

U.S. Department of Education, National Center for Education Statistics. (2018). Common Core of Data. The Local Education Agency (School District) Universe Survey, 2013/14–2016/17. Retrieved November 7, 2017, from https://nces.ed.gov/ccd/pubagency.asp.

U.S. Department of Education, Office of Postsecondary Education. (n.d.). *2016 Title II reports: National teacher preparation data.* Retrieved November 7, 2017, from https://title2.ed.gov/Public/Home.aspx.

Appendix B. Other analyses

This appendix provides additional findings from the analyses.

Enrollment

Table B1. Total enrollment in Michigan public schools, by region, 2013/14–2017/18

Region	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18	
						Number	Percent
Upper Peninsula	41,221	40,854	40,461	39,891	39,379	–1,842	–4.5
Northwest	44,061	44,993	44,870	45,153	45,266	1,205	2.7
Northeast	26,676	26,271	25,978	25,944	25,552	–1,124	–4.2
West Michigan	261,180	258,997	258,535	258,466	256,554	–4,626	–1.8
East Central Michigan	81,995	81,657	80,525	79,387	77,837	–4,158	–5.1
East Michigan	143,144	140,366	138,129	136,162	133,867	–9,277	–6.5
South Central	71,236	71,800	71,844	71,914	71,865	629	0.9
Southwest	126,446	126,026	125,511	125,317	124,838	–1,608	–1.3
Southeast Michigan	145,937	144,442	143,282	142,585	141,857	–4,080	–2.8
Detroit Metro	622,211	615,396	610,870	607,516	602,541	–19,670	–3.2
Total	1,564,107	1,550,802	1,540,005	1,532,335	1,519,556	–44,551	–3.0

Note: See figure A1 in appendix A for a map of the regions. Students from Success Virtual Learning Centers of Michigan (*n* = 509) were excluded from the analysis in 2017/18 because they could not be accurately placed in a given region. There is an additional discrepancy of seven students between the total 2013/14 enrollment count here and table 1 in the main text. The difference preceded the analysis by region and is likely due to an unknown discrepancy in Michigan school data at the topline and district levels.
Source: Authors' analysis of data from the MI School Data portal.

Table B2. English learner student enrollment in Michigan public schools, by region, 2013/14–2017/18

Region	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18	
						Number	Percent
Upper Peninsula	0	0	0	0	0	0	na
Northwest	260	336	418	570	571	311	119.6
Northeast	17	0	31	24	23	6	35.3
West Michigan	15,012	15,974	16,990	17,831	18,224	3,212	21.4
East Central Michigan	525	843	832	717	758	233	44.4
East Michigan	1,263	1,489	1,438	1,445	1,428	165	13.1
South Central	2,301	2,462	2,828	3,250	3,389	1,088	47.3
Southwest	5,197	6,146	6,647	6,914	7,175	1,978	38.1
Southeast Michigan	2,550	2,982	3,352	3,556	3,851	1,301	51.0
Detroit Metro	49,345	53,912	57,047	60,116	61,700	12,355	25.0
Total	76,470	84,144	89,583	94,423	97,119	20,649	27.0

na is not applicable.
Note: See figure A1 in appendix A for a map of the regions. Students from Success Virtual Learning Centers of Michigan (*n* = 509) were excluded from the analysis in 2017/18 because they could not be accurately placed in a given region. District-level data were aggregated to the region level for this analysis. At the district level, enrollment is not reported if fewer than 10 students of a given subgroup are enrolled. All Upper Peninsula districts had fewer than 10 English learner students enrolled in every year included in the analysis, which appears in data as a zero. This loss of data also caused an undercount in the total number of English learner students in each year compared with state totals in table 1 in the main text, ranging from 496 students in 2014/15 to 719 students in 2017/18.
Source: Authors' analysis of data from the MI School Data portal.

Table B3. Enrollment of students in special education in Michigan public schools, by region, 2013/14–2017/18

Region	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18	
						Number	Percent
Upper Peninsula	5,677	5,686	5,605	5,695	5,752	75	1.3
Northwest	5,594	5,694	5,837	6,020	6,122	528	9.4
Northeast	3,493	3,384	3,233	3,242	3,168	–325	–9.3
West Michigan	33,846	33,112	32,888	32,942	33,331	–515	–1.5
East Central Michigan	12,560	12,413	12,098	11,915	11,811	–749	–6.0
East Michigan	19,027	18,580	18,550	18,390	18,526	–501	–2.6
South Central	9,124	9,146	9,144	9,301	9,349	225	2.5
Southwest	14,958	15,061	15,098	15,467	15,722	764	5.1
Southeast Michigan	19,292	19,319	18,913	19,007	18,958	–334	–1.7
Detroit Metro	76,664	75,462	75,244	75,605	75,613	–1,051	–1.4
Total	200,235	197,857	196,610	197,584	198,352	–1,883	–0.9

Note: See figure A1 in appendix A for a map of the regions. Students from Success Virtual Learning Centers of Michigan (*n* = 509) were excluded from the analysis in 2017/18 because they could not be accurately placed in a given region. There is an additional discrepancy of seven students between the total 2013/14 enrollment count here and in table 1 in the main text. The difference preceded the region analysis and is likely due to an unknown discrepancy in Michigan school data at the topline and district levels. As a result, total enrollment of students in special education is undercounted in each year in this table compared with state totals in table 1 in the main text, ranging from 184 students in 2017/18 to 287 students in 2013/14.
Source: Authors' analysis of data from the MI School Data portal.

Table B4. Enrollment of students eligible for the national school lunch program in Michigan public schools, by region, 2013/14–2017/18

Region	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18	
						Number	Percent
Upper Peninsula	19,870	19,230	18,559	18,508	20,019	149	0.7
Northwest	21,525	20,253	19,716	20,947	23,230	1,705	7.9
Northeast	15,924	15,459	15,366	15,199	15,852	–72	–0.5
West Michigan	127,518	122,864	121,929	118,710	127,070	–448	–0.4
East Central Michigan	42,005	38,527	38,261	37,708	41,746	–259	–0.6
East Michigan	74,374	69,273	68,183	66,461	73,253	–1,121	–1.5
South Central	30,281	28,697	29,840	29,597	33,083	2,802	9.3
Southwest	67,961	65,769	64,419	64,532	68,918	957	1.4
Southeast Michigan	53,480	52,013	49,663	48,493	55,983	2,503	4.7
Detroit Metro	304,813	293,879	287,359	282,635	311,708	6,895	2.3
Total	757,751	725,964	713,295	702,790	770,862	13,111	1.7

Note: See figure A1 in appendix A for a map of the regions. Students from Success Virtual Learning Centers of Michigan (*n* = 509) were excluded from the analysis in 2017/18 because they could not be accurately placed in a given region. There is an additional discrepancy of seven students between the total 2013/14 enrollment count here and in table 1 in the main text. The difference preceded the region analysis and is likely due to an unknown discrepancy in Michigan school data at the topline and district levels. As a result, total enrollment of students eligible for the national school lunch program in this table differs from that in table 1 in the main text by 5 students in 2013/14 and by 377 students in 2017/18.
Source: Authors' analysis of data from the MI School Data portal.

Table B5. Enrollment in Michigan public schools, by district locale and subgroup of disadvantaged students, 2013/14–2017/18

District locale and student subgroup	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18	
						Number	Percent
City							
Total	389,890	384,511	370,294	366,875	362,398	–27,492	–7.1
English learner students	41,721	44,992	48,009	49,885	50,971	9,250	22.2
Students in special education	51,227	49,530	47,627	47,694	47,544	–3,683	–7.2
Students eligible for the national school lunch program	249,659	235,854	226,947	225,564	241,933	–7,726	–3.1
Suburban							
Total	707,923	702,956	700,189	704,908	699,872	–8,051	–1.1
English learner students	27,641	30,691	32,214	34,896	36,048	8,407	30.4
Students in special education	86,320	85,940	85,624	86,981	87,679	1,359	1.6
Students eligible for the national school lunch program	282,017	274,263	271,810	267,257	297,827	15,810	5.6
Town							
Total	199,833	197,623	192,763	194,920	193,483	–6,350	–3.2
English learner students	3,842	4,241	4,566	4,733	5,133	1,291	33.6
Students in special education	27,024	26,655	25,966	26,274	26,405	–619	–2.3
Students eligible for the national school lunch program	96,642	91,470	87,827	88,866	97,695	1,053	1.1
Rural							
Total	266,461	265,712	276,759	264,836	261,750	–4,711	–1.8
English learner students	3,266	4,220	4,794	4,909	4,967	1,701	52.1
Students in special education	35,664	35,732	37,393	36,617	36,580	916	2.6
Students eligible for the national school lunch program	129,433	124,377	126,711	120,812	132,130	2,697	2.1

Note: The 12 National Center for Education Statistics urban-centric locale codes were collapsed into four categories. See https://nces.ed.gov/pubs2007/ruraled/exhibit_a.asp for definitions of the locale codes. Nine school districts were excluded from the analysis between 2016/17 and 2017/18 because their locale data were missing or could not be determined. As a result, total student enrollment across locales in this table is undercounted by 796 students in 2016/17 and 2,562 students in 2017/18. There is a similar undercount of seven students in 2013/14, which preceded the analysis and is explained in the note to table B2.

Source: Authors' analysis of data from the MI School Data portal.

Table B6. Enrollment in Michigan public schools, by district average teacher salary and subgroup of disadvantaged students, 2013/14–2016/17

Salary category	2013/14	2014/15	2015/16	2016/17	Change between 2013/14 and 2016/17	
					Number	Percent
Low salary						
Total	96,158	100,902	96,060	95,432	–726	–0.8
English learner students	2,350	4,762	3,935	2,675	325	13.8
Students in special education	11,953	12,765	12,852	12,995	1,042	8.7
Students eligible for the national school lunch program	59,568	63,064	56,803	54,980	–4,588	–7.7
Medium salary						
Total	635,770	588,472	639,174	585,218	–50,552	–8.0
English learner students	22,897	26,714	32,548	33,137	10,240	44.7
Students in special education	83,081	74,393	83,036	74,786	–8,295	–10.0
Students eligible for the national school lunch program	334,191	293,092	322,833	288,296	–45,895	–13.7
High salary						
Total	665,875	685,150	616,363	663,705	–2,170	–0.3
English learner students	42,060	41,829	39,438	44,083	2,023	4.8
Students in special education	79,033	83,595	72,387	81,403	2,370	3.0
Students eligible for the national school lunch program	251,947	252,576	207,764	235,572	–16,375	–6.5

Note: Low-salary districts are those in the lowest quartile of average teacher salary, medium-salary districts are those in the middle two quartiles of average teacher salary, and high-salary districts are those in the highest quartile of average teacher salary. Salary data were missing for about 90 percent of charter districts and for 2–4 percent of local education agency districts in each year. These districts accounted for 10–12 percent of the student sample in each year and were excluded from this analysis.

Source: Authors' analysis of data from the MI School Data portal and data from various editions of the Michigan Department of Education's Bulletin 1014.

Student–teacher ratios

Table B7. Student–teacher ratios in Michigan public schools, by region of the state, district locale, and district average teacher salary, 2013/14–2017/18

Category	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18	
						Students per teacher	Percent
Statewide	16.9	16.9	17.1	17.1	16.8	–0.1	–0.8
Region[a]							
Upper Peninsula	15.8	15.7	15.5	15.5	15.2	–0.6	–3.9
Northwest	16.0	16.0	16.2	16.3	16.0	0.0	0.0
Northeast	17.4	17.3	17.2	17.2	16.9	–0.4	–2.5
West Michigan	16.7	16.6	16.8	16.7	16.4	–0.3	–1.7
East Central Michigan	16.9	17.3	17.3	17.2	16.8	–0.1	–0.4
East Michigan	17.9	18.0	18.2	18.0	17.8	–0.1	–0.6
South Central	16.7	16.7	17.0	17.0	16.8	0.1	0.3
Southwest	16.4	16.5	16.7	16.7	16.5	0.1	0.6
Southeast Michigan	16.8	16.6	16.7	16.6	16.0	–0.8	–5.0
Detroit Metro	17.1	17.1	17.4	17.5	17.2	0.1	0.5
District locale[b]							
City	16.2	16.4	16.5	16.7	16.2	0.0	0.3
Suburb	17.4	17.3	17.5	17.5	17.2	–0.2	–1.1
Town	17.0	17.0	17.0	17.1	16.8	–0.2	–1.2
Rural	16.8	16.8	17.0	16.7	16.4	–0.3	–2.1
Salary category[c]							
Low	16.6	16.6	16.5	16.7	—	0.1[d]	0.4[d]
Medium	17.7	17.7	17.7	17.8	—	0.1[d]	0.6[d]
High	17.4	17.3	17.7	17.6	—	0.2[d]	1.1[d]

— is not available.

a. See figure A1 in appendix A for a map of the regions.

b. The 12 National Center for Education Statistics urban-centric locale codes were collapsed into four categories. See https://nces.ed.gov/pubs2007/ruraled/exhibit_a.asp for definitions of the locale codes.

c. Low-salary districts are those in the lowest quartile of average teacher salary, medium-salary districts are those in the middle two quartiles of average teacher salary, and high-salary districts are those in the highest quartile of average teacher salary.

d. Refers to the change between 2013/14 and 2016/17.

Source: Authors' analysis of data from the MI School Data portal, data from various editions of the Michigan Department of Education's Bulletin 1014, and Registry of Educational Personnel data provided by the Michigan Department of Education.

Active teacher supply

Table B8. Full-time equivalent teachers in Michigan public schools, by subject area, 2013/14–2017/18

Subject area	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18	
						Number	Percent
Arts	4,597	4,508	4,472	4,505	4,589	–8	–0.2
Bilingual education	224	254	287	289	259	35	15.8
Business education	587	552	540	532	505	–82	–14.0
Career and technical education	1,309	1,292	1,264	1,304	1,281	–28	–2.1
Early childhood education	1,433	1,472	1,518	1,500	1,419	–14	–1.0
English language arts	32,028	31,736	31,205	30,819	30,814	–1,214	–3.8
General elementary	3,422	3,342	3,307	3,268	3,313	–109	–3.2
Health and physical education	8,015	7,795	7,677	7,545	7,567	–448	–5.6
Math	6,691	6,519	6,412	6,346	6,418	–273	–4.1
Science	5,601	5,554	5,451	5,420	5,547	–54	–1.0
Social studies	5,437	5,354	5,327	5,282	5,364	–73	–1.4
Special education	15,367	15,395	15,299	15,545	15,786	419	2.7
Technology	1,244	1,193	1,139	1,160	1,167	–77	–6.2
World languages	2,615	2,675	2,675	2,663	2,832	217	8.3
Other[a]	5,129	5,139	4,597	4,526	4,915	–214	–4.2
Total	93,699	92,779	91,169	90,705	91,777	–1,922	–2.1

a. Includes humanities, miscellaneous assignments, other grade-level education, and support services.
Source: Authors' analysis of Registry of Educational Personnel data provided by the Michigan Department of Education.

Table B9. Percentage of teachers retained in the same district from the previous year, by subject area, 2013/14–2017/18

Subject area	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Arts	88.9	89.3	89.5	88.3	87.1	88.6	–1.8
Bilingual education	90.7	86.1	82.4	88.6	83.8	86.3	–6.9
Business education	93.8	93.2	92.5	90.3	91.8	92.3	–2.0
Career and technical education	86.8	88.3	88.4	85.4	87.0	87.2	0.2
Early childhood education	73.5	79.3	82.9	83.8	85.8	81.1	12.3
English language arts	90.0	90.4	89.7	89.0	88.6	89.5	–1.4
General elementary	90.6	91.0	91.1	89.8	88.5	90.2	–2.1
Health and physical education	91.9	91.3	92.1	91.1	89.1	91.1	–2.8
Math	89.0	90.0	89.7	89.1	87.8	89.1	–1.2
Science	90.9	90.8	91.1	90.9	89.4	90.6	–1.5
Social studies	91.0	91.2	91.3	91.4	90.2	91.0	–0.8
Special education	87.3	87.7	87.6	86.4	84.8	86.8	–2.5
Technology	91.7	92.0	90.5	90.1	91.1	91.1	–0.6
World languages	84.4	85.4	86.0	86.2	85.1	85.4	0.7

Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education.

Table B10. Percentage of teachers who transferred from another Michigan district, by subject area, 2013/14–2017/18

Subject area	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Arts	3.7	3.7	3.6	3.9	4.3	3.8	0.6
Bilingual education	2.7	6.6	4.5	3.8	7.3	5.0	4.7
Business education	3.0	4.2	3.4	3.9	2.8	3.5	–0.2
Career and technical education	4.5	2.8	2.4	3.0	3.0	3.1	–1.5
Early childhood education	4.7	4.8	4.3	3.8	3.6	4.2	–1.1
English language arts	3.1	3.0	3.5	4.2	4.2	3.6	1.1
General elementary	2.3	2.5	2.9	3.4	4.0	3.0	1.7
Health and physical education	2.4	2.6	2.8	3.0	4.6	3.1	2.1
Math	3.6	3.8	4.0	4.4	4.7	4.1	1.1
Science	3.0	3.2	3.3	3.7	3.9	3.4	0.9
Social studies	2.7	2.2	2.6	2.9	3.1	2.7	0.4
Special education	4.8	4.6	4.9	5.1	6.0	5.1	1.3
Technology	2.4	2.8	3.2	3.3	2.4	2.9	0.0
World languages	4.8	4.9	4.5	4.8	4.8	4.8	–0.1

Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education.

Table B11. Percentage of newly certified teachers, by subject area, 2013/14–2017/18

Subject area	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Arts	3.1	3.5	7.9	2.8	4.2	4.3	1.1
Bilingual education	1.7	0.3	0.9	0.9	0.6	0.9	–1.1
Business education	0.8	0.9	0.8	0.9	0.4	0.7	–0.4
Career and technical education	8.4	6.7	4.5	3.8	2.7	5.2	–5.7
Early childhood education	3.2	3.0	3.5	2.8	2.9	3.1	–0.3
English language arts	2.6	2.3	2.1	2.2	2.2	2.3	–0.5
General elementary	4.2	3.3	3.3	3.2	3.0	3.4	–1.2
Health and physical education	2.4	2.6	2.8	3.0	4.6	3.1	2.1
Math	3.0	3.0	2.9	2.1	2.6	2.7	–0.4
Science	3.6	3.2	3.1	2.8	2.9	3.1	–0.7
Social studies	2.1	1.9	1.6	1.7	1.7	1.8	–0.3
Special education	1.5	0.9	2.0	1.1	1.2	1.3	–0.3
Technology	2.6	2.7	1.9	1.9	1.9	2.2	–0.8
World languages	3.1	3.5	7.9	2.8	4.2	4.3	1.1

Note: Includes new hires who received their initial teaching certificate within the previous three years.
Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education.

Table B12. Percentage of other entrants, by subject area, 2013/14–2017/18

Subject area	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Arts	3.7	3.5	3.3	4.0	4.5	3.8	0.8
Bilingual education	3.5	3.9	5.2	4.8	4.6	4.4	1.1
Business education	1.5	2.3	3.2	4.8	4.8	3.3	3.3
Career and technical education	7.8	8.0	8.5	10.7	9.6	8.9	1.7
Early childhood education	13.4	9.2	8.3	8.7	7.9	9.5	–5.4
English language arts	3.7	3.5	3.3	4.0	4.3	3.8	0.6
General elementary	4.5	4.2	3.9	4.5	5.4	4.5	0.9
Health and physical education	2.4	2.6	2.8	3.0	4.6	3.1	2.1
Math	3.1	2.9	3.0	3.3	4.4	3.4	1.3
Science	3.1	3.1	2.7	3.3	4.1	3.3	1.0
Social studies	2.8	3.4	2.9	2.9	3.9	3.2	1.1
Special education	5.8	5.8	5.9	6.7	7.4	6.3	1.6
Technology	4.3	4.3	4.2	5.5	5.2	4.7	0.9
World languages	5.5	5.5	6.0	5.7	7.6	6.0	2.1

Note: Includes teachers who were not teaching in the previous year and were not certified within any of the previous three years.
Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education.

Table B13. Percentage of teachers retained in the same district from the previous year, by region, 2013/14–2017/18

Region	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Upper Peninsula	90.0	90.0	89.3	89.4	88.5	89.4	–1.5
Northwest	89.7	88.5	89.8	89.5	88.2	89.1	–1.5
Northeast	91.9	89.3	90.6	90.3	88.0	90.0	–4.0
West Michigan	89.7	90.0	89.5	89.5	88.4	89.4	–1.3
East Central Michigan	91.6	91.3	90.6	89.2	89.7	90.5	–1.9
East Michigan	91.9	91.4	91.4	90.2	89.3	90.8	–2.6
South Central	90.3	90.5	90.6	88.3	87.6	89.4	–2.7
Southwest	88.5	89.2	88.9	87.9	86.6	88.2	–1.9
Southeast Michigan	90.4	90.5	90.4	88.5	86.7	89.3	–3.8
Detroit Metro	87.7	88.8	89.2	88.1	86.7	88.1	–0.9

Note: See figure A1 in appendix A for a map of the regions.
Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education

Table B14. Percentage of teachers who transferred from other Michigan districts, by region, 2013/14–2017/18

Region	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Upper Peninsula	2.3	2.7	2.9	3.1	3.2	2.8	0.9
Northwest	2.7	2.8	2.8	2.8	3.8	3.0	1.1
Northeast	2.2	2.7	2.5	3.4	3.7	2.9	1.5
West Michigan	3.3	3.4	3.8	3.6	3.9	3.6	0.7
East Central Michigan	2.2	2.6	3.2	4.0	3.6	3.1	1.5
East Michigan	2.3	2.4	2.5	3.2	4.2	2.9	1.8
South Central	2.4	2.5	2.9	4.2	4.6	3.3	2.2
Southwest	3.0	3.0	3.2	3.7	4.5	3.5	1.5
Southeast Michigan	3.4	3.2	3.2	3.4	3.9	3.4	0.5
Detroit Metro	3.8	3.8	4.0	4.5	5.0	4.2	1.2

Note: See figure A1 in appendix A for a map of the regions.
Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education.

Table B15. Percentage of newly certified teachers, by region, 2013/14–2017/18

Region	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Upper Peninsula	2.9	2.5	2.5	2.2	2.2	2.5	–0.7
Northwest	2.2	2.4	2.1	2.1	2.0	2.2	–0.2
Northeast	2.1	3.1	2.8	1.9	3.0	2.6	0.9
West Michigan	2.7	2.6	2.6	2.3	2.7	2.6	0.0
East Central Michigan	2.4	2.1	2.0	1.8	2.0	2.1	–0.4
East Michigan	1.9	2.0	1.7	1.6	1.4	1.7	–0.5
South Central	3.0	2.4	2.3	2.7	2.4	2.5	–0.6
Southwest	3.5	2.9	3.2	2.9	2.4	3.0	–1.1
Southeast Michigan	2.4	2.3	2.5	2.8	2.7	2.5	0.3
Detroit Metro	3.4	2.7	2.5	2.4	2.3	2.6	–1.2

Note: See figure A1 in appendix A for a map of the regions.
Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education.

Table B16. Percentage of other entrants, by region, 2013/14–2017/18

Region	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Upper Peninsula	4.8	4.9	5.3	5.3	6.1	5.3	1.3
Northwest	5.4	6.3	5.3	5.6	6.0	5.7	0.6
Northeast	3.7	5.0	4.1	4.4	5.2	4.5	1.5
West Michigan	4.3	4.0	4.1	4.6	5.0	4.4	0.7
East Central Michigan	3.8	4.0	4.2	4.9	4.6	4.3	0.8
East Michigan	3.9	4.2	4.4	5.0	5.1	4.5	1.2
South Central	4.4	4.6	4.2	4.9	5.5	4.7	1.1
Southwest	5.1	4.9	4.8	5.5	6.5	5.4	1.4
Southeast Michigan	3.8	4.0	3.9	5.3	6.8	4.7	3.0
Detroit Metro	5.1	4.7	4.3	5.0	6.0	5.0	0.9

Note: See figure A1 in appendix A for a map of the regions.
Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education.

Table B17. Percentage of teachers from different supply sources, by district locale, 2013/14–2017/18

Supply source and locale	2013/14	2014/15	2015/16	2016/17	2017/18	Five-year average	Change between 2013/14 and 2017/18 (percentage points)
Retained in the same district from a previous year							
City	85.1	85.9	85.4	85.3	83.2	85.0	–1.9
Suburban	90.5	91.4	91.5	90.3	89.3	90.6	–1.1
Town	91.2	90.0	90.8	89.9	89.1	90.2	–2.1
Rural	90.9	90.5	90.6	88.8	88.2	89.8	–2.7
Transferred from another Michigan district							
City	4.4	4.8	5.1	5.1	5.4	5.0	1.1
Suburban	3.2	2.7	3.1	3.5	4.1	3.3	0.9
Town	2.2	2.7	2.8	3.2	3.5	2.9	1.3
Rural	2.2	2.8	2.8	3.7	4.0	3.1	1.8
Newly certified							
City	3.9	3.3	3.4	3.0	3.0	3.3	–0.9
Suburban	2.6	2.2	2.1	2.0	1.9	2.2	–0.7
Town	2.5	2.4	2.1	2.3	2.1	2.3	–0.4
Rural	2.5	2.6	2.4	2.3	2.4	2.4	–0.1
Other entrants							
City	6.6	5.9	6.1	6.6	8.4	6.7	1.8
Suburban	3.7	3.7	3.4	4.1	4.6	3.9	0.9
Town	4.1	5.0	4.3	4.6	5.3	4.7	1.1
Rural	4.4	4.1	4.2	5.2	5.4	4.7	1.0

Note: The 12 National Center for Education Statistics urban-centric locale codes were collapsed into four categories. See https://nces.ed.gov/pubs2007/ruraled/exhibit_a.asp for definitions of the locale codes.

Source: Authors' analysis of Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education

Table B18. Percentage of teachers from different supply sources, by district average teacher salary, 2013/14–2016/17

Supply source and salary category	2013/14	2014/15	2015/16	2016/17	Four-year average	Change between 2013/14 and 2016/17 (percentage points)
Retained in the same district from the previous year						
Low	84.5	82.9	86.4	84.7	84.7	0.2
Medium	90.7	91.5	91.3	90.2	90.9	–0.6
High	93.6	93.4	94.0	92.7	93.4	–0.9
Transferred from another Michigan district						
Low	3.8	4.3	3.8	4.4	4.1	0.6
Medium	2.7	2.6	2.9	3.5	2.9	0.8
High	2.1	2.1	2.2	2.7	2.3	0.7
Newly certified						
Low	4.9	5.0	3.6	3.6	4.3	–1.3
Medium	2.3	2.3	2.3	2.4	2.3	0.1
High	1.8	1.5	1.4	1.5	1.5	–0.3
Other entrants						
Low	6.8	7.7	6.1	7.2	7.0	0.5
Medium	4.3	3.5	3.5	3.9	3.8	–0.4
High	2.6	2.9	2.5	3.1	2.8	0.5

Note: Low-salary districts are those in the lowest quartile of average teacher salary, medium-salary districts are those in the middle two quartiles of average teacher salary, and high-salary districts are those in the highest quartile of average teacher salary. Data on average teacher salaries in 2017/18 were not available, so only four years of data are presented.
Source: Authors' analysis of data from various editions of the Michigan Department of Education's Bulletin 1014 and Registry of Educational Personnel data and teacher certification data provided by the Michigan Department of Education.

Table B19. Number of permits issued to Michigan schools, by region, district locale, and district average teacher salary, 2013/14–2017/18

Group category	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2016/17	
						Number	Percent
Region[a]							
Upper Peninsula	929	935	1,020	1,038	1,121	192	20.7
Northwest	823	885	939	907	968	145	17.6
Northeast	448	488	500	528	546	98	21.9
West Michigan	7,614	6,211	6,044	6,059	6,131	–1,483	–19.5
East Central Michigan	1,922	1,901	1,791	1,980	2,385	463	24.1
East Michigan	3,021	2,810	2,739	4,997	5,229	2,208	73.1
South Central	1,971	1,737	1,741	1,840	1,926	–45	–2.3
Southwest	2,891	2,801	2,806	2,959	2,865	–26	–0.9
Southeast Michigan	4,636	4,388	4,429	3,581	3,707	–929	–20.0
Detroit Metro	23,261	21,425	20,575	20,011	21,285	–1,976	–8.5
District locale[b]							
City	14,837	13,780	12,213	11,649	11,958	–2,879	–19.4
Suburban	21,406	18,954	19,145	20,390	21,949	543	2.5
Town	4,675	4,242	4,772	4,484	4,748	73	1.6
Rural	6,598	6,605	6,454	7,348	7,455	857	13.0
Salary category[c]							
Low	556	832	488	560	—	4[d]	0.7[d]
Medium	4,338	4,499	5,087	6,465	—	2,127[d]	49.0[d]
High	8,420	7,850	8,950	10,461	—	2,041[d]	24.2[d]

— is not available.

a. See figure A1 in appendix A for a map of the regions.

b. The 12 National Center for Education Statistics urban-centric locale codes were collapsed into four categories. See https://nces.ed.gov/pubs2007/ruraled/exhibit_a.asp for definitions of the locale codes. Nine school districts were excluded from the analysis between 2016/17 and 2017/18 because their locale data were missing or could not be determined, resulting in an undercount of a total of 29 permits in 2016/17 and 53 permits in 2017/18.

c. Low-salary districts are those in the lowest quartile of average teacher salary, medium-salary districts are those in the middle two quartiles of average teacher salary, and high-salary districts are those in the highest quartile of average teacher salary. Salary data were missing for all intermediate districts, for about 90 percent of charter districts, and for 2.4–4 percent of local education agency districts in each year. These districts were excluded from the analysis, resulting in an undercount of total permits.

d. Refers to the change between 2013/14 and 2016/17.

Source: Authors' analysis of data from various editions of the Michigan Department of Education's Bulletin 1014 and substitute permit data provided by the Michigan Department of Education.

Table B20. Number of permits issued to Michigan schools, by permit type, 2013/14–2017/18

Permit type	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18	
						Number	Percent
Daily Substitute Permit	46,617	42,615	41,454	41,891	43,489	–3,128	–6.7
Long-term substitute permits	899	966	1,130	2,009	2,674	1,775	197.4
Full-Year Basic Substitute Permit	173	251	368	886	1,267	1,094	632.4
Annual Career and Technical Education Authorization	312	271	308	373	435	123	39.4
Extended Daily Substitute Permit	0	0	0	262	382	382	na
Day-to-Day Substitute Annual Career and Technical Education Authorization	221	220	214	229	276	55	24.9
Credit Track Annual Career and Technical Education Authorization	112	146	162	164	178	66	58.9
Full-Year Shortage Permit	0	0	0	32	61	61	na
Expert Substitute Permit	0	0	0	20	30	30	na
Less-Than-Class-Size Annual Career and Technical Education Authorization	35	30	26	21	29	–6	–17.1
Adult Education Annual Career and Technical Education Authorization	25	33	21	16	8	–17	–68.0
Long-Term Substitute Annual Career and Technical Education Authorization	5	3	6	6	8	3	60.0
Emergency Permit	6	0	8	0	0	–6	–100.0
Expert in Residence Permit	6	11	15	0	0	–6	–100.0
Section 1233(b) Permit	4	1	2	0	0	–4	–100.0

na is not applicable.
Note: For the definition of each permit type, see Michigan Department of Education (2016).
Source: Authors' analysis of substitute permit data provided by the Michigan Department of Education.

Table B21. Number of permits issued to Michigan schools by subject area and permits issued to Michigan schools as a percentage of total teacher count in each subject area, 2013/14–2017/18

Subject area	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18
Arts						
Number	5	21	30	72	132	127
Percent	0.1	0.4	0.6	1.4	2.6	2.5
Bilingual						
Number	2	2	3	17	15	13
Percent	0.9	0.8	1.0	5.6	5.5	4.7
Business education						
Number	2	1	5	14	11	9
Percent	0.3	0.1	0.7	1.9	1.4	1.2
Career and technical education						
Number	710	706	728	825	961	251
Percent	47.6	48.2	50.6	56.2	66.2	18.6
English language arts						
Number	11	20	45	174	203	192
Percent	0.1	0.2	0.5	1.9	2.1	2.0
General elementary						
Number	0	0	0	132	291	291
Percent	0.0	0.0	0.0	0.4	0.9	0.9
Health and physical education						
Number	21	17	43	91	164	143
Percent	0.5	0.4	1.1	2.4	4.2	3.6
Math						
Number	7	14	29	67	103	96
Percent	0.1	0.2	0.4	0.9	1.3	1.2
Miscellaneous						
Number	3	7	0	14	18	15
Percent	0.1	0.3	0.0	0.8	1.0	0.8
Science						
Number	17	15	27	68	130	113
Percent	0.3	0.2	0.4	1.1	1.9	1.6
Social studies						
Number	4	3	3	36	67	63
Percent	0.1	0.0	0.1	0.6	1.0	0.9
Special education						
Number	20	43	57	151	227	207
Percent	0.1	0.3	0.3	0.9	1.3	1.2

Subject area	2013/14	2014/15	2015/16	2016/17	2017/18	Change between 2013/14 and 2017/18
Technology						
Number	13	16	25	62	80	67
Percent	0.7	0.9	1.5	3.6	4.2	3.5
World languages						
Number	81	100	122	160	185	104
Percent	2.6	3.2	3.9	5.1	4.6	2.0

Note: The first row for each subject area represents counts of permits; the second row represents permits as a percentage of total teaching count in each subject area.
Source: Authors' analysis of substitute permit data and Registry of Educational Personnel data provided by the Michigan Department of Education.

Projections of teacher demand and active teacher supply

Table B22. Historical and projected enrollment by region, 2013/14–2022/23

	Historical					Projected					
Region	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Change between 2018/19 and 2022/23 (percent)
Upper Peninsula	39,886	39,487	39,046	38,608	38,156	37,615	37,240	36,911	36,736	37,056	–1.5
Northwest	41,885	41,070	40,539	40,358	40,079	40,041	40,234	40,471	40,385	40,892	2.1
Northeast	25,441	24,858	24,576	24,516	24,220	23,744	23,532	23,359	23,231	23,393	–1.5
West Michigan	253,900	250,388	248,361	247,940	247,354	243,189	242,149	241,871	241,376	243,537	0.1
East Central Michigan	78,175	77,121	76,008	74,886	74,224	72,501	71,626	70,991	70,131	70,498	–2.8
East Michigan	136,808	133,627	130,399	127,889	125,645	122,277	120,042	118,091	116,340	116,750	–4.5
South Central	68,986	68,399	67,839	67,649	67,449	66,833	66,869	66,780	66,766	67,351	0.8
Southwest	119,565	118,474	117,946	118,620	118,284	116,978	116,058	115,426	114,823	115,536	–1.2
Southeast Michigan	141,042	138,874	137,239	136,330	135,936	133,904	132,532	131,277	130,361	131,170	–2.0
Detroit Metro	602,390	594,075	586,570	583,598	581,563	568,409	563,387	559,800	556,325	561,298	–1.3

Source: Authors' analysis of data from the MI School Data portal and data from various editions of the U.S. Census Bureau's Annual County Resident Population Estimates report.

Table B23. Historical and projected enrollment by district locale, 2013/14–2022/23

	Historical					Projected					
Locale	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Change between 2018/19 and 2022/23 (percent)
City	374,592	366,984	352,315	349,999	347,831	336,467	333,928	332,127	330,362	333,198	–1.0
Suburban	685,194	677,104	669,041	673,154	671,304	655,214	649,507	645,361	641,354	646,194	–1.4
Town	192,044	187,965	182,226	185,002	183,857	176,028	174,901	173,978	173,155	174,688	–0.8
Rural	256,248	254,320	264,941	252,239	249,918	257,781	255,332	253,511	251,602	253,400	–1.7

Note: The 12 National Center for Education Statistics urban-centric locale codes were collapsed into four categories. See https://nces.ed.gov/pubs2007/ruraled/exhibit_a.asp for definitions of the locale codes.
Source: Authors' analysis of data from the MI School Data portal and data from various editions of the U.S. Census Bureau's Annual County Resident Population Estimates report.

Table B24. Historical and projected enrollment by level of district average teacher salary, 2013/14–2022/23

	Historical					Projected					
Salary category	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Change between 2018/19 and 2022/23 (percent)
Low	96,452	97,416	104,379	102,958	53,273	52,439	51,932	51,518	51,102	51,322	–2.1
Medium	642,287	587,632	639,174	579,679	485,586	475,774	471,596	468,565	465,592	469,231	–1.4
High	659,344	691,578	616,363	668,794	805,915	790,231	783,901	779,380	774,982	780,769	–1.2

Note: Low-salary districts are those in the lowest quartile of average teacher salary, medium-salary districts are those in the middle two quartiles of average teacher salary, and high-salary districts are those in the highest quartile of average teacher salary.
Source: Authors' analysis of data from the MI School Data portal, data from various editions of the Michigan Department of Education's Bulletin 1014, and data from various editions of the U.S. Census Bureau's Annual County Resident Population Estimates report.

Table B25. Projected teacher demand and active teacher supply in terms of full-time equivalent teachers, by region, 2018/19–2022/23

Region and year	Projected demand	Projected active supply	Absolute difference	Relative difference
Upper Peninsula				
2018/19	2,564[a]	2,389	–174	–6.8
2019/20	2,542[a]	2,387	–155	–6.1
2020/21	2,523[a]	2,387	–136	–5.4
2021/22	2,515[a]	2,396	–118	–4.7
2022/23	2,540[a]	2,434	–105	–4.2
Northwest				
2018/19	2,419	2,252	–168	–6.9
2019/20	2,434	2,266	–168	–6.9
2020/21	2,451	2,283	–167	–6.8
2021/22	2,449	2,282	–167	–6.8
2022/23	2,483	2,315	–168	–6.8
Northeast				
2018/19	1,354	1,389	35	2.6
2019/20	1,344	1,390	46	3.4
2020/21	1,336	1,393	58	4.3
2021/22	1,330	1,399	69	5.2
2022/23	1,341	1,422	81	6.1
West Michigan				
2018/19	14,042	14,106	64	0.5
2019/20	13,999	14,097	98	0.7
2020/21	14,000	14,133	133	1.0
2021/22	13,988	14,157	168	1.2
2022/23	14,132	14,335	203	1.4
East Central Michigan				
2018/19	3,951	4,049	98	2.5
2019/20	3,908	4,018	110	2.8
2020/21	3,878	4,001	123	3.2
2021/22	3,836	3,971	135	3.5
2022/23	3,860	4,012	152	3.9
East Michigan				
2018/19	6,658	6,576	–82	–1.2
2019/20	6,545	6,458	–86	–1.3
2020/21	6,446	6,358	–89	–1.4
2021/22	6,359	6,268	–90	–1.4
2022/23	6,388	6,305	–83	–1.3

Region and year	Projected demand	Projected active supply	Absolute difference	Relative difference
South Central				
2018/19	3,647	3,843	197	5.4
2019/20	3,653	3,846	193	5.3
2020/21	3,652	3,840	188	5.2
2021/22	3,655	3,840	184	5.0
2022/23	3,692	3,874	182	4.9
Southwest				
2018/19	6,773	6,597	–176	–2.6
2019/20	6,729	6,522	–207	–3.1
2020/21	6,701	6,464	–237	–3.5
2021/22	6,674	6,407	–267	–4.0
2022/23	6,725	6,428	–297	–4.4
Southeast Michigan				
2018/19	7,511	7,868	357	4.7
2019/20	7,442	7,858	416	5.6
2020/21	7,380	7,854	474	6.4
2021/22	7,336	7,871	534	7.3
2022/23	7,390	7,988	598	8.1
Detroit Metro				
2018/19	32,022	32,697	675	2.1
2019/20	31,953	32,338	385	1.2
2020/21	32,038	32,062	24	0.1
2021/22	32,170	31,793	–376	–1.2
2022/23	33,163	32,018	–1,146	–3.5

Note: See figure A1 in appendix A for a map of the regions. Absolute difference is the difference between projected demand and projected active supply; relative difference is absolute difference divided by projected demand.
a. Indicates projections with a mean absolute percentage error (a measure of forecast error) of greater than 10 percent.
Source: Authors' analysis of data from the MI School Data portal, data from various editions of the U.S. Census Bureau's Annual County Resident Population Estimates report, and Registry of Educational Personnel and teacher certification data provided by the Michigan Department of Education.

Table B26. Projected teacher demand and active teacher supply in terms of full-time equivalent teachers, by district locale, 2018/19–2022/23

District locale and year	Projected demand	Projected active supply	Absolute difference	Relative difference
City				
2018/19	19,121	20,069	948	5.0
2019/20	19,190	19,854	664	3.5
2020/21	19,373	19,682	309	1.6
2021/22	19,597	19,512	–85	–0.4
2022/23	20,449	19,611	–838	–4.1
Suburban				
2018/19	36,919	37,261	343	0.9
2019/20	36,629	37,006	377	1.0
2020/21	36,428	36,841	412	1.1
2021/22	36,236	36,684	448	1.2
2022/23	36,563	37,044	480	1.3
Town				
2018/19	9,791	9,689	–102	–1.0
2019/20	9,742	9,643	–99	–1.0
2020/21	9,704	9,609	–95	–1.0
2021/22	9,671	9,581	–90	–0.9
2022/23	9,769	9,690	–78	–0.8
Rural				
2018/19	15,110	14,747	–363	–2.4
2019/20	14,987	14,678	–309	–2.1
2020/21	14,901	14,645	–255	–1.7
2021/22	14,808	14,607	–201	–1.4
2022/23	14,932	14,786	–146	–1.0

Note: The 12 National Center for Education Statistics urban-centric locale codes were collapsed into four categories. See https://nces.ed.gov/pubs2007/ruraled/exhibit_a.asp for definitions of the locale codes. Absolute difference is the difference between projected demand and projected active supply; relative difference is absolute difference divided by projected demand.
Source: Authors' analysis of data from the MI School Data portal, data from various editions of the U.S. Census Bureau's Annual County Resident Population Estimates report, and Registry of Educational Personnel and teacher certification data provided by the Michigan Department of Education.

Table B27. Projected teacher demand and active teacher supply in terms of full-time equivalent teachers, by district average teacher salary level, 2018/19–2022/23

Salary category and year	Projected demand	Projected active supply	Absolute difference	Relative difference
Low				
2018/19	3,078	3,136	58	1.9
2019/20	3,052	3,117	65	2.1
2020/21	3,031	3,104	72	2.4
2021/22	3,010	3,090	80	2.6
2022/23	3,027	3,113	86	2.9
Medium				
2018/19	26,985	27,112	127	0.5
2019/20	26,784	26,954	170	0.6
2020/21	26,648	26,864	215	0.8
2021/22	26,515	26,776	262	1.0
2022/23	26,756	27,075	320	1.2
High				
2018/19	44,860	45,572	712	1.6
2019/20	44,731	45,247	516	1.2
2020/21	44,779	45,028	249	0.6
2021/22	44,873	44,816	–57	–0.1
2022/23	45,931	45,198	–732	–1.6

Note: Low-salary districts are those in the lowest quartile of average teacher salary, medium-salary districts are those in the middle two quartiles of average teacher salary, and high-salary districts are those in the highest quartile of average teacher salary. Absolute difference is the difference between projected demand and projected active supply; relative difference is absolute difference divided by projected demand.

Source: Authors' analysis of data from the MI School Data portal, data from various editions of the Michigan Department of Education's Bulletin 1014, data from various editions of the U.S. Census Bureau's Annual County Resident Population Estimates report, and substitute permit data provided by the Michigan Department of Education.

Table B28. Projected teacher demand and active teacher supply in terms of full-time equivalent teachers, by subject area, 2018/19–2022/23

Subject area and year	Projected demand	Projected active supply	Absolute difference	Relative difference
Arts				
2018/19	4,208	4,478	270	6.4
2019/20	4,191	4,499	308	7.3
2020/21	4,187	4,541	355	8.5
2021/22	4,184	4,584	399	9.5
2022/23	4,255	4,626	371	8.7
Bilingual education				
2018/19	260[a]	283[a]	23	8.9
2019/20	279[a]	312[a]	33	11.8
2020/21	303[a]	336[a]	33	10.9
2021/22	332[a]	361[a]	29	8.8
2022/23	377[a]	385[a]	8	2.1
Business education				
2018/19	501	486	–16	–3.1
2019/20	497	463	–34	–6.9
2020/21	496	447	–49	–9.9
2021/22	499	432	–67	–13.5
2022/23	513	416	–97	–18.8
Career and technical education				
2018/19	721	671	–50	–6.9
2019/20	735	677	–58	–7.9
2020/21	751	684	–68	–9.0
2021/22	769	691	–78	–10.1
2022/23	801	698	–104	–12.9
English language arts				
2018/19	7,224	7,127	–97	–1.3
2019/20	7,163	7,059	–104	–1.5
2020/21	7,128	6,993	–135	–1.9
2021/22	7,099	6,927	–172	–2.4
2022/23	7,207	6,861	–346	–4.8
General elementary				
2018/19	29,669	29,516	–154	–0.5
2019/20	29,420	29,492	72	0.2
2020/21	29,261	29,438	177	0.6
2021/22	29,125	29,385	260	0.9
2022/23	29,563	29,332	–231	–0.8

Subject area and year	Projected demand	Projected active supply	Absolute difference	Relative difference
Health and physical education				
2018/19	3,111	3,172	61	2.0
2019/20	3,101	3,179	78	2.5
2020/21	3,102	3,181	79	2.6
2021/22	3,104	3,183	79	2.5
2022/23	3,162	3,185	23	0.7
Math				
2018/19	5,975	6,053	78	1.3
2019/20	5,925	6,053	128	2.2
2020/21	5,896	6,032	137	2.3
2021/22	5,871	6,012	140	2.4
2022/23	5,958	5,991	33	0.6
Science				
2018/19	5,105	5,294	189	3.7
2019/20	5,065	5,330	266	5.2
2020/21	5,041	5,358	317	6.3
2021/22	5,021	5,385	364	7.2
2022/23	5,091	5,413	321	6.3
Social studies				
2018/19	5,023	5,126	103	2.1
2019/20	5,003	5,154	151	3.0
2020/21	5,004	5,179	174	3.5
2021/22	5,013	5,203	190	3.8
2022/23	5,125	5,227	102	2.0
Special education				
2018/19	11,029	11,571	542	4.9
2019/20	11,194	11,455	261	2.3
2020/21	11,399	11,597	198	1.7
2021/22	11,615	11,739	124	1.1
2022/23	12,062	11,882	–181	–1.5
Technology				
2018/19	1,035	1,074	39	3.8
2019/20	998	1,100	102	10.2
2020/21	965	1,096	130	13.5
2021/22	934	1,091	157	16.8
2022/23	916	1,086	170	18.5
World languages				
2018/19	2,723	2,794	71	2.6
2019/20	2,787	2,838	51	1.8
2020/21	2,862	2,910	49	1.7

Subject area and year	Projected demand	Projected active supply	Absolute difference	Relative difference
2021/22	2,940	2,983	44	1.5
2022/23	3,072	3,056	–16	–0.5

Note: Absolute difference is the difference between demand and supply; relative difference is the difference between demand and supply divided by demand. Early childhood education teachers were not included in the demand and supply projections because data on prekindergarten student enrollment were not available.

a. Indicates projections with a mean absolute percentage error (a measure of forecast error) of greater than 10 percent.

Source: Authors' analysis of data from the MI School data portal, data from various editions of the U.S. Census Bureau's Annual County Resident Population Estimates report, and Registry of Educational Personnel and teacher certification data provided by the Michigan Department of Education.

Reference

Michigan Department of Education. (2016). *About Michigan substitute permits.* Lansing, MI: Author. Retrieved from https://www.michigan.gov/documents/mde/Permit_Overview_529841_7.pdf