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The Interaction of Disability Status and Family Income Level as a Predictor of STEM Achievement for Youth in U.S. High Schools

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The Individuals with Disabilities Education Act (IDEA) mandates that U.S. public schools shall provide special education services to youth with disabilities, and each student's Individualized Educational Plan (IEP) outlines how the school will provide these accommodations. Employment outcomes for youth with disabilities remain far lower than for youth who do not have disabilities. Completion of Science/Technology/Engineering/Math (STEM) courses in high school may increase access to employment. Data from the United States National Center for Education Statistics High School Longitudinal Study of 2009 (HSLS:09), n=23,415 were analyzed using an Ordinary Least Squares (OLS) linear regression model to determine the number of STEM classes completed in high school for students who received accommodations under an IEP. The results indicate that there was a significant reduction in STEM classes completed by the end of high school for the students who both received accommodations under an IEP and were from low-income families, while controlling for sex, race, previous GPA, and significant cognitive disabilities. Given the increasing numbers of STEM occupations, incentives that specifically target youth with disabilities from low-income families to pursue education in high school STEM coursework are needed.

Keywords: STEM achievement, HSLS:09, Individualized Educational Plan, Transition-aged Youth

Nationwide, 14% of all the kindergarten through twelfth grade public school students in the United States have a disability, and many of these youth are from low-income families (Institute of Education Sciences [IES], 2020; United States Department of Education [USDOE], 2016; USDOE, 2018). Race and socioeconomic status (SES) impact the accommodations that students with disabilities receive in public school systems (Scarborough & McCrae, 2010; Skiba et al., 2005). Students who identify as having a disability and are also members of additional underrepresented groups may face multiple barriers to academic achievement and success after high school (Balcazar et al., 2012; Carter et al., 2012; Prince et al., 2018; Wehman et al., 2015). Academic achievement is associated with higher employment and income levels (United States Bureau of Labor Statistics [USBLS], 2021; United States Census Bureau [USCB], 2021). Despite legislation and academic programs that seek to prepare students with disabilities in public education for future careers, youth with disabilities finish high school and complete degrees in higher education in lower numbers than their peers who do not have disabilities (Balcazar et al., 2012; Carter et al., 2012; IES, 2020; Prince et al., 2018; Wehman et al., 2015; USDOE, 2014; USDOE, 2020). Employment outcomes for youth with disabilities continued to remain low in 2020; 44.2% of youth with disabilities aged 20-24 participated in the labor force compared to 70.4% of their peers in the same age group without disabilities(United States Department of Labor [USDOL], 2021).

Students with Disabilities

In the United States, the Individuals with Disabilities Education Act (IDEA) mandates that public schools shall provide special education services to youth with disabilities, and each student's Individualized Educational Plan (IEP) outlines how the school will provide the student's accommodations that are necessary for the them to receive a free and appropriate public education. (USDOE, 2015; USDOE 2021a). IDEA includes specific language urging school doctors and therapists to avoid cultural, SES, and language biases when establishing diagnoses of disabilities (USDOE, 2020). Nevertheless, disparities in the decisions that are made about which youth receive a disability label due to factors such as gender, race, and SES have been noted in the literature (Beratan, 2008; Blanchett, 2006; Bryan et al., 2012; Coutinho, Oswald & Best, 2002; Coutinho, Oswald, Best & Forness, 2002; Shifrer et al., 2011; Skiba et al., 2011). Specifically, Shifrer et al. (2011) found that youth who are male, youth who are from minority backgrounds, and youth who are from low SES families are more likely to be diagnosed with a learning disability. Other studies have found that African-American males are more likely than all other races to be diagnosed as emotionally disturbed (Beratan, 2008; Blanchett, 2006; Bryan et al., 2012; Coutinho, Oswald & Best, 2002; Coutinho, Oswald, Best & Forness, 2002; Skiba et al., 2011).

Disability and Academic Achievement

Few scholars have studied the effects of receiving accommodations under an IEP specifically on academic achievement for K-12 students, and most findings are not generalizable to all high school students with disabilities (Ball et al., 2018; Baltodano et al., 2005; Barnard-Brak & Lechtenberger, 2010; Chapman, 1988; Estes et al., 2011; Shin et al., 2013; Wei et al., 2015). Academic achievement and IEP services have typically been discussed in the literature as they relate to specific disability diagnoses such as learning disabilities, schizophrenia, or autism (Ball et al., 2018; Chapman, 1988; Estes et al., 2011; Wei et al., 2015). Ball et al. (2018) discussed the impacts that IEP plans had on the academic success of youth with early onset schizophrenia, but did not study students with other types of disabilities. Barnard-Brak and Lechtenberger (2010) analyzed the relationship between IEP participation and academic achievement in elementary school students who were enrolled in special education classes. However, the students' academic achievement was not compared to a sample of students not receiving accommodations under an IEP. Similarly, the Longitudinal Transition Study-2 (NLTS2) only included youth who were in special education and focused on vocational outcomes rather than on academic achievement (Wagner et al., 2005). Shin et al. (2013) assessed academic achievement for children receiving accommodations under an IEP, but only for students who were in 7th grade or lower. Baltodano et al. (2005) examined the impact of age, ethnicity, and disability on the academic achievement of participants in a juvenile corrections setting. However, their study did not specifically address IEP and academic achievement.

SES and Academic Achievement

The impact of SES on academic achievement is complex. There are significant differences in academic achievement for youth from low-income families when compared to youth from high-income families (Brown et al., 2016; Reardon, 2011). Researchers have concluded that belonging to an underrepresented race or ethnic group, family income, and the educational level of parents all contribute to an individual student's SES level, which can, in turn, affect the student's academic achievement (Owens et al., 2016; Riegle-Crumb & Grodsky, 2010; Sirin, 2005). Being a member of an underrepresented race or ethnic group is associated with lower SES including experiencing disparities in housing, health, and access to resources (Corcoran & Nichols-Casebolt, 2004; Massey & Brodmann, 2014). Riegle-Crumb and Grodsky (2010) noted specifically that Hispanic youth from low-income families and African American youth who attended segregated schools, performed at significantly lower levels academically in math than their white peers from low-income families.

It has been well-established that disparities exist in funding for school districts, and these disparities have led to limitations in access to resources for students attending schools in high-poverty areas (Owens et al., 2016). Schools in high-poverty areas oftentimes have teachers with less experience and fewer qualifications, resulting in a more limited curriculum than schools with higher levels of funding. Class sizes in schools located in high-poverty areas are typically larger. These types of resource disparities have a significant impact on the academic achievement of the students in these schools (Cardichon et al., 2020; Darling-Hammond, 2001).

The Interaction of Disability and SES and its Effect on Academic Achievement

Another factor that has been shown to affect academic achievement is the disability status of a student (Balcazar et al., 2012; Carter et al., 2012; IES, 2020; Prince et al., 2018; USDOE, 2014; USDOE, 2020; Wehman et al., 2015). Students with disabilities who attend school in high-poverty areas are more likely to be educated in segregated classrooms, separated from their peers who do not have disabilities, resulting in limited access to curriculum, and ultimately a negative impact on student academic achievement (Blanchett, 2006). IEP accommodations, which can include a wide range of educationally-related services and adaptations (i.e., classroom aides, behavioral specialists, interpreting services, physical therapy, speech-language services, mobility training, are social work services), are dependent upon the individual needs of the student but also the resources available in the school district (USDOE, 2015). IEP accommodations and modifications are meant to be individualized, but often times they are ultimately mandated by the school district personnel who help plan the IEP. Lalvani (2012) noted in interviews with parents of youth diagnosed with autism that family SES seemed to play a role in how accommodations and modifications were decided for the student. For example, the student's family SES seemed to affect the level of academic coursework the student was encouraged to take. SES also seemed to affect whether the student was served in general education classes or was taught in segregated special education classrooms (Lalvani, 2012). The combination of being from a low-income family and having to navigate the IEP planning process may impact resources provided to the student labeled with a disability to complete academic coursework during high school.

Authors have documented the dissatisfaction in IEP planning expressed by cultural minority parents—especially those with low SES (Kalyanpur et al., 2000; Landmark et al., 2007; Zeitlin & Curcic, 2014). Parents expressed frustrations with the IEP process, such as not feeling like they were included in planning the accommodations and modifications their child would receive, feeling discounted by school staff, feeling like the process focused too much on deficits, and feeling like their children were depersonalized (Kalyanpur et al., 2000; Landmark et al., 2007; Zeitlin & Curcic, 2014). Overall, students from underserved minority groups who had less parental involvement in IEP meetings and who were served in segregated special education classrooms were less satisfied with IEP planning and were less likely to receive access to the curriculum they needed for success (Tucker & Schwartz, 2013; Wagner et al., 2012; Zeitlin & Curcic, 2014).

Policies Encouraging Early Intervention Vocational Planning for Youth with Disabilities

Documented predictors that improve post-high school outcomes for students with disabilities include participation in general education classes, career awareness, paid work experience, and support from family and other social networks to find employment (Livermore et al., 2020; Test et al., 2009). Recent national policies and initiatives have promoted opportunities for youth with disabilities to receive vocational planning services before they leave high school including IEP transition planning, the Workforce Innovation and Opportunity Act (WIOA), and the national Promoting the Readiness of Minors in Supplemental Security Income (PROMISE) grants.

WIOA is the most recent amendment to the Rehabilitation Act of 1973 (USDOL, 2017). Under WIOA, 15% of state-federal vocational rehabilitation (VR) agency funds are to be used specifically for youth with disabilities. WIOA also directs VR counselors to attend IEP and other person-centered meetings

for students with disabilities, when invited (Workforce Innovation Technical Assistance Center, 2018). This earlier involvement in IEP transition planning by VR agency staff has the potential to have a positive impact on transition-planning and employment outcomes for youth with disabilities.

The PROMISE grant study was targeted to assist youth with disabilities who received Social Security Supplemental Security Income (SSI) and their families (USDOE, 2014). Only youth from low-income families are qualified to receive SSI, so the PROMISE grants' study was designed specifically to address the barriers that youth with disabilities from low-income families face when making the transition from high school to post-secondary education and work. Overall, the PROMISE grant projects impacted these youth and families positively in supporting the youth during their transitions to adulthood (Levere et al., 2020; Livermore et al., 2020).

The most recent reauthorization of IDEA was in 2006 and included significant changes to the IEP process regarding transition planning. Some of the most important additions in the reauthorization of IDEA were detailed requirements for establishing post-secondary goals in the IEP for the student including goals related to the transition from high school to college, into employment, and/or into independent living. Specifically, the academic courses needed to meet these transition goals are to be listed in the annual IEP beginning at age 16 (Gartin & Murdick, 2005; USDOE, 2015; USDOE 2021a).

IEP transition planning, the WIOA directives, and the recommendations resulting from the PROMISE grant projects are needed to assist students with disabilities—and especially the students from lower income families—to successfully transition from high school to work and to work in the expanding STEM labor market. Early intervention and encouragement to complete STEM classes while in high school will prepare students with disabilities to be more competitive in the current labor market.

Achievement in STEM and Access to the Labor Market

Understanding the impact of SES and disability on academic achievement is important because of the influence academic achievement has on the readiness of youth to enter the labor market (USBLS, 2021; USCB, 2021). Currently, successful employment outcomes for individuals with disabilities remain far lower than for those who do not have disabilities. Only 20% of individuals aged 16 and older participate in the workforce, compared to nearly 70% of those in the same age group who do not have disabilities (USDOL, 2021; USBLS, 2020).

The Bureau of Labor Statistics projects that there will be a large increase in STEM occupations in the next few years (Vilorio, 2014; Zilberman & Ice, 2021). Experts predict that there will be well over nine million new jobs in science, technology, engineering, and mathematics (STEM) occupations by 2029 (Zilberman & Ice, 2021).

To meet the demand for individuals to work in STEM fields, the USDOE (2021b) is currently offering a variety of incentives to improve STEM education for high school youth-Although USDOE grant incentives target underrepresented groups in STEM, such as females and students from minority backgrounds, there are fewer incentives that specifically target youth with disabilities to pursue education in high school STEM coursework—a group that desperately needs incentives to prepare for success in the workplace. The USDOE (2021b) listed the Office of Special Education and Rehabilitative Services (OSERS) as a department office that supports STEM, and Dr. Temple Grandin was featured in a USDOE presentation on differing abilities in STEM in March, 2021. Discretionary grants that can support youth with disabilities to participate in STEM are available (USDOE, 2021b). These efforts have the potential to assure that students receiving accommodations under an IEP are taking STEM classes in the same numbers as their peers without disabilities while in high school—especially students with disabilities from low-income families.

The number of STEM classes completed during high school influences employment outcomes for high school youth because of the high numbers of jobs available that require the knowledge and skills taught in STEM courses (Zilberman & Ice, 2021). Advocates have encouraged youth with disabilities to pursue education and careers in STEM (Basham & Marino, 2013; Dunn et al., 2012; Lee, 2014).

Current national policies and initiatives offer resources and guidance for early vocational rehabilitation interventions that are needed to encourage youth with disabilities to pursue the STEM classes in high school that will lead to successful employment in this sector of the labor market.

Given the importance of STEM coursework in post-secondary outcomes for youth with disabilities, it is important to study the specific effect of receiving accommodations under an IEP on completion of STEM coursework for students with disabilities. However, as indicated in the literature, the interaction of additional demographic factors in relationship with disability and IEP status should be considered.

Interaction of Disability and SES and its Effect on STEM Completion

This study analyzed the interaction of having received accommodations under an IEP and having a family income of less than 185% poverty level on the completion of STEM coursework during high school. Specifically, this study tested the hypothesis that the combination of having received accommodations under an IEP and being from a low-income family, most likely had an effect on the number of STEM classes completed by the end of high school for these students. A frequently used measure of the poverty level of students at a high school has been the percentage of students who received free or reduced lunches (FRL) at school (Heuer & Stullich, 2011; Miller & Rubenstein, 2008; Roza, 2008). Because the students captured in the HSLS:09 study qualified for FRL if their family lived below 185% of poverty level (United States Department of Agriculture, 2021), the author used students' eligibility for FRL under the National School Lunch Program as one measure of SES when exploring disparities in resources available at schools in regard to academic achievement (Owens et al., 2016, Sirin, 2005). This variable was captured and labeled "FRL" for the analysis in this study.

Research Question

Research Question: Did receiving accommodations under an IEP in high school, being from a low-income family, and having the combination of an IEP and being from a low-income family predict the number of STEM classes completed in high school?

H_o: Receiving accommodations under an IEP in high school, being from a low-income family, and the combination of receiving accommodations under and IEP in high school and being from a low-income family does not predict the number of STEM classes taken in high school.

H_a: Receiving accommodations under an IEP in high school, being from a low-income family, and the combination of receiving accommodations under and IEP in high school and being from a low-income family does predict the number of STEM classes taken in high school.

Method

In this study, data from the 2009 High School Longitudinal Study were utilized to assess if the interaction of having an IEP and being from a low-income family affected how many STEM courses a student completed during high school. The impact of having an IEP on the number of STEM classes completed during high school was analyzed, and then analyzed again, taking into consideration whether the students' families were low-income or not, as indicated by receiving FRL.

Ordinary Least Squares Linear Regression Model

Data from the High School Longitudinal Study of 2009 (HSLS:09) were used in this study (IES, 2021). The HSLS:09 collected data for students from 944 schools in the United States who were in the 9^{th} grade in 2009 (n = 23,415). Ultimately, the study will continue to gather information on post-high school education and career outcomes. One of the areas of inquiry pertains to STEM coursework offered by the high schools and completed by students. The high school transcript information was

available for the student participants who had completed high school. The HSLS:09 researchers attempted to gather a sample from all 50 states in both rural and metro areas that was representative of students nationally, including students with and without disabilities (IES, 2021).

For this research study, the HSLS:09 data set was used which non-randomly selected students into the groups that received accommodations under IEPs and FRL during high school. An Ordinary Least Squares (OLS) linear regression model was used to analyze the group of students who received accommodations under an IEP and FRL to those who did not:

When using an OLS linear regression model with a large administrative data set, omitted variable

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \hat{\beta}_3 z, \text{ where } x_1 = \text{IEP}, x_2 = \text{FRL}, \text{ and } z = \text{interaction IEP*FRL}$$

bias must be avoided to the greatest extent possible. Omitted variable bias occurs when an omitted variable affects the value of Y and the omitted variable has a relationship with X. Both of these conditions must be met in order for omitted variable bias to occur (Stock and Watson, 2019). Therefore, in order to reduce omitted variable bias, one needs to establish control variables in the OLS linear regression model. In this study, control variables for sex, race, and previous academic achievement were included in order to avoid omitted variable bias as much as possible.

Males, youth of certain races, and youth from low-income families are more likely to be diagnosed with some types of disabilities (e.g., ADHD, behavioral problems, or learning disabilities) and are more likely to receive accommodations under an IEP in school (Shifrer et al., 2011; Skiba et al., 2011). Sex and race also has an impact on the number of math classes taken in high school (Signer et al., 1995). The number of math classes taken in high school is very closely related to the STEM variable in this model. Students with low academic achievement, as measured by the student's overall grade point average (GPA), and students with certain types of cognitive disabilities may be more likely to receive accommodations under an IEP. Also students with previous low academic achievement and certain types of cognitive disabilities are less likely to take math classes. The best measure of previous academic achievement would have been a variable that represented the student's GPA in 8th grade, however this variable was not available in the data set. GPA in 9th grade was the best choice for this control variable for the model. In total, variables that controlled for sex, race, types of significant cognitive disabilities, and previous academic achievement were added to the model (see Table 1).

Dependent Variable of Interest

The HSLS:09 administrators defined STEM classes as any classes in science, technology, engineering, or math. The dependent variable of interest was a continuous measure of the number of Carnegie units of STEM classes the student completed by the end of high school (see Table 1). A Carnegie unit is equivalent to a one-year academic course taken one period a day, five days a week. This measure was captured by analyzing the high school transcripts of the students in the HSLS:09 study. Roughly 7% (n = 1,575) of the students did not have STEM information, and were dropped from the analysis. The range of values for the other students were from zero Carnegie units up to 16 Carnegie units worth of STEM classes.

Independent Variables of Interest

The independent variables of interest were categorical measures of whether the student received accommodations under an IEP or not, and whether the student's family income was below 185% of poverty level (labeled "FRL") or not. A third category for each of these variables was "don't know" (see Table 1). Of the total 23,415 observations in the data set, 56.5% (n = 13,231) of the observations for IEP status were missing, and were coded as "don't know", so as to not invalidate the analysis by excluding this large number of observations in the calculations. Approximately 34.7% (n = 8,115) of the students did not receive accommodations under an IEP, and 8.8% (n = 2,069) did receive accommodations under an IEP.

Table 1

Variables Used in the OLS Linear Regression Analyses

Dependent Variable	
STEM: Total Carnegie credits in STEM courses completed by the end of high school. A Carnegie unit is equivalent to a one-year academic course taken one period a day, five days a week.	Range: 0 to 16
Independent Variables	
IEP: Student received services under an IEP	0=no 1=yes 2=don't know
FRL: Student Qualified for Free and Reduced Lunch (student's family was less than 185% of poverty level)	0=no 1=yes 2=don't know
Control Variables	
Sex	1=male 2=female
Race	1=American Indian/Alaska Native, non-Hispanic 2=Asian, non-Hispanic 3=Black/African-American, non-Hispanic 4=Hispanic, no race specified 5=Hispanic, race specified 6=More than one race, non-Hispanic 7=Native Hawaiian/Pacific Islander, non-Hispanic 8=White, non-Hispanic
Significant Cognitive Disabilities: Parent reported that the student had any of the following disabilities: Developmental Disability Autism Intellectual Disability	Coded for each disability: 0=no 1=yes 2=don't know
GPA: Student's grade point average in 9th Grade was used a measure of previous academic achievement	Range: .25 to 4

Interaction Variable

Ideally the variable in the HSLS:09 data set that measured the percentage of students on the FRL program at the students' high school would have been used in the analysis, as this is a better measure of the discrepancy in resources available at the high school for the student according to literature discussed previously in this manuscript. However, this information was suppressed in the data set and not available to the public. Therefore, a variable which indicated if the student's family was below 185% of poverty level was used because this is equivalent to eligibility for the FRL program for the individual student. Approximately 28.5% (n = 6682) of the observations were missing or labeled "non-response", and these were coded as "don't know", again so as to not invalidate the analysis by excluding this large number of observations in the calculations.

Approximately 47.7% (n = of 1,175) the students were coded with family income level at or above 185%, and 23.7% (n = 5,558) were coded with family income level below 185% (eligible for FRL). Authors have noted that stigma may be associated with FRL (Mirtcheva & Powell, 2009; Moore et al., 2009). Nicholson et al. (2014) noted that eligibility for FRL is a good proxy for SES because it is associated with other indicators of poverty and insecurities in the environment. These types of insecurities for students with disabilities may include fewer educational supports in the home environment, fewer educational resources in the classroom, less advocacy in IEP planning, and less advocacy for the student being included in mainstream classes, as discussed previously. In the HSLS:09 data set there was a continuous SES variable available that was a composite score of five factors including the income and educational levels of the parents. However, the below 185% income level (indicating eligibility for FRL) variable was categorical and was felt to be a better choice to measure the interaction of income level and having an IEP for the purposes of this study because of the ability to analyze any differences between the two distinct income level groups.

Results

Data from the 2009 High School Longitudinal Study was utilized to perform an OLS linear regression. An analysis of the effect of receiving accommodations under an IEP on the number of STEM classes completed was conducted. The average effect of receiving accommodations under an IEP as opposed to not having received accommodations under an IEP was an insignificant decrease in .06 Carnegie units of STEM classes taken by the end of high school when controlling for sex, race, FRL status, types of significant cognitive disabilities, and previous academic achievement. Received of IEP services had no significant effect on the number of STEM courses completed by high school exit, p=.40 (see Table 2). However, when IEP and FRL were utilized in the model as a Z variable interaction variable with STEM as the Y variable, the interaction of IEP and FRL did appear to have a significant impact on STEM coursework completed, p=.03 (see Table 3). The average marginal effect of having received accommodations under an IEP as opposed to not having received accommodations under an IEP was a 0.17 decrease in the Carnegie units of STEM classes completed by the end of high school for those students who qualified for FRL as opposed to those students who did not qualify for FRL. In contrast, the students who had received accommodations under an IEP as opposed to not having received accommodations under an IEP and did not qualify for FRL actually experienced an average of a 0.14 increase in STEM classes completed as compared to those students who did qualify for FRL (see Table 4). Because one Carnegie unit is equivalent to a one-year academic course taken one period a day, five days a week, this means that the students who received accommodations under an IEP and did *not* qualify for FRL completed STEM coursework for about one extra class period per week, on average, than the students who did qualify for FRL and received accommodations under an IEP.

Table 2

Results of OLS Linear Regression (n=19,331)

$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2$, where x_1 = IEP

VARIABLE	(1) STEM
1.IEP	-0.0566
	(0.0676)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3

Results of OLS Linear Regression with Interaction (n=19,331)

$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \hat{\beta}_3 z$, where x_1 = IEP, x_2 = FRL, and z = interaction IEP*FRL

VARIABLES	(1) STEM
1.FRL	-0.283***
	(0.0655)
1.IEP	0.138
	(0.0963)
1.FRL#1.IEP	-0.311**
	(0.146)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4

Average Marginal Effects on number of STEM classes taken for students who had an IEP, compared to those who did not have an IEP, for those who qualified for FRL as opposed to those who did not qualify for FRL

(Interaction of IEP*FRL)	Average marginal effect	Standard Error	95% Confidence interval
IEP			
FRL			
0=does not qualify for FRL	.138	.043	.050 - .327
1=qualifies for FRL	-.173	.118	-.404 - .059

Discussion

The results of this study indicate a significant reduction in STEM classes completed by the end of high school for the students who both received accommodations under an IEP and were from low-income families. This was expected after reviewing the literature that indicated both SES and disability status have been factors that have impacted academic achievement for high school students (Ball et al., 2018; Baltodano et al., 2005; Barnard-Brak & Lechtenberger, 2010; Chapman, 1988; Estes et al., 2011; Owens et al., 2016; Riegle-Crumb & Grodsky, 2010; Shin et al., 2013; Sirin, 2005; Wei et al., 2015;)

What was surprising was that the students who received accommodations under an IEP and did not qualify for FRL, on average completed .26 more units of STEM classes compared to the students who received accommodations under an IEP and also qualified for FRL. This explains why no significant result was found in the first OLS linear regression analysis that only used the IEP variable in the model instead of the IEP*FRL interaction (see Table 2). The group of students who received accommodations under IEPs completed STEM coursework in significantly different amounts according to their eligibility for FRL (see Table 3). This finding reinforced what was found in the literature regarding the disparities in IEP planning and services experienced by youth with disabilities from low SES families (Kalyanpur et al., 2000; Landmark et al., 2007; Zeitlin & Curcic, 2014). Students captured in the HSLS:09 data set from low SES families were likely to have participated in their high school education in segregated special education classrooms, were likely to have had less parental involvement in IEP planning, and were probably less likely to receive access to STEM classes, which has been described in previous research (Tucker & Schwartz, 2013; Wagner et al., 2012; Zeitlin & Curcic, 2014). Students captured in the HSLS:09 data set who had IEPs, but were from higher SES families, who were served in school districts with more resources, who had more parental involvement in IEP planning, and who received accommodations in integrated classrooms were probably more likely to complete STEM coursework in high school, which has been described in previous research (Lalvani, 2012). Lalvani's (2012) discussion of how family SES has played a large role in how accommodations and modifications were decided for students with disabilities, was reflected in the findings in this analysis when the interaction of IEP*FRL was used to predict STEM completion (see Table 3).

FRL and IEP must both be included as an interaction in the OLS linear regression model in order to discern the impact of both of these factors on STEM completion. When only the IEP variable was in included in the model, it falsely appeared that IEP had no impact on STEM completion. When only the IEP variable was included in the model, the students with disabilities from higher SES families who completed more STEM coursework and those students with disabilities from lower SES families who completed fewer STEM courses in the data set canceled each other out in the analysis, and it falsely appeared that receiving accommodations under an IEP had no significant impact on the number of STEM courses completed (see Table 2). The IEP*FRL interaction must be included in the analysis to capture the impact of SES on STEM completion for students with disabilities (see Table 3). It is important to note the significant effect that FRL had in combination with IEP on the number of STEM courses completed by the end of high school. This was only possible by including the IEP*FRL interaction in the OLS linear regression model (see Table 3).

Limitations

The purpose of this study was to bring attention to the need to explore potential interaction effects of important student-related variables that may impact outcomes for students with disabilities as they prepare to exit high school, pursue higher education, and seek employment. Although precautions were taken to minimize bias and error in this analysis, there may be information that was not accurately captured in this study. Most of the information in the study was captured by school personnel, student, and parent self-report. Kaplan et al. (2014) have noted that caution should be used whenever analyzing large data sets due to potential bias.

Ideally in research experiments, participants are randomly assigned to groups that receive a treatment or not. For ethical and legal reasons, it is not feasible to randomly assign students to receive accommodations under an IEP or not. Therefore, in large data analyses of educational services a counterfactual is established because researchers are not able to establish traditional research treatment and control conditions for ethical reasons (Stock & Watson, 2019). In this study, for a student who received accommodations under an IEP, the counterfactual would be their STEM coursework had the student not received accommodations under an IEP.

This study used a large dataset, where n = 23, 415. A large percentage of the survey participants did not indicate one way or the other if they had received accommodations under an IEP while in high school. Approximately 34.7% (n = 8,115) of the students did not receive accommodations under an IEP, and 8.8% (n = 2,069) did receive accommodations under an IEP. This may impact the analysis even though a third category "not known" was created so that this large number of observations would be included in the calculations.

With a large data set there may be additional variables that were not included in the regression model that may impact results. Examples of other variables that were not included were the population size of the school the student attended, the educational level of the teachers at their school, the average SES of students at their school, and the total percentage of students at their school that qualified for FRL. These types of factors related to the school resources have been shown to impact academic achievement (Owens et al., 2016). These variables were not available to the public or did not meet the criteria for omitted variable bias and were not included in the regression model.

Conclusion

Being labelled a student with a disability and receiving accommodations under an IEP does not always result in equal access. In fact, for some students—especially those who are from low-income families—completion of STEM coursework suffers. With the ongoing increase in STEM occupations available in the labor market, vocational rehabilitation counselors, teachers, and other professionals involved with students with disabilities can look to current national policies and incentives regarding IEP transition planning, WIOA youth programs, and the PROMISE study recommendations for guidance on how to best support low-income youth with disabilities to pursue high school STEM coursework.

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