Special Education Personnel Attrition in Pennsylvania

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Abstract

We used longitudinal staffing data from Pennsylvania to explore differences in special education personnel attrition across personnel categories, individual characteristics, and district characteristics. Special education administrators and school psychologists had the highest attrition rates among special education personnel, with special education administrators 6.4 percentage points more likely to leave their district than observably similar special educators in the same district. Black special education personnel were 2.1 percentage points more likely to leave than observably similar White special education personnel in the same district. Special education personnel in urban districts and districts serving high proportions of students of color also were more likely to leave, all else equal. These trends suggest the need for targeted retention efforts for these important categories of special education personnel.

1. Introduction

Many students with disabilities (SWDs) who receive special education services require support from a team of educational providers to receive the free appropriate public education to which they are entitled under the Individuals with Disabilities Education Act (IDEA). However, there are growing concerns that personnel shortages may prevent schools from meeting the requirements of IDEA that SWDs are taught by qualified teachers and support personnel (Mason-Williams et al., 2020). Schools across the United States reported that they were understaffed in special education in fall 2022 (National Center for Education Statistics [NCES], 2023), and studies have documented high special educator attrition rates (Gilmour, 2023; Gilmour et al., 2023; Gilmour & Wehby, 2019; Theobald et al., 2021). Yet to date, researchers have paid little attention to the attrition of other school personnel who directly or indirectly support SWDs.

Attrition has high costs to students. Research from general education suggests that teacher attrition is associated with declines in students' test scores (Hanushek et al., 2016), in part because of how attrition disrupts educational teams and program implementation (McLeskey & Billingsley, 2008; Ronfeldt et al., 2013). The costs of attrition may be even greater for SWDs who may rely on multiple personnel to provide specialized services and whose coordinated services may be more substantially disrupted when a direct or indirect member of their support team leaves (Kaler et al., 2024). Within SWDs, SWDs of color may be disproportionately harmed by differential attrition of special educators of color given the well-documented benefits of special education workforce diversity for SWDs of color (e.g., Scott & Alexander, 2019).

Additional evidence suggests that the costs of attrition are not equitably distributed among schools and districts. Teachers tend to move from traditionally under-resourced schools to schools and districts with more resources, resulting in students from minoritized or low-

income backgrounds having less access to qualified, experienced teachers (Bruno et al., 2020; Goldhaber et al., 2015; Goldhaber, Theobald et al., 2022). In special education, schools serving more low-income or minoritized students tend to have special educators with fewer qualifications and less experience than schools serving fewer low-income or minoritized students (Cooc & Yang, 2016; Mason-Williams, 2015), potentially reflecting higher attrition rates from schools serving higher proportions of students from minoritized or low-income backgrounds (e.g., Billingsley & Bettini, 2019). Recent research examining job postings, a potential proxy for vacancies, found that schools serving higher proportions of under-represented minority students post more special education positions than schools with lower proportions of under-represented minority students (Goldhaber et al., 2024). Together, these data suggest that problems arising from attrition may not be equitably distributed across contexts.

There is also considerable prior evidence of special education staffing challenges in Pennsylvania, the setting for this paper. In each of the past ten years Pennsylvania has reported shortages of special educators, teachers for students with visual impairments, teachers for students with hearing impairments, and/or professionals focused on language and speech (U.S. Department of Education, 2023). These shortages are likely due in part to decreases in the number of first-time certifications in the state; the number of initial special education certificates declined by 57.2% from the 2010–11 school year to the 2022–23 school year, whereas the number of teachers with emergency certification increased (Fuller, 2024). Exploring trends in attrition and differences in attrition by district characteristics is even more essential given the context of declining certifications and increased reliance on teachers with emergency licenses.

The purpose of this study was to investigate special education personnel attrition using longitudinal staffing data from Pennsylvania from the 2013–14 through the 2022–23 school year,

and to examine the extent to which this attrition varied by teacher and district characteristics. We focused on eight categories of special education personnel: special education teachers, school psychologists, special education administrators, teachers of the visually impaired, teachers of the deaf, speech language personnel (SLPs), occupational therapists, and physical therapists. These are not all the personnel who may support SWD, but data availability limited us to these categories. We explored three broad research questions:

1) How does special education personnel attrition vary across personnel categories?

2) How does special education personnel attrition vary by individual characteristics?

3) How does special education personnel attrition vary by district characteristics.

2. Literature Review

Depending on their individualized needs, SWDs may receive direct services, such as specialized instruction or support from a special education teacher or specialist, or indirect support, such as consultation from specialists, school psychologists, and special education administrators. Students could be negatively influenced when special education personnel leave if this attrition results in an inability to receive services or a decline in the effectiveness of services as a new professional learns the students' specific needs. Indirectly, SWDs could be harmed by personnel attrition if it results in heavier workloads for remaining staff, either through higher staff to student ratios or changes in other working conditions. Attrition could also exacerbate the racial/ethnic mismatch of SWDs and their educators if special education personnel of color have higher attrition rates than their White counterparts (Billingsley et al., 2019). Attrition has the potential to disrupt the conditions in a school necessary for providing services to SWDs, in addition to directly disrupting the services a student receives.

Special educators appear to have higher attrition than general education teachers in most settings (Gilmour & Wehby, 2020; Sutcher et al., 2016; Theobald et al., 2021). However, only a

few studies have attended to the attrition of other special education school personnel (Ghere & York-Barr, 2007; Penner et al., 2023; Prater et al., 2007; Theobald et al., 2023), and these have primarily focused on paraeducators. Using 25 years of data from Washington state, Theobald et al. (2023) explored paraeducator attrition over time. Paraeducator attrition was consistently higher than special educator attrition with 40% of paraeducators leaving their positions at the end of the 2022–23 school year. Paraeducator attrition was highest in schools serving larger proportions of students from underrepresented minority backgrounds. Penner et al. (2023), using data from Oregon from 2007 to 2016 and defining attrition as when paraeducators left their position, identified paraeducator attrition rates of 26.5%, slightly lower than the special educator attrition rate of 28%. In their qualitative study of paraeducator attrition, Ghere and York-Barr (2007) found paraeducator attrition substantially disrupted program continuity and increased workloads for remaining staff because substitute paraeducators were not available. Additionally, recruiting and training a new paraeducator required 4.5–38.5 hours of staff time, depending on the school district.

Outside of these investigations of paraeducator attrition, limited studies have examined special education administrator attrition (Penner et al., 2023) or other special education staff attrition, including school psychologists and speech-language pathologists (Penner et al., 2023; Prater et al., 2007). Penner et al. (2023) found about 22% of special education administrators, and 28% of special education licensed staff (i.e., audiologists, speech pathologists, interpreters, psychologists, occupational therapists, physical therapists etc.) left their positions each year. Prater et al. (2007) investigated school psychologist and speech-language pathologist attrition in rural and urban districts in Utah over two school years. They reported that 18.9% of school psychologists in rural settings and 15.9% of school psychologists in urban settings left their

positions in the years they studied. In rural settings, 5.4% of speech-language pathologists left their positions and 14.3% of speech-language pathologists in urban settings left their positions.

Additional survey data suggests that attrition of special education personnel results in staffing problems. Data projections based on surveys of National Association of School Psychologists members suggest that there will be a shortage of 1,055 school psychologists by 2025 (Castillo et al., 2014). Twenty-three percent of surveyed speech-language pathologists report that personnel shortages are one of the biggest challenges they face working in schools (American Speech-Language-Hearing Association, 2018), and that there are more speech-language positions open than job seekers in their area (American Speech-Language-Hearing Association, 2022). We were unable to find any recent data related to teachers of the deaf, teachers of the visually impaired, occupational therapists, or physical therapists.

The descriptive evidence on special education personnel attrition is sparse, but it suggests that concerns about high rates of special education teacher attrition should extend to other special education personnel. Particularly worrisome is the loss of a team member with specialized skills, such as an SLP, teacher of the visually impaired, or teacher of the deaf, who may be hard to replace or train on the specific needs of a student and for whom there may not be a substitute (Ghere & York-Barr, 2007). Special education personnel attrition also raises questions about the ability of schools to meet IDEA requirements and provide the services required by SWDs to make progress in school. High-profile reports from some school districts highlight the problems of special education staffing challenges with long waitlists for services (e.g., Clossen, 2023), inability to provide specific therapies because of lack of trained professionals (e.g., Powers, 2023), and an inability for districts to provide the timely special education evaluations required by law (e.g., Higgins, 2023). Understanding the extent to which special education personnel

attrition takes place, and the extent to which attrition varies systematically by individual characteristics and district context, could motivate strategic investment in recruitment and retention of staff beyond special educators.

3. Methods

3.1 Data Sources and Sample

We examined special education personnel attrition using staffing data provided by the Pennsylvania Department of Education from 2013–14 to 2022–23, using the final year of data in our attrition calculations. The dataset includes information about each staff member's job assignment each year, the district where they were employed, the school or schools where they worked, demographic information, and qualification information. We also merged district location codes from the Common Core of Data with the datasets provided by the state.

We classified special education staff based on their position assignments. We classified teachers as special educators if their assignment was designated as special education, but the assignment code did not specifically designate "visually impaired" or "hearing impaired." We designated special educators with an assignment specified as "hearing impaired" as teachers of the deaf. We designated special educators with an assignment specified as "visually impaired" as teachers of the visually impaired. We classified personnel as SLPs if their assignment was "speech correction." Special education administrators included special education supervisors and coaches. The data included direct assignment codes for school psychologists, physical therapists, and occupational therapist. In our descriptive analyses of attrition over time, we also included general education personnel, defined as certificated staff and administrators that were not in the special education personnel categories defined above.

The demographic and qualification information for each special education staff category is reported in Table 1, with each column representing the different categories of special

education staff described above. There are a few broad takeaways from these summary statistics. The special education workforce was overwhelmingly White, and school psychologists had the most relatively diverse workforce. Special education personnel had, on average, 12.00 to 16.97 years of experience, with special education administrators having the most experience. Most special education personnel had a master's degree, with SLPs having the highest proportion of master's degrees (91%) and physical therapists the lowest (46%). The workforce was mostly female, with school psychologists having the highest percent of male employees (20%). Special educators and special education administrators were less frequently part time than other personnel and less often worked in more than one school in a school year. Special educators had the lowest average salaries ($65,000), whereas special education administrators had the highest average salaries ($96,000).

The personnel in our sample worked in districts where 29.43% to 36.39% of students were students of color. The average percentage of students of color in the district was lowest for SLPs and highest for teachers of the visually impaired. The personnel in our sample worked in districts where, on average, 43.41% to 47.72% of students received free or reduced-price lunch. Across all personnel types, the majority worked in suburban districts. Finally, a lower percentage of SLPs (12.85%) worked in districts in cities than special educators, school psychologists, and school administrators (18.90%, 19.55%, and 20.43%, respectively, worked in districts in cities).

3.2 Variables

Our dependent variable for all analyses was district attrition. We coded attrition "1" if the individual was not working in the same district the following year or the individual left the Pennsylvania public school workforce and "0" if the personnel was working in the same district the following school year. We did not investigate attrition from a school because many special

education personnel worked in more than one school during the same school year (e.g., the average occupational therapist worked in 1.49 schools; see Table 1).

Table A1 provides a summary of the variables used in our models. Our predictors of interest in the first set of models described in the next section were binary variables indicating an individual's specific special education role, with special educators as the comparison. We included additional control variables in our statistical models to account for differences between types of personnel that could be associated with attrition. We included two binary variables indicating that the individual was Black or another non-White race/ethnicity, with White as the comparison condition (we combined teachers with different race/ethnicities who were not Black or White into one group because of small sample sizes; see Table 1). We included a binary variable indicating that an individual had 0–2 years of experience and a binary variable indicating that the individual had 30 or more years of experience; individuals with 3–29 years of experience were the comparison condition. We created three binary variables indicating an individual's highest degree (if the individual had a master's or specialist degree, a doctoral degree, or other, with bachelor's as the comparison). We also included a binary variable indicating that the individual reported they were male. Following Penner et al. (2023), we also included salary in thousands (mean-centered), the number of schools the individual worked in (centered on 1), and if they were employed part-time (full-time as comparison).

We also included district information to assess differences in special education staff attrition by context. We merged district location designations from the Common Core of Data available from NCES to create binary variables indicating if the district was in a city, suburb (comparison category), town, or rural area. We used student-level data files from the state to calculate the percentage of students in each district who were eligible for free or reduced-price

lunch (FRPL). We then created binary variables indicating that a district was in the top quartile of the percentage of students who were eligible for FRPL (high-FRPL) or bottom quartile of the percentage of students who were eligible for FRPL (low-FRPL); the comparison was districts in the middle two quartiles of the percentage of students receiving FRPL. Similarly, we used student-level data to calculate the percentage of students in the district who were non-White (i.e., students of color). Because the distribution of the percentage of racially/ethnically minoritized students in districts was bimodal, we created a binary variable indicating if ≥ 50% of the student population in the district were racially/ethnically minoritized students, with the comparison being districts where < 50% of the student population in the district were racially/ethnically minoritized students.

3.3 Data Analysis

We used descriptive statistics and regression to examine special education personnel attrition. First, we plotted attrition rates for special education personnel type over time compared to general education personnel. Second, we estimated linear probability models to examine the extent to which special education personnel type attrition was different from special education teacher attrition (Model 1). Coefficients from linear probability models can be interpreted as the average percentage point change in attrition associated with a one unit change in the predictor. We then added teacher characteristics to the model to account for differences between special education personnel types that are also associated with attrition (Model 2). We fit a third model that included district characteristics (Model 3):

$$y_{ijt} = \beta_0 + \beta_1 \boldsymbol{ROLE}_{it} + \beta_2 \boldsymbol{INDIVIDUAL}_{it} + \beta_3 \boldsymbol{DISTRICT}_{jt} + \gamma_t + \varepsilon_{ijt} \quad (1)$$

where y_{ijt} represents attrition for personnel *i* from district *j* in year *t*. $\boldsymbol{ROLE}_{it}$ is a vector of binary variables indicating personnel *i*'s role in year *t.* $\boldsymbol{INDIVIDUAL}_{it}$ is a vector of personnel

individual characteristics. $\boldsymbol{DISTRICT}_{jt}$ is a vector of district characteristics. γ_t are year fixed effects to account for school year–specific changes in attrition. ε_{ijt} is the random error term.

The estimates from various specifications of the model in equation 1 addressed the three research questions outlined in the introduction. The estimated coefficients in β_1 addressed research question 1 (How does special education personnel attrition vary across personnel categories?). The estimated coefficients in β_2 addressed research question 2 (How does special education personnel attrition vary by individual characteristics?). The estimated coefficients in β_3 addressed research question 3 (How does special education personnel attrition vary by district characteristics?).

The estimated coefficients from the model in equation 1 are "all else equal" in the sense that they compare observably similar personnel in observably similar districts, but attrition may vary across districts in ways that are not captured by the variables in $\boldsymbol{DISTRICT}_{jt}$. We therefore estimated additional models that drop these district characteristics and add district fixed effects to account for unobserved differences between districts (Model 4). In each model we clustered standard errors at the teacher level and included year fixed effects. We conducted the analyses in Stata 16.

Sensitivity Analyses

We conducted additional sensitivity analyses to ensure our variable and model choices did not influence the results. First, we re-estimated our models using logistic regression instead of linear probability models. Second, we re-estimated the models using a continuous parameterization of years of experience, including years of experience squared to account for the nonlinear association between experience and attrition. Finally, we re-estimated the linear probability models examining district attrition and state attrition as separate dependent variables.

4. Results

4.1 Personnel Attrition Over Time

We begin by reporting descriptive information about attrition in the years we studied. Figure 1 shows the proportion of general education personnel, special educators, SLPs, school psychologists, and special education administrators who left their district each year. All special education personnel had higher levels of attrition than general education personnel: pooling across years, 8.36% of general education personnel left their district compared to 9.65% of special educators, 13.90% of special education administrators, 9.85% of SLPs, 11.31% of school psychologists, 9.34% of teachers of the deaf, 8.5% of teachers of the visually impaired, 9.06% of occupational therapists, and 9.09% of physical therapists. Special education administrators had the highest attrition rates in every year but 2020–21, when SLPs had the highest attrition rate. Across all groups, and consistent with prior evidence on general education teachers from other states (e.g., Bacher-Hicks et al., 2023; Camp et al., 2023; Goldhaber & Theobald, 2023), attrition decreased in 2020, increased in 2021, and, except for SLPs, continued to increase in 2022.

In Figure 2, we plotted attrition for all special education personnel by their self-reported race/ethnicity. As shown in Figure 2, district attrition was higher for Black and other non-White special education personnel than for White special education personnel each year. In this sample, pooling across years, 16.21% of Black special education personnel left their districts, 14.09% of other non-White special education personnel left their districts, and 9.65% of White special education personnel left their districts. This pattern of higher attrition among Black and other non-White special education personnel might be driven in part by differences in the types of positions they occupy and/or differences in their district characteristics. We account for these observable differences in the regression results discussed later.

4.2 Differences in Attrition by Personnel Type (RQ1)

We estimated regression models to examine whether differences in special education personnel and special education teacher attrition were statistically significant, controlling for other observable characteristics of the districts in which they worked and other individual characteristics (e.g., experience). The first column of Table 2 reports the coefficients from the model that only included personnel roles. On average, school psychologists had attrition rates that were 1.7 percentage points higher than special educators, whereas special education administrators' attrition rates were 4.2 percentage points higher. The attrition rates for other special education personnel were not significantly different from attrition rates of special educators.

We then added personnel characteristics to Model 2 in Table 2. After accounting for individual characteristics, the difference in attrition rates between special education administrators and special educators increased and remained statistically significant; in other words, accounting for other observable differences between special education administrators and teachers such as years of experience, administrators were even *more* differentially likely to leave the district than the raw numbers suggest. The difference in attrition rates between school psychologists and special educators remained substantively similar to Model 1. But after accounting for observable differences, SLPs and teachers of the visually impaired had statistically significant lower average attrition than special educators, -0.7 percentage points and -2.2 percentage points, respectively.

In Model 3 we added characteristics of the districts in which these personnel worked. Accounting for district characteristics (the importance of which we explore in a later section), the differences in attrition rates between special educators and SLPs, school psychologists, and teachers of the visually impaired remained the same or decreased slightly and remained

statistically significant. The difference in attrition rates between special educators and administrators grew even more, with special education administrators 8.3 percentage points more likely to leave the district than special educators after accounting for personnel and district characteristics.

Finally, in Model 4 we removed district characteristics and included district fixed effects. In these models, we compared the probability of attrition for special education personnel working in the same district. This approach eliminates unmeasured differences across districts such as special education staffing models or district supports for special education. Accounting for personnel characteristics, SLPs, occupational therapists, and physical therapists did not have significantly different attrition rates compared to special educators in their district. Teachers of the deaf and teachers of the visually impaired had 1.6 percentage points and 2.5 percentage points lower average attrition rates than special educators in their districts after accounting for other individual characteristics. School psychologists had district attrition rates that were 1.6 percentage points higher than special educators in their district, an association that was consistent across models. The difference between special education administrators' and special educators' attrition rates declined slightly after accounting for unobserved differences between districts. However special education administrators' attrition rates were still 6.4 percentage points higher than special educators' attrition rates.

4.3 Personnel Attrition and Individual Characteristics (RQ2)

Individual characteristics were strongly associated with attrition rates (Models 2, 3, and 4). Black special education personnel had attrition rates that were 6.9 percentage points higher than White special education personnel after accounting for other individual characteristics and their roles. Other non-White personnel had attrition rates that were 4.1 percentage points higher

than White personnel. These differences were more modest but still statistically significant when comparing personnel from observably-similar districts: Black personnel and other non-White personnel had attrition rates 4.4 percentage points and 2.8 percentage points higher than White personnel, respectively. Again, the differences declined when we included district fixed effects to account for other differences between districts but remained substantively large and statistically significant, as Black special education personnel had attrition rates 2.1 percentage points higher than White special education personnel in their district, after accounting for other individual characteristics and roles. Other non-White special education personnel had attrition rates 1.4 percentage points higher than White special education personnel. As shown in Table 4, Black and other non-White personnel had higher district attrition rates across many staff categories that declined somewhat in the district fixed effects models (Table 5). However, many of the differences were not statistically significant likely in part due to small numbers of Black and other non-White personnel in some staff categories.

Aligning with prior research, attrition was also higher for novice special education personnel and special education personnel with 30+ years of experience. Novice special education personnel had average district attrition rates that were 5.1 percentage points higher than mid-career personnel, after accounting for other personnel and district characteristics (Table 3). Within districts, novice special education personnel had district attrition rates that were 4.2 percentage points higher than mid-career personnel. Novice SLPs and special education administrators had even higher district attrition than mid-career SLPs and special education administrators, 7.2 percentage points higher for SLPs and 8.1 percentage points higher for special education administrators. Personnel with 30 or more years of experience had district attrition rates that were 16.8 percentage points higher than mid-career personnel, likely reflecting

retirement. Differences in attrition by experience followed similar trends when the comparisons were within district (Table 4).

The highest levels of educational attainment were also associated with higher district attrition. In all models, personnel with a master's or specialist's degree had around 1 percentage point higher district attrition than personnel with only a bachelor's degree (Table 2). Personnel with doctoral degrees had attrition rates 3 percentage points higher than personnel with only a bachelor's degree (Table 3), a difference that declined to 2.3 percentage points in the district fixed-effects model. However, differences between attrition for personnel with higher degrees and bachelor's degrees were larger for special educators and special education administrators. Special educators and administrators with doctoral degrees had attrition rates 6.6 and 4.8 percentage points, respectively, higher than those with a bachelor's degree, after accounting for individual and district characteristics. These differences reduced slightly in the district fixed-effects models (Table 4).

Other aspects of individuals' jobs were also associated with differences in attrition. For every $1,000 increase in salary, the average district attrition rate declined by 0.1 percentage points, after accounting for personnel and district characteristics (Tables 3 and 4). Working in a greater number of schools was associated with higher attrition. An increase of one school was associated with a 0.9 percentage point average in district attrition, after accounting for role and observed individual and district characteristics. Personnel who worked in one more school had district attrition rates 1.3 percentage points higher than personnel in the same district who only worked in one school. The association between number of schools and attrition was only statistically significant for special educators when we examined predictors of attrition by personnel type and accounted for individual and observed district characteristics. Within

districts, special educators and SLPs who worked in more schools had higher district attrition rates than special educators and SLPs in their district who worked in one school (2.3 percentage points and 1.0 percentage points higher, respectively; Table 3).

Special education personnel in part-time positions had higher district attrition than special education personnel in full-time positions. After accounting for role, other personnel characteristics, and district characteristics, personnel employed part-time were 6.5 percentage points more likely to leave their district than personnel employed full-time (Tables 3 and 4). Special education administrators had particularly high attrition when they were part-time, a 24.2 higher district attrition rate compared to full-time special education administrators, after accounting for individual and observed district characteristics. However, this difference declined to 15.7 percentage points and was not statistically significant after accounting for unobserved district characteristics (Table 4)

4.4 Personnel Attrition and District Characteristics (RQ3)

We now turn to differences in attrition associated with district characteristics reported in Tables 2 and 3. Overall, special education personnel working in districts in rural areas or towns had lower district attrition than personnel working in suburban districts, after accounting for role, personnel, and other district characteristics, whereas personnel working in a city were 0.7 percentage points more likely to leave (Table 2). In Table 3 we report the results from models estimated separately for the different personnel samples; these models include personnel and district characteristics. Special educators and occupational therapists in cities had higher average district attrition rates than those who worked in suburbs (1.1 percentage points and 4.6 percentage points higher, respectively; see Table 3). Special education administrators in cities had district attrition rates that were, on average, 2.3 percentage points lower than special

education administrators working in suburbs, after accounting for other individual and district characteristics. Special educators and SLPs working in rural areas or towns had attrition rates 1.5–2.2 percentage points lower than their counterparts in the suburbs.

Overall special education personnel district attrition was not different in districts with high percentages of students receiving FRPL compared to personnel in districts with moderate percentages of students receiving FRPL (Table 2). However, special education administrators in high-FRPL districts had district attrition rates that were 4.0 percentage points higher than special education administrators in mid-FRPL districts (Table 3).

Personnel working in districts where ≥ 50% of the student population were racially/ethnically minoritized students had, on average, 3.2 percentage points higher district attrition, after accounting for personnel roles, characteristics, and other district characteristics than personnel in districts where < 50% of the student population were racially/ethnically minoritized students (Table 2). When we estimated models separately by personnel category, most special education personnel in districts serving more students of color still had, on average, higher district attrition than special education personnel who served lower proportions of students of color. The difference in average attrition rates ranged from 2 percentage points for SLPs to 4.2 percentage points for occupational therapists. Teachers of the deaf, teachers of the visually impaired, or physical therapists working in a district with more students of color did not have different attrition rates from those working in districts with fewer students of color.

4.5 Sensitivity Analyses

For our first sensitivity analysis, we re-estimated the models using logistic regression instead of linear probability models. The results, reported in Table A2, were substantively the same across the two modeling approaches. Next, we replaced the binary parameterizations of

experience with a continuous parameterization of years of experience and years of experience squared. The results of our analyses did not change (Table A3).

Finally, we separated leaving public schools in Pennsylvania from moving between districts as the dependent variables (Table A4). Overall, the results were similar to the full model with slightly attenuated coefficients. The results also provided a more nuanced understanding of attrition. For example, special education administrators' average attrition from public schools in Pennsylvania was 5.9 percentage points higher than special educators but only 3.2 percentage points higher for moving between districts. Results related to district characteristics were mostly consistent across the models where we considered attrition or disaggregated district attrition and leaving the public education workforce in the state.

5. Discussion

School leaders, policymakers, and researchers have long lamented the problem of special education teacher attrition (Brownell & Smith, 1993; Mason-Williams, 2020), yet SWDs are educated and supported by a variety of professionals with specialized knowledge. In this study, we compared district attrition of SLPs, school psychologists, special education administrators, teachers of the deaf, teachers of the visually impaired, occupational therapists, and physical therapists to special educators using data from Pennsylvania. We also examined how attrition varied by district characteristics. The results suggested that concerns about special education teacher attrition should extend to most types of special education personnel. Attrition of many special education personnel types outpaced general education teacher, and often special education teacher, attrition. After accounting for personnel and district characteristics, and school-year specific changes in attrition, we found that SLPs and teachers of the visually impaired had lower attrition rates than special educators. In contrast, school psychologists and special education administrators had substantially higher attrition rates than special educators.

Nearly all types of special education personnel had higher district attrition rates when they taught in districts where ≥ 50% of students were from racially/ethnically minoritized backgrounds.

We also found that individual characteristics were strongly associated with attrition. Most concerning were differences in attrition by race/ethnicity, with Black and other non-White special education personnel having attrition rates 2–7 percentage points higher than White personnel, depending on the model. The decline in attrition rates associated with personnel race attenuated when we added observable district characteristics to the model (Model 3) and was lowest when we accounted for non-observable district characteristics (Model 4). This suggests that the higher attrition rates of Black and other non-White personnel were due in part to differences between districts, but differences between the districts in which personnel work did not entirely account for the higher attrition rates of Black and other non-White personnel.

Together, these findings raise concerns that access to effective support and intervention for SWDs, particularly those from racially/ethnically minoritized backgrounds, may be influenced by personnel attrition. We discuss the implications of this concern in more detail before discussing the findings regarding special education personnel of color. We close with the limitations of the study and future directions for practice and research.

5.1 The Potential Implications of Special Education Personnel Attrition

SWDs and their teachers rely on a variety of professionals to receive both direct and indirect services. Two of the personnel types with the highest district attrition, and district attrition consistently higher than that of special educators, were school psychologists and special education administrators. These special education personnel may provide less direct support to students but are important to essential special education activities. School psychologists support the evaluation and IEP development process. If their attrition results in vacant positions or

positions filled by less qualified staff, evaluation responsibilities could potentially shift to other special education staff or there could be delays in evaluation. Older research suggested a coming shortage of school psychologists (Castillo et al., 2014); this work should be updated considering the findings that school psychologists have high rates of attrition and inform proactive approaches to recruiting and retaining school psychologists. For example, Pennsylvania is providing internship stipends for out-of-state school psychology trainees. States may also need to implement other types of interventions such as increased pay to attract school psychologists to public school settings and away from employment opportunities in the private sector.

Special education administrators also provide indirect support to students with roles that likely vary depending on the districts in which they work. Their responsibilities might include supporting special educators, monitoring compliance with IDEA, making staffing and service delivery decisions, supporting the IEP process, and addressing any special education complaints brought by parents. After accounting for personnel and district characteristics, special education administrators had district attrition rates that were 8.3 percentage points higher than attrition rates of special educators (6.4 percentage points when comparing special education administrators to special educators in the same district). This already high attrition was four percentage point higher in districts serving higher proportions of racially/ethnically minoritized students. These high levels of attrition could be particularly disruptive at the programmatic levels and couple potentially contribute to special education teacher attrition (Penner et al., 2023).

We conducted some additional exploratory analyses to better understand special education administrator attrition and found that charter school districts had particularly high administrator turnover, with 13.8% of special education administrators in charter districts leaving their district over the years we studied compared to 9.3% of regular school districts. This could,

to some extent, be due to the structure of charter schools with charter district attrition being more comparable to school level attrition. Many charter schools operate as their own district potentially resulting in more administrative positions available in the same geographical areas. Charter schools in Pennsylvania area also concentrated in areas that serve more ethnically/racially minoritized students (72.02% of charter school districts were majority ethnically/racially minoritized students compared to 9.02% of regular school districts). We re-estimated models including district charter school status in the models resulting in an attenuated, but not eliminated, association between majority ethnically/racially minoritized students and attrition (2.9 percentage points versus 4 percentage points without a counting for charter status).

The higher attrition of personnel in roles that often include less direct, consistent work with students could reflect the preference of educators for the work they do that directly involves students (Jones et al., 2022). In a study examining time use and teacher affect, Jones and colleagues found teachers reported a more positive affect when they were directly providing instruction to students compared to when they were engaging in administrative or non-instructional tasks. Similarly, Stark et al. (2023) found special educators of students with EBD reported more positive affect when they were directly working with students. Of the personnel who became special education administrators during the years that we studied, 88.04% were former special educators. The other personnel we studied had lower or the same rates of district attrition compared to special educators, potentially reflecting that personnel who work directly with students may have more positive feelings toward their positions, and thus be comparatively at less risk of leaving, than personnel who provide less direct support to students.

However, a hypothesis to understand variations in attrition related to the "psychic rewards" of teaching (Lortie, 2002) does not help to explain the variations in attrition by district

characteristics. Special education personnel attrition was higher in districts with higher proportions of racially/ethnically minoritized students, but not in districts serving higher proportions of students qualifying for FRPL. This seemingly inconsistent finding, given how race/ethnicity tracks family income on average (Reardon et al., 2015), could reflect the Pennsylvania-specific context. Districts with more ethnically/racially minoritized students have historically been underfunded by the state's funding formula (Kelly, 2022). Higher attrition in these districts is likely related to underinvestment in schools that result in less desirable working conditions for staff. Higher attrition can exacerbate inequities due to underinvestment both by directly affecting the outcomes of students (Atteberry et al., 2017; Ronfeldt et al., 2013) and if it results in positions filled by less qualified, and potentially less effective, staff (Mason-Williams, 2015)

5.2 Attrition of Special Education Personnel of Color

Prior research on special educator attrition has largely ignored race/ethnicity as a potential predictor, although scholars have also noted the need for more special educators of color (Scott, 2016; Scott et al., 2021). Although some studies have reported that special educators reported higher intentions to remain in the profession than White special educators (Scott et al., 2023), we found that Black and other non-White special education personnel had substantially higher rates of attrition compared to White special education personnel (although not all associations between race/ethnicity and attrition were statistically significant in the subgroup analyses likely due to low statistical power).

The changing estimates across models provide some insight to the potential mechanisms for the increased attrition of special education personnel of color. Accounting for roles and other individual characteristics (Model 2), Black and other non-White personnel had attrition rates 6.9

and 4.1 percentage points higher than White personnel. After accounting for district urbanicity and the race/ethnicity and FRPL status of students in the districts, the differences in attrition rates declined suggesting that some of the initial differences in attrition rates were due to the districts in which Black and other non-White special education personnel worked. This finding aligns with prior research that found Black special educators more frequently worked in urban schools and schools with higher proportions of students of color (Billingsley et al., 2019). After we added district fixed effects to the model, the differences in attrition between Black and other non-White special education personnel and White special education personnel declined, but was not entirely eliminated. This finding suggests that within a district, Black and other non-White special education personnel may be experiencing their working conditions differently than White personnel, in ways that lead to their attrition (Bettini et al., 2022; Cormier et al., 2022).

The higher attrition of special education personnel of color may contribute to the mismatch between the race/ethnicities of school personnel and the race/ethnicities of the students they work with. In our sample, the proportion of Black or other non-White personnel ranged from nearly 0% for physical therapists—nearly all physical therapists in our sample were White—to 8.91% for school psychologists. By contrast, 37.7% of the student population in Pennsylvania is Black or another non-White race/ethnicity (NCES, 2022). A mismatch between SWDs and the special education personnel exacerbated by higher attrition is particularly alarming given increasing evidence that students of color have better academic and behavioral outcomes when they are taught by teachers of color (Blake et al., 2016; Blazar, 2022; Dee, 2004; Gershenson et al., 2022; Hwang et al., 2023; Lindsay et al., 2021; Shirrell et al., 2023). Scholars have noted the particular importance of same-race/ethnicity teachers for SWDs, whose understanding of their students' culture may help students and their families navigate the special

education system while acting as a relatable role model and providing more effective services (Scott, 2016). Special education recruitment and retention efforts should include targeted outreach and support to improve the retention of special education personnel of color (Scott & Alexander, 2019).

5.3 Limitations

The present study has three main limitations. First, the dataset does not include information about all types of special education personnel such as paraeducators and very specialized supports such as audiologists, behavior analysts, adapted PE teachers etc. These other personnel provide important supports to students with disabilities that may be affected by attrition. This limitation highlights the importance of ensuring that administrative data include information about all school staff. Second, we focused on district attrition because many special education personnel worked in > 1 school, for example, 25.3% of speech language personnel-by-year observations and 23.9% of school psychologist-by-year observations in our sample worked in more than one school. District attrition likely underestimates the actual movement of personnel. For example, total special education teacher attrition (moving schools, changing positions, or leaving the state) following the 2021–22 school year was 21.6%. The focus on district attrition also limits comparisons between the results of the present study and other studies of personnel attrition (Theobald et al., 2023; Penner et al., 2023). Third, our analyses assume that personnel attrition has a negative effect on schools. Although studies from general education suggest that personnel attrition is associated with lower student outcomes (Atteberry et al., 2017; Ronfeldt et al., 2013), future work is needed to connect special education personnel attrition with student outcomes. Researchers should also consider how special education personnel is interrelated, for example if special education administrator attrition is associated with special

education teacher attrition, in analyses similar to those included in Penner et al. (2023) and Shaheen and Bacher-Hicks (2024).

5.4 Future Directions

Pennsylvania is experiencing declines in the number of new certifications earned in special education (Fuller, 2024) while also experiencing high attrition of special education personnel. Future research and practice need to address both the production of new special education personnel while increasing the retention of currently employed personnel. Pennsylvania is implementing multiple programs to address production and retention including: grants to institutions of higher education for accelerated programs for special education teacher certification; grants that support learning opportunities that promote interest in the field of special education among high school and college students; mentoring for novice special education personnel; networking and learning community opportunities for special education personnel; grants that support paraeducators to earn their associate degree and begin the path toward a bachelor's degree and certification; and learning institutes for special education personnel in similar roles that consist of in-person workshops to develop tools and strategies. Future research can use longitudinal administrative data to examine how these programs affect recruitment and retention of special education personnel and the subsequent effects on SWDs.

Researchers also need to conduct more studies across states examining special education personnel turnover. Emerging evidence from Pennsylvania, Washington (Theobald et al., 2023), and Oregon (Penner et al., 2023) suggests that special education personnel attrition is quite high with the potential to negatively impact the services that students with disabilities receive. A growing body of research has explored malleable variables associated with special education teacher attrition (Billingsley & Bettini, 2019; Gilmour et al., 2023), needed is a parallel body of

research focused on other special education personnel. Access to all types of experienced, well-prepared special education personnel is essential for meeting the requirements of IDEA for students with disabilities from all backgrounds in all types of districts.

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Tables and Figures

Table 1. Characteristics of Special Education Personnel in Pennsylvania

	Special Educators	Speech/Language Specialists	School Psychologist	Special Education Administrators	Teachers of the Deaf	Teachers of the Visually Impaired	Occupational Therapists	Physical Therapists
Race/ethnicity								
White	95.59	98.07***	91.09***	96.49***	99.13***	96.82*	95.01	99.90***
Black	2.93	0.92***	5.59***	2.61	0.73***	1.67**	3.07	0
Hispanic	0.56	0.51	1.62***	0.34**	0.14*	0	0.74	0
Asian	0.45	0.34*	1.07***	0.09***	0	0.84*	0.96***	0.10
Other[a]	0.47	0.16	0.63	0.47	0	0.67	0.0.22	0
Avg. Experience	12.15 (8.48)	12.34** (9.13)	12.00* (8.28)	16.97 *** (8.80)	15.01*** (10.01)	14.60** (10.28)	12.23 (7.67)	12.57 (8.22)
Highest degree								
Bachelor's	40.04	8.28***	4.31***	7.93***	29.43***	36.10**	27.00***	19.86***
Master's	59.53	91.40***	74.97***	82.53***	69.75***	62.79**	65.83***	45.65***
Specialist[a]	0.03	0.03	1.84	0.56	0	0.06	0.22	0
Doctoral	0.36	0.26**	17.18***	8.96***	0.82**	1.06**	4.99***	34.39***
Other[a]	0.04	0.02	1.69	0	0	0	1.96	0.10
Female	85.57	97.95***	80.39***	81.42***	97.76***	88.91***	95.45***	92.69***
Part-time	0.64	5.03***	4.88***	0.85	4.81***	3.12***	11.95***	13.64***
Avg. salary (in thousands)	65.04 (17.62)	65.40 * (17.75)	74.62 *** (18.97)	96.47*** (24.26)	67.46*** (17.38)	67.41 *** (18.82)	67.92*** (18.66)	70.39*** (18.79)
Avg. number of Schools	1.04 (0.30)	1.33*** (0.63)	1.38*** (0.83)	1.04 (0.28)	1.30 *** (1.13)	1.31*** (1.29)	1.49*** (1.29)	1.38*** (1.39)
District Urbanicity								
Rural	16.76	18.90***	15.60***	18.03**	16.29	15.26	13.57***	16.60
Town	9.25	10.19***	7.08***	10.12**	8.24	5.91***	9.65	9.58
Suburban	55.09	58.06***	57.77***	51.42***	53.59	59.33***	60.10***	60.38***
City	18.90	12.85***	19.55	20.43***	21.88***	19.50	16.68**	13.44***
Avg. % URM	34.09 (27.66)	29.43*** (20.59)	35.89*** (27.26)	32.03*** (24.93)	34.76 (21.11)	36.39*** (19.98)	33.96 (21.69)	31.80** (16.56)
Avg. % FRPL	47.72 (27.97)	44.69*** (25.30)	47.57 (28.41)	44.52*** (26.26)	47.37 (28.86)	45.94** (29.12)	44.18*** (30.54)	43.41*** (28.26)
Staff year obs.	166,127	20,715	13,562	8,016	2,185	1,795	2,704	1,012

Table 2. Linear Probability Models Predicting Attrition Across Special Education Personnel

	Model 1	Model 2	Model 3	Model 4
Speech/Language	0.002	-0.007**	-0.005*	-0.004
Teachers/Pathologists	(0.002)	(0.002)	(0.002)	(0.002)
School Psychologist	0.017***	0.016***	0.016***	0.016***
	(0.003)	(0.003)	(0.003)	(0.003)
Special Education Administrators	0.042***	0.078***	0.083***	0.064***
	(0.004)	(0.004)	(0.004)	(0.004)
Teachers of the Deaf	-0.003	-0.011	-0.010	-0.016**
	(0.006)	(0.006)	(0.006)	(0.006)
Teachers of the Visually Impaired	-0.012	-0.022**	-0.023**	-0.025***
	(0.007)	(0.007)	(0.007)	(0.007)
Occupational Therapists	-0.006	-0.009	-0.007	-0.010
	(0.006)	(0.006)	(0.006)	(0.006)
Physical Therapists	-0.006	-0.013	-0.009	-0.017
	(0.010)	(0.010)	(0.010)	(0.010)
Black		0.069***	0.044***	0.021***
		(0.005)	(0.005)	(0.005)
Other non-White race/ethnicity		0.041***	0.028***	0.014*
		(0.006)	(0.006)	(0.006)
Novice		0.055***	0.051***	0.042***
		(0.002)	(0.002)	(0.002)
30+ years of experience		0.165***	0.168***	0.166***
		(0.004)	(0.004)	(0.004)
Master's/specialist degree		0.007***	0.011***	0.008***
		(0.002)	(0.002)	(0.002)
Doctoral degree		0.026***	0.030***	0.023***
		(0.006)	(0.006)	(0.006)
Other degree		0.003	-0.007	-0.003
		(0.019)	(0.018)	(0.018)
Male		0.002	0.002	0.003
		(0.002)	(0.002)	(0.002)
Salary in thousands		-0.001***	-0.001***	-0.001***
		(0.000)	(0.000)	(0.000)
Number of schools		0.008***	0.009***	0.013***
		(0.002)	(0.002)	(0.002)
Part-time		0.068***	0.065***	0.065***
		(0.008)	(0.008)	(0.008)
Rural			-0.010***	
			(0.002)	
City			0.007**	
			(0.002)	
Town			-0.015***	
			(0.002)	
Low-FRPL district			0.004*	
			(0.002)	
High-FRPL district			0.004	
			(0.002)	
High students of color district			0.032***	
			(0.002)	
Teacher characteristics		X	X	X
District characteristics			X	
District fixed effects				X
Staff year obs.	215,668	215,668	215,668	215,668

Note. Standard errors are clustered at the personnel level. Each model includes year fixed effects.

Table 3. Linear Probability Models Predicting Attrition by Personnel Type

	Special Educators	Speech/Language Teachers/Pathologists	School Psychologist	Special Education Administrators	Teachers of the Deaf	Teachers of the Visually Impaired	Occupational Therapists	Physical Therapists
Black	0.047***	-0.003	0.006	0.107**	0.244*	0.105	0.046	---
	(0.006)	(0.020)	(0.012)	(0.035)	(0.111)	(0.074)	(0.046)	---
Other non-White	0.033***	0.033	0.012	0.033	-0.129***	-0.100*	-0.070	0.646***
	(0.007)	(0.023)	(0.017)	(0.042)	(0.024)	(0.039)	(0.037)	(0.066)
Novice	0.047***	0.072***	0.047***	0.081***	0.056*	0.029	0.040*	0.014
	(0.003)	(0.007)	(0.010)	(0.019)	(0.023)	(0.023)	(0.020)	(0.029)
30+ years	0.171***	0.163***	0.194***	0.127***	0.194***	0.118***	0.204**	0.078
	(0.005)	(0.010)	(0.019)	(0.014)	(0.022)	(0.027)	(0.066)	(0.044)
Master's or specialist	0.012***	-0.019*	0.006	0.031*	0.010	-0.002	-0.011	-0.021
	(0.002)	(0.008)	(0.014)	(0.013)	(0.014)	(0.015)	(0.014)	(0.028)
Doctoral	0.066***	0.039	0.016	0.048**	0.160	-0.060*	0.011	-0.005
	(0.015)	(0.045)	(0.015)	(0.018)	(0.123)	(0.028)	(0.023)	(0.028)
Other	0.084	-0.223***	-0.035	---	---	---	0.057	0.573***
	(0.049)	(0.025)	(0.022)	---	---	---	(0.073)	(0.072)
Male	0.000	0.022	0.009	0.001	0.009	0.007	0.016	-0.067**
	(0.002)	(0.016)	(0.008)	(0.010)	(0.045)	(0.023)	(0.032)	(0.025)
Salary (in thousands)	-0.002***	-0.001***	-0.002***	-0.001***	-0.001	-0.001	-0.002***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Number of Schools	0.021***	0.004	0.005	0.014	-0.002	0.000	-0.009	0.001
	(0.003)	(0.003)	(0.004)	(0.017)	(0.005)	(0.005)	(0.004)	(0.007)
Part-time	0.072***	0.080***	-0.008	0.242**	0.075*	0.154*	0.068**	0.079*
	(0.014)	(0.014)	(0.019)	(0.088)	(0.037)	(0.067)	(0.025)	(0.035)
Rural	-0.010***	-0.021***	-0.001	-0.006	-0.006	0.025	0.011	0.053
	(0.002)	(0.005)	(0.009)	(0.011)	(0.017)	(0.023)	(0.018)	(0.033)
Town	-0.018***	-0.015*	0.022	-0.020	0.013	0.027	-0.020	-0.052
	(0.003)	(0.007)	(0.013)	(0.013)	(0.023)	(0.036)	(0.022)	(0.035)
City	0.011***	-0.005	-0.004	-0.023*	0.010	-0.027	0.046*	0.050
	(0.003)	(0.007)	(0.011)	(0.012)	(0.016)	(0.016)	(0.021)	(0.034)
High- FRPL	0.003	-0.009	-0.003	0.040**	-0.013	-0.030	-0.004	0.007
	(0.002)	(0.006)	(0.010)	(0.012)	(0.015)	(0.017)	(0.016)	(0.024)
Low- FRPL	0.005**	-0.003	-0.003	0.007	-0.001	-0.034*	-0.008	-0.020
	(0.002)	(0.005)	(0.007)	(0.009)	(0.016)	(0.016)	(0.014)	(0.025)
High-Students of color	0.034***	0.020**	0.026*	0.041***	0.006	-0.001	0.042*	-0.020
	(0.003)	(0.007)	(0.010)	(0.012)	(0.017)	(0.017)	(0.021)	(0.026)
Staff year obs.	166,127	20,715	13,562	8,016	2,185	1,795	2,704	1,012

Note. Standard errors are clustered at the personnel level. Each model includes year fixed effects.

Table 4. Linear Probability Models Predicting Attrition by Personnel Type with District Fixed Effects

	Special Educators	Speech/Language Teachers/Pathologists	School Psychologist	Special Education Administrators	Teachers of the Deaf	Teachers of the Visually Impaired	Occupational Therapists	Physical Therapists
Black	0.023***	-0.030	-0.003	0.076*	0.133	0.063	0.018	--
	(0.006)	(0.023)	(0.014)	(0.037)	(0.100)	(0.072)	(0.045)	--
Other non-	0.014*	0.010	0.013	0.044	-0.152***	-0.079	-0.049	0.653***
White	(0.007)	(0.024)	(0.016)	(0.047)	(0.037)	(0.042)	(0.040)	(0.033)
Novice	0.036***	0.054***	0.017	0.052*	0.053*	0.024	0.014	0.002
	(0.003)	(0.007)	(0.010)	(0.021)	(0.025)	(0.024)	(0.020)	(0.030)
30+ years	0.169***	0.160***	0.211***	0.152***	0.185***	0.132***	0.229***	0.099
	(0.005)	(0.011)	(0.020)	(0.016)	(0.026)	(0.031)	(0.066)	(0.053)
Master's or	0.008***	-0.015	-0.008	0.030	0.038*	-0.003	-0.008	-0.071*
specialist	(0.002)	(0.009)	(0.015)	(0.017)	(0.018)	(0.018)	(0.014)	(0.034)
Doctoral	0.056***	0.004	0.012	0.042	0.146	-0.035	0.000	-0.042
	(0.014)	(0.044)	(0.017)	(0.023)	(0.108)	(0.027)	(0.027)	(0.034)
Other	0.041	-0.165***	-0.013	--	--	--	0.080	-0.087
	(0.048)	(0.025)	(0.022)	--	--	--	(0.076)	(0.061)
Male	0.002	0.015	0.013	0.004	0.027	0.014	0.001	-0.083*
	(0.002)	(0.016)	(0.008)	(0.012)	(0.045)	(0.025)	(0.032)	(0.038)
Salary (in	-0.001***	-0.001**	-0.001***	0.000	-0.000	-0.000	-0.001	-0.002*
thousands)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Number of	0.023***	0.010*	0.010	0.005	-0.013	0.006	0.000	-0.026
Schools	(0.003)	(0.005)	(0.007)	(0.014)	(0.008)	(0.008)	(0.014)	(0.019)
Part-time	0.070***	0.053***	-0.001	0.157	0.085*	0.130	0.062*	0.052
	(0.014)	(0.014)	(0.019)	(0.089)	(0.040)	(0.067)	(0.028)	(0.038)
Staff year obs.	166,127	20,715	13,562	8,016	2,185	1,795	2,704	1,012

Note. Standard errors are clustered at the personnel level. Each model includes year fixed effects.

Figure 1. District attrition over time for select special education personnel compared to general education personnel.

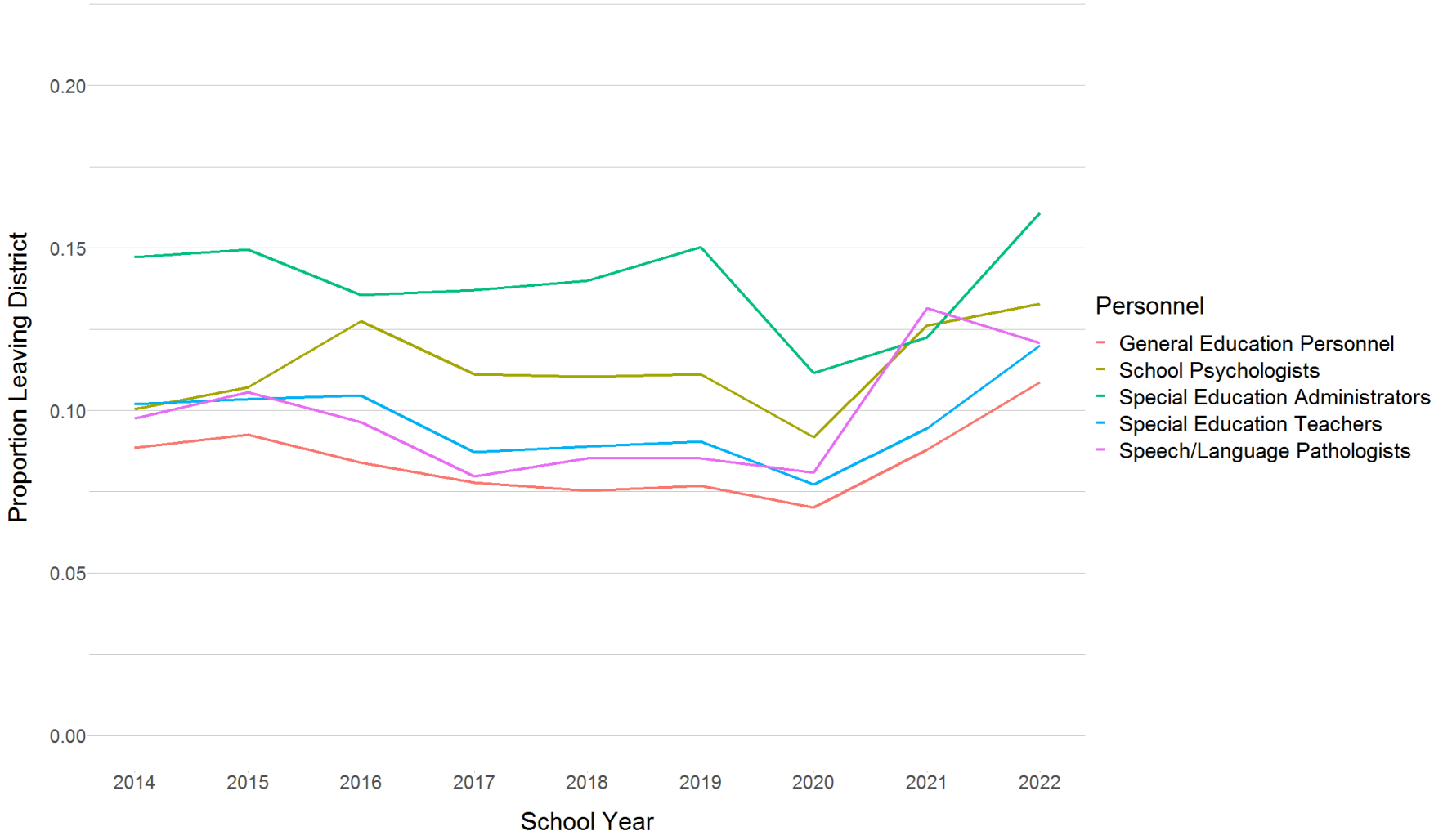
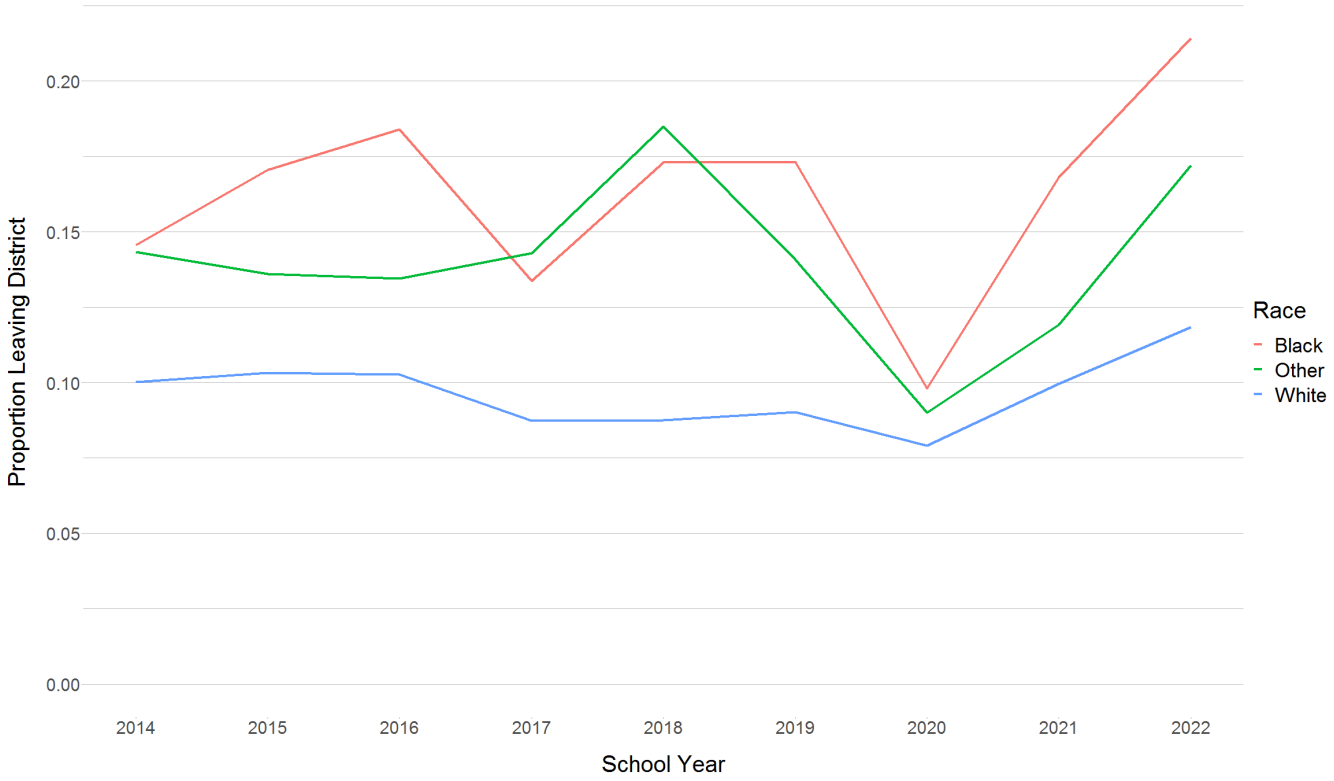


Figure 2. District attrition by race over time for all special education personnel.



Appendix

Table A1. Summary of Variables Used In Analyses

Variables	Type	Definition and Coding
Teacher of the deaf	Individual-role	Binary variable indicating the individual was a special education teacher with an assignment specified as "hearing impaired" (coded "1") with special education with an assignment code not specifying "visually impaired" or "hearing impaired" as the comparison (coded "0")
Teacher of the visually impaired	Individual-role	Binary variable indicating the individual was a special education teacher with an assignment specified as "visually impaired" (coded "1") with special education with an assignment code not specifying "visually impaired" or "hearing impaired" as the comparison (coded "0")
Speech language personnel	Individual-role	Binary variable indicating that an individual's assignment was "speech correction" (coded "1") with special education with an assignment code not specifying "visually impaired" or "hearing impaired" as the comparison (coded "0")
Special education administrator	Individual-role	Binary variable indicating that an individual's assignment was as a special education supervisor or coach (coded "1") with special education with an assignment code not specifying "visually impaired" or "hearing impaired" as the comparison (coded "0")
School psychologist	Individual-role	Binary variable indicating that an individual's assignment was as a school psychologist (coded "1") with special education with an assignment code not specifying "visually impaired" or "hearing impaired" as the comparison (coded "0")
Physical therapist	Individual-role	Binary variable indicating that an individual's assignment was as a physical therapist (coded "1") with special education with an assignment code not specifying "visually impaired" or "hearing impaired" as the comparison (coded "0")
Occupational therapist	Individual-role	Binary variable indicating that an individual's assignment was as an occupational therapist (coded "1") with special education with an assignment code not specifying "visually impaired" or "hearing impaired" as the comparison (coded "0")
Black	Individual-Control	Binary variable indicating the individual was Black (coded "1") with White as the comparison (coded "0")
Other non-White race/ethnicity	Individual-Control	Binary variable indicating the individual was another non-White/ethnicity and not Black (coded "1") with White as the comparison (coded "0")
Novice	Individual-Control	Binary variable indicating an individual had 0-2 years of experience (coded "1") with individuals with 3-29 years of experience as the comparison (coded "0")
30+ years of experience	Individual-Control	Binary variable indicating an individual had 30 or more years of experience (coded "1") with individuals with 3-29 years of experience as the comparison (coded "0")
Master's or specialist degree	Individual-Control	Binary variable indicating that an individual's highest degree was a master's or specialist degree (coded "1") with individuals with a bachelor's as their highest degree as the comparison (coded "0")
Doctoral degree	Individual-Control	Binary variable indicating that an individual's highest degree was a doctoral degree (coded "1") with individuals with a bachelor's as their highest degree as the comparison (coded "0")
Other degree	Individual-Control	Binary variable indicating that an individual's highest degree was not a bachelor's, master's or specialist degree, or doctorate (coded

		"1") with individuals with a bachelor's as their highest degree as the comparison (coded "0")
Male	Individual-Control	Binary variable indicating that the individual reported they were male (coded "1") with female as the comparison (coded "2")
Salary	Individual-Control	A continuous variable reporting an individual's salary in thousands, sample mean-centered
Number of schools	Individual-Control	The number of schools an individual worked in minus 1
Part-time	Individual-Control	Binary variable indicating that the individual worked part-time (coded "1") with full-time as the comparison (coded "2")
City	District	Binary variable indicating that the district was designated by National Center for Education Statistics (NCES) as in a city (coded "1") with districts in suburbs as the comparison (coded "0")
Town	District	Binary variable indicating that the district was designated by National Center for Education Statistics (NCES) as in a town (coded "1") with districts in suburbs as the comparison (coded "0")
Rural	District	Binary variable indicating that the district was designated by National Center for Education Statistics (NCES) as in a rural area (coded "1") with districts in suburbs as the comparison (coded "0")
High-FRPL	District	Binary variable indicating that a district was in the top quartile of the percentage of students who were eligible for FRPL (coded "1") with districts in the two middle quartiles as the comparison (coded "0")
Low-FRPL	District	Binary variable indicating that a district was in the bottom quartile of the percentage of students who were eligible for FRPL (coded "1") with districts in the two middle quartiles as the comparison (coded "0")
≥ 50% of the student population in the district were racially/ethnically minoritized students	District	Binary variable indicating that ≥50% of the student population in the district were racially/ethnically minoritized students (coded "1") with districts with <50% of the student population were racially/ethnically minoritized students as the comparison (coded "0")

Table A2. Logistic Regression Models Examining Differences in Attrition Across Special Education Personnel

	Model 1	Model 2	Model 3
Speech/Language Teachers/Pathologists	0.022	-0.070*	-0.046
	(0.026)	(0.027)	(0.028)
School Psychologist	0.177***	0.205***	0.208***
	(0.032)	(0.034)	(0.034)
Special Education Administrators	0.412***	0.856***	0.896***
	(0.035)	(0.039)	(0.039)
Teachers of the Deaf	-0.032	-0.120	-0.108
	(0.076)	(0.073)	(0.073)
Teachers of the Visually Impaired	-0.143	-0.279**	-0.277**
	(0.090)	(0.093)	(0.095)
Occupational Therapists	-0.071	-0.102	-0.070
	(0.072)	(0.074)	(0.074)
Physical Therapists	-0.066	-0.157	-0.113
	(0.124)	(0.120)	(0.121)
Black		0.651***	0.387***
		(0.039)	(0.041)
Other non-White race/ethnicity		0.401***	0.262***
		(0.054)	(0.054)
Novice		0.512***	0.472***
		(0.020)	(0.020)
30+ years of experience		1.481***	1.526***
		(0.026)	(0.027)
Master's/specialist degree		0.082***	0.119***
		(0.018)	(0.018)
Doctoral degree		0.291***	0.325***
		(0.060)	(0.061)
Other degree		0.044	-0.036
		(0.175)	(0.172)
Male		0.026	0.015
		(0.023)	(0.023)
Salary in thousands		-0.017***	-0.018***
		(0.001)	(0.001)
Number of schools		0.077***	0.085***
		(0.016)	(0.015)
Part-time		0.388***	0.364***
		(0.055)	(0.056)
Rural			-0.112***
			(0.022)
City			0.069**
			(0.023)
Town			-0.179***
			(0.029)
Low- FRPL district			0.032
			(0.019)
High-FRPL district			0.028
			(0.023)
High students of color district			0.347***
			(0.023)
Teacher characteristics		X	X
District characteristics			X
Staff by year obs.	215,668	215,668	215,668

Note. Coefficients are in logits. Standard errors are clustered at the personnel level. Each model includes year fixed effects.

Table A3. Linear Probability Models Examining Differences in Attrition Across Special Education Personnel Replacing Experience Binary Variables with Continuous and Quadratic

	Model 3
Speech/Language Teachers/Pathologists	-0.007**
	(0.002)
School Psychologist	0.016***
	(0.003)
Special Education Administrators	0.081***
	(0.004)
Teachers of the Deaf	-0.014*
	(0.006)
Teachers of the Visually Impaired	-0.026***
	(0.007)
Occupational Therapists	-0.007
	(0.006)
Physical Therapists	-0.009
	(0.010)
Black	0.043***
	(0.005)
Other non-White race/ethnicity	0.028***
	(0.006)
Years of experience	-0.013***
	(0.000)
Years of experience ^2	0.000***
	(0.000)
Master's/specialist degree	0.014***
	(0.002)
Doctoral degree	0.033***
	(0.006)
Other degree	-0.009
	(0.019)
Male	0.002
	(0.002)
Salary in thousands	-0.002***
	(0.000)
Number of schools	0.009***
	(0.002)
Part-time	0.064***
	(0.008)
Rural	-0.009***
	(0.002)
City	0.006**
	(0.002)
Town	-0.015***
	(0.002)
Low-FRPL district	0.004*
	(0.002)
High-FRPL district	0.004
	(0.002)
High students of color district	0.032***
	(0.002)
Staff year obs.	215,668

Note. Standard errors are clustered at the personnel level. Each model includes year fixed effects.

Table A4. Linear Probability Models Separating Moving Between Districts and Leaving Pennsylvania Public Schools

	Leaving Pennsylvania	Moving
Speech/Language Teachers/Pathologists	0.000	-0.007***
	(0.002)	(0.001)
School Psychologist	0.010***	0.007***
	(0.003)	(0.002)
Special Education Administrators	0.059***	0.032***
	(0.004)	(0.002)
Teachers of the Deaf	-0.008	-0.003
	(0.005)	(0.003)
Teachers of the Visually Impaired	-0.019**	-0.006
	(0.006)	(0.003)
Occupational Therapists	0.002	-0.012***
	(0.006)	(0.002)
Physical Therapists	-0.005	-0.005
	(0.009)	(0.006)
Black	0.039***	0.009**
	(0.005)	(0.003)
Other non-White race/ethnicity	0.026***	0.004
	(0.006)	(0.003)
Novice	0.039***	0.017***
	(0.002)	(0.001)
30+ years of experience	0.171***	-0.002*
	(0.004)	(0.001)
Master's/specialist degree	0.006***	0.007***
	(0.001)	(0.001)
Doctoral degree	0.024***	0.009**
	(0.005)	(0.003)
Other degree	-0.002	-0.005
	(0.017)	(0.009)
Male	-0.002	0.004***
	(0.002)	(0.001)
Salary in thousands	-0.001***	-0.001***
	(0.000)	(0.000)
Number of schools	0.003*	0.008***
	(0.001)	(0.001)
Part-time	0.055***	0.022***
	(0.007)	(0.006)
Rural	-0.007***	-0.004***
	(0.002)	(0.001)
City	0.007**	-0.000
	(0.002)	(0.001)
Town	-0.011***	-0.006***
	(0.002)	(0.001)
Low- FRPL district	0.005***	-0.001
	(0.001)	(0.001)
High-FRPL district	0.004	0.000
	(0.002)	(0.001)
High students of color district	0.025***	0.011***
	(0.002)	(0.001)
Staff by year obs.	211,866	198,107

Note. Standard errors are clustered at the personnel level. Each model includes year fixed effects.