Curriculum Differentiation and Its Impacts on Students' College Entrance

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Introduction

Curriculum differentiation is one of the enduring issues in the curriculum theory and practice over several decades (Oakes, Gamoran, & Page, 1992; Terwel & Walker, 2004). However, the benefits of differentiated curriculum and ability grouping of students still remain controversial. Scholars examining the effects of differentiated curriculum on students' educational outcomes have emphasized different viewpoints and reported contradictory findings.

Curriculum differentiation by student ability is a type of within-school tracking systems.[1] When it occurs, students are grouped based on some measure or estimation of their learning abilities, such as previous academic achievements and teacher evaluations, and they may form separate groups within the same classroom or be "pulled out" to study elsewhere. Examples of differentiated curriculum include ability-based reading groups and gifted programs (LeTendre, Hofer, & Shimizu, 2003).

Curriculum differentiation was widely adopted in the U.S. school systems from the 1960s to the end of the 1980s. Then, this practice began to fall out of fashion from the middle of the 1980s to the end of the 1990s, partly due to opposition from advocates of equity and equality.

[1] Sometimes curriculum differentiation is used as a broader concept including not only within-school tracking but also between-school and between-region tracking. In this paper, curriculum differentiation is used in a narrower sense, referring to differentiated instructions provided to different student ability groups within schools.

However, curriculum differentiation has increased remarkably since the end of the 1990s and has been gaining popularity in the recent years (Steenbergen-Hu, Makel, & Olszewski-Kubilius, 2016). According to the Brooking's *2013 Brown Center Report on American Education*, the percentage of students who were provided with differentiated reading instructions based on ability group in their schools considerably increased from 28% to 71% during 1998-2009; and the percentage of differentiated math instructions also increased from 42% to 61% during 2003-2011 (Loveless, 2013).

Scholars have mainly focused on two different aspects of the impact of curriculum differentiation on students. On the one hand, a group of scholars have questioned whether curriculum differentiation produces differences in academic outcomes of students. The three competing hypotheses about the effects of curriculum differentiation include that 1) it has positive effects on every student; 2) it has no effects on students' overall learning outcomes; and 3) it has differential effects on high- and low-achieving students, likely to benefit high-achievers only. On the other hand, another group of scholars have focused on the reproduction of inequality through curriculum differentiation. They have argued that curriculum differentiation is a mechanism which reinforces discrimination in schools based on socioeconomic status (SES) and race.

This study aimed to explore the causal relationship between curriculum differentiation and educational outcomes in the U.S. by addressing limitations of the prior studies through a quasi-experimental design using a nationally representative large-scale sample. Another contribution of this research to the existing literature is that this research used postsecondary education enrollment as an outcome variable while most previous studies used math test score as outcome variable. This study suggested that using postsecondary education enrollment as outcome variable can be a valid alternative approach to studying curriculum differentiation and students' educational outcomes. The findings provide strong evidence that curriculum differentiation has differential effects depending on student SES while it has no effect on any ability groups. Especially, treatment of receiving differentiated instructions causes a considerable increase in the probability of going to four-year university among high-SES students. However, it has a slightly negative effect for low-SES students.

Literature review

Curriculum differentiation and students' learning outcomes

Curriculum differentiation is one of the persistently studied topics in the field of curriculum theory and practice. What has drawn great attention of educational scholars is the effect of curriculum differentiation on students' academic achievement. Though more than thousands of studies were conducted over decades, scholars have not reached a consensus because of the contradictory findings. Some studies have reported a positive effect of curriculum differentiation on student learning outcomes while others have not found any significant effects. In addition, another group of studies has reported heterogeneous effects across ability groups.

Steenbergen-Hu, Makel and Olszewski-Kubilius (2016) synthesized 13 published meta-analyses and concluded that within-class and cross-grade curriculum differentiation practices had small but significantly positive effects on learning outcomes, whereas between-class curriculum differentiation had no significant effects. They reported that effects did not vary depending on ability groups. By contrast, Duflo, Dupas and Kremer (2011) found strong evidence of positive effects of between-class curriculum differentiation from a large-scale experimental study. They argued the necessity of experimental studies employing a full random assignment to capture the true effects of curriculum differentiation on learning outcomes. Based on a randomized tracking experiment in 121 primary schools in Kenya, they found that students receiving differentiated instructions consistently showed higher increase in math test scores compared to their counterparts in schools with a common curriculum. They found students at all levels of ability benefited from curriculum differentiation though the effect sizes were slightly different. However, application of these findings to other social contexts must be qualified, given that this experiment was conducted in Kenya.

Figlio and Page (2002) focused more on the heterogeneity of the effects by ability groups. Using the National Education Longitudinal Study of 1988 (NELS 1988), a nationally representative large-scale dataset, they found providing differentiated curriculum had small but significantly positive effects on math achievement for low-ability students but had negative effects for high-ability students. Some scholars argued that large-scale quantitative datasets had limitations in capturing the processes underlying curriculum differentiation because these datasets often did not include detailed information about ability grouping and curriculum differentiation (Terwel, 2005; Domina et al., 2019). However, Figlio and Page showed that despite limited information about curriculum differentiation, using other available variables enabled capturing the effects of curriculum differentiation. Furthermore, they showed that using a large-scale dataset allowed researchers to take into account the school-level variables which were significant in analyzing the effects of curriculum differentiation.

Figlio and Page detected a self-selection problem that students from high SES were systematically more likely to choose school providing a differentiated curriculum. Therefore, they used instrumental variable method to adjust for potential bias due to self-selection. However, their research design also had limitations. While they controlled for selection bias using instrumental method, it is difficult to determine whether their instruments were valid since they used two-way and three-way interaction terms between three variables which were not straightforward.[2] Moreover, the dataset they used were collected in 1988, a time when curriculum differentiation was yet to gain popularity. Therefore, it is necessary to reinvestigate the effects of curriculum differentiation using more recent dataset.

Curriculum differentiation and reproduction of inequality

A sociological perspective on curriculum differentiation adds another layer to the discussion on the effects of curriculum differentiation. This perspective called for more attention to be placed on the association between curriculum differentiation and reproduction of inequality, instead of learning outcomes. Scholars have raised concerns that curriculum differentiation may facilitate reproduction of inequality.

In *Keeping Track*, one of the most influential studies on curriculum differentiation, Oakes (1985) argued that curriculum differentiation deprived low-performing students of equal opportunity, because many low-track classes provided students with adverse learning environments. In a later study, Oakes and her colleagues again argued that curriculum differentiation fostered friendship networks linked to students' group membership, and these peer groups may contribute to "polarized" attitudes among high school students, with high-ability students becoming more enthusiastic and low-ability students more alienated (Oakes, Gamoran, & Page, 1992).

Terwel (2005) also contended that curriculum differentiation can foster persistent

[2] The three instrument variables include the number of academic courses required for state graduation, the number of schools in the county, and the fraction of voters in the county who voted for President Reagan.

inequality between groups of students. He viewed curriculum differentiation as an institutional mechanism that offers different opportunities to different categories of students by creating differences not only in learning content and methods, but also in learning experiences. For example, in lower tracks, students are more likely to be involved in simple teacher-formulated question-and-answer activities. However, students in higher tracks are encouraged to formulate their own questions and to reflect on different solutions. He argued that this boundary of learning experiences established between one category of students and another are difficult to cross.

Several scholars suggested empirical evidence of strong association between curriculum differentiation and reproduction of inequality. Using the High School and Beyond of 1980 (HSB 1980) dataset, Ayalon and Gamoran (2000) suggested that diversifying curriculum lowered overall math test scores of high-achieving students in the U.S. high schools, while the achievement gap between high-, middle-, and low-SES students widened. Furthermore, Batruch and his colleagues (2019) revealed that teachers were likely to consider a lower track more suitable for lower SES than higher SES students, and the higher track more suitable for higher SES than lower SES students, even though the students' achievement was identical.

LeTendre, Hofer and Shimizu (2003) provided some evidence that the association between curriculum differentiation and inequality is culturally ignored in the U.S. schools. They showed that the term "tracking" has negative connotations since tracking appears virtually synonymous with segregated education. However, they found that curriculum differentiation by ability group is hardly recognized as a form of tracking but considered as a legitimate practice that meets individual student needs. This finding resonates with the current trend in which curriculum differentiation has regained popularity since the end of 1990s, while criticism toward tracking as "second-generation segregation" remains persistent (Mickelson, 2001).

Research questions

This study aimed to revisit the causal relationship between curriculum differentiation and educational outcomes in the U.S. high schools by addressing limitations found in previous studies. First, prior studies using large-scale datasets had limitations in that they did not adequately account for selection-bias. Moreover, experimental studies on the effectiveness of curriculum differential were mostly conducted on a small scale. Some large-scale experimental studies exist, but they were conducted in non-U.S. contexts, limiting their generalizability to the U.S. context. To address these limitations, this study employed a quasi-experimental design which near-randomly assigned a nationally representative sample of U.S. high school students to differentiated curriculum by propensity score matching. This quasi-experimental setting controls selection bias, enabling causal inference on the relationship between curriculum differentiation and students' educational outcomes.

Second, this study used postsecondary education enrollment as an outcome variable instead of math test score that was used in most previous studies. Though math test score provides a good measure of students' cognitive ability, some scholars suggested a possibility that curriculum differentiation not only affects cognitive outcomes but also other non-cognitive outcomes, which may be more critical to students' educational trajectories. For example, Hattie (2002) pointed out that differential instruction could affect students' learning outcomes, but the influences were primarily indirect. He argued that the placement in different classes based on ability grouping changed the educational expectations of students, which in turn affected their academic performances. In this regard, postsecondary education enrollment can be an alternative measure of students' educational outcomes, since it is determined based on students' expectations and motivations as well as academic achievement. In addition, postsecondary education enrollment has more significance on students' overall educational career than math test score. Further, college enrollment has advantages in measurement over test scores because there is no standardization issue since it is a clearly identifiable and comparable variable.

Third, building on the different streams of literature, this research focused on identifying heterogenous effects of curriculum differentiation depending on students' ability and SES. Based on the previous literature on the effects of differentiated curriculum on student learning outcomes, this research examined whether curriculum differentiation has heterogenous effects on educational outcomes depending on student ability groups. Furthermore, informed by the literature that viewed curriculum differentiation as a mechanism of reproduction, this study also investigated whether the effects of curriculum differentiation significantly differed by students' SES. The two research questions of this study are as follows:

1) Does the effect of curriculum differentiation on postsecondary education enrollment differ by student ability group?
2) Does the effect of curriculum differentiation on postsecondary education enrollment differ by student SES?

Data and methodology

Data

This study utilized a publicly available version of the Education Longitudinal Study of 2002 (ELS 2002) organized by the National Center for Education Statistics (NCES). The ESL 2002 first collected data from a nationally representative sample of U.S. high school sophomores in the spring of 2002, which included approximately 16,000 participants from 752 schools. After the base-year survey, additional data were obtained through three follow-up surveys in 2004 (12th

grade), 2006 (two years after high school graduation), and 2012 (eight years after high school graduation) as well as by appending high school and college transcript information.

Measures

Postsecondary education enrollment (outcome variable). The outcome variable of this study is postsecondary education enrollment categorized into three levels: 1) no postsecondary education, 2) postsecondary education institutions other than four-year university, and 3) four-year university. This information was obtained in the third follow-up survey conducted eight years after the respondents graduated from high school. Four-year university enrollment was distinguished from other types of postsecondary institutions because prior literature suggests that bachelor's degree is a significant determinant of achieving equal opportunity in labor market regardless of individuals' family and demographic background (Hout, 1988; Torche, 2011).

Curriculum differentiation (treatment variable). Students who attended schools that offered differentiated courses based on student ability were assigned as the treatment group; and students who attended schools offering undifferentiated courses were assigned as the control group. This information was obtained from the school principal survey in the base year. School principals were asked about school's approach to providing instruction in the core curriculum to students who come to school with different abilities, learning rates, interests or motivations.[3]

Ability. Students' ability at 10th grade was measured using quartile scores of reading and math tests developed by NCES to evaluate general proficiency of students (Ingels et al., 2005, pp. 24-

[3] The original responses were categorized into three: 1) offering differentiated courses but students have open access to any course provided they have taken the required prerequisites, 2) offering differentiated courses and do differentiated grouping, and 3) offering undifferentiated courses. However, the cases with the first response were excluded because of no clear theoretical ground for such practice. This compromised sample sizes.

26).[4] The first and second quartiles were categorized as the low ability group while the third and fourth are categorized as the high ability group to construct an interaction term between ability and the treatment. When the ability variable was included as a control variable, raw continuous score was used instead of quartile scores.

SES. Students' SES was measured using standardized SES variables constructed by NCES. Quartile scores for SES were used to construct an interpretable interaction term with the treatment variable. In addition, a continuous measure of SES was used when it was included as a control variable.

Covariates. Student characteristics and school characteristics were controlled to address self-selection bias for attending schools with a differentiated curriculum. Student characteristics included gender, race and ethnicity, family structure, and educational expectations of students and parents, educational discussion with parents as well as school characteristics; School characteristics include school type, school urbanicity, and geographical region. In addition, cumulative GPA measured at 12th grade and tracking were also controlled because, though these two variables were not involved in self-selection process, they were significant predictors of choosing postsecondary education.

Analytic strategies

This study used propensity score matching as a data preprocessing technique to estimate the causal effects of curriculum differentiation by ability and SES. First, preliminary descriptive

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[4] This variable based on the composite test score in reading and math does not reflect teachers' subjective evaluation which is often a significant determinant of ability grouping. Thus, another binary variable indicating whether a student is recommended by teacher for advanced placement, or honors classes was used as an alternative measure of students' ability. However, the results were not significantly different.

analyses were conducted using the full unmatched data to check the existing imbalance in the sample. Second, the effects of curriculum differentiation by ability and SES were examined using multinomial logistic regressions with unmatched sample. Third, resampled data were obtained based on propensity score matching. Specifically, the nearest neighbor 1-to-1 matching within a caliper was applied (Guo & Fraser, 2015). Table 1 shows significant imbalance of treatment variable across all covariates. However, after matching, all imbalances disappeared (see Figure 1 and 2), which implies the sample is near-randomly assigned to treatment. Lastly, the effect of curriculum differentiation by ability and SES was estimated using multinomial logistic regressions with the matched sample. To implement the analyses, R version 4.0.5 was used with *nnet* packages to specify the multinomial logistic regression models and *matchIt* package to conduct propensity score matching.

Model specification

The first research question about the heterogenous effects of curriculum differentiation depending on ability group was addressed by the following regression equation:

$$\ln \frac{\Pr(y_i = k)}{\Pr(y_i = 0)} = \beta_{k0} + \beta_{k1} Diff_i + \beta_{k2} Abil_i^D + \beta_{k3} Diff_i \times Abil_i^D + \gamma_{k1} SES_i + \boldsymbol{\gamma}_{k2}^T \boldsymbol{x}_i.$$

Here, *i* indexes individual students and *k* indexes different choices of postsecondary education enrollment where the base category is no postsecondary education ($y_i = 0$). $Diff_i$ is the treatment variable of receiving differentiated instruction, and $Abil_i^D$ is a dichotomized variable measuring student low or high ability (low = 0, high = 1). The coefficients of interest β_{k1} and β_{k3} indicate the main effect of curriculum differentiation and its interaction effect with ability, respectively. Remaining variables, SES_i and $\boldsymbol{x}_i$, are control variables.

Table 1. Descriptive statistics of variables by treatment: Full sample
(Mean and standard deviation for continuous variables, and proportion for categorical variables)

Variables	*Total*	*Differentiated curriculum*	*Common curriculum*	*Significance test*
Outcome variable				$p < 0.001$
No postsecondary education	0.119	0.099	0.138	
Four-year university	0.556	0.634	0.484	
Other postsecondary institutions	0.324	0.266	0.378	
SES (continuous)	0.11 (0.76)	0.24 (0.75)	0 (0.74)	$p < 0.001$
Ability (continuous)	51.41 (9.87)	52.57 (9.77)	50.35 (9.84)	$p < 0.001$
Gender				$p < 0.01$
Male	0.506	0.527	0.486	
Female	0.494	0.473	0.514	
Race/ethnicity				$p < 0.001$
White	0.606	0.641	0.574	
Black	0.106	0.114	0.098	
Hispanic	0.147	0.117	0.175	
Asian	0.092	0.087	0.097	
Others	0.049	0.041	0.056	
Family structure				$p < 0.001$
Broken family	0.378	0.346	0.407	
Two-parent family	0.622	0.654	0.593	
Students' educational expectation				$p < 0.001$
High school diploma	0.161	0.135	0.184	
College degree	0.089	0.069	0.107	
University degree or higher	0.751	0.796	0.709	
Parents' educational expectation				$p < 0.001$
High school diploma	0.032	0.026	0.038	
College degree	0.081	0.061	0.099	
University degree or higher	0.887	0.912	0.863	
Discussion with parents				$p < 0.001$
No discussion	0.109	0.091	0.126	
Some discussions	0.435	0.425	0.444	
Frequent discussions	0.456	0.483	0.430	
School type				$p < 0.001$
Public school	0.642	0.498	0.774	
Catholic school	0.193	0.309	0.088	
Private school	0.164	0.069	0.138	
School urbanicity				$p < 0.001$
Urban area	0.361	0.411	0.315	
Suburban area	0.459	0.520	0.403	
Rural area	0.181	0.069	0.283	
Geographical region of school				$p < 0.001$
Northwest	0.233	0.325	0.149	
Midwest	0.281	0.251	0.308	
South	0.282	0.331	0.236	
West	0.204	0.092	0.307	
GPA at 12^{th} grade	2.74 (0.76)			
Track placement				
General	0.338			
Academic	0.565			
Vocational	0.096			
Number of observations	5,071	2,424	2,647	

Figure 1. Covariate imbalance check before and after matching

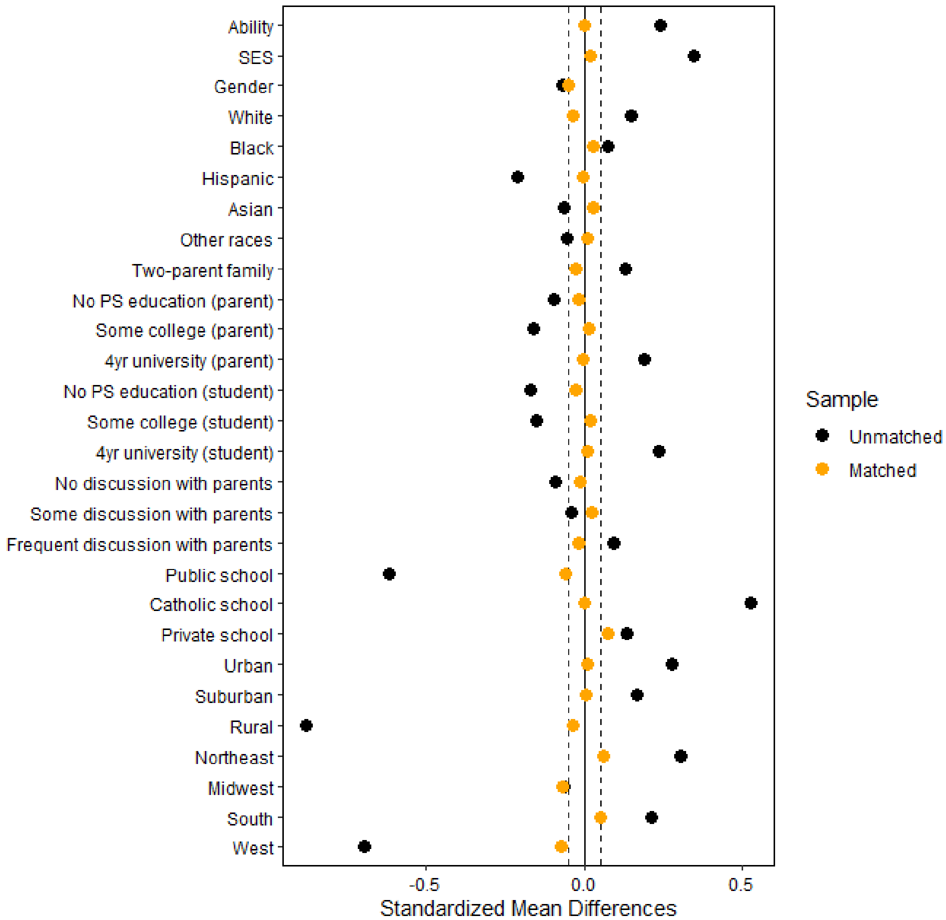
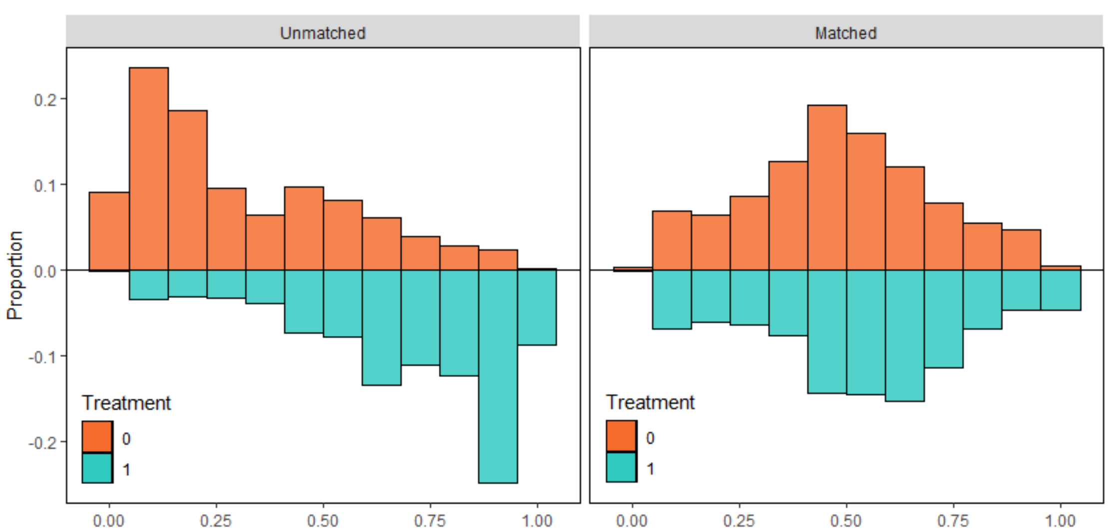


Figure 2. Distributions of estimated probability in unmatched and matched samples



The second research question about the heterogenous effect of curriculum differentiation depending on student SES was addressed by the following regression equation:

$$\ln \frac{\Pr(y_i = k)}{\Pr(y_i = 0)} = \delta_{k0} + \delta_{k1} Diff_i + \delta_{k2} SES_i^D + \delta_{k3} Diff_i \times SES_i^D + \phi_{k1} Abil_i + \boldsymbol{\phi}_{k2}^T \boldsymbol{x}_i.$$

Most variables were the same as the regression equation for the first model, while SES_i^D, a dichotomized variable of student SES (low = 0, high = 1), was included in the model instead of $Abil_i^D$ in the second model. The coefficients of interest δ_{k1} and δ_{k3} indicate the main effect of curriculum differentiation and its interaction effect with SES, respectively. In this model, control variables included $Abil_i$, a variable of student ability, as well as $\boldsymbol{x}_i$.

Results

Does the effect of curriculum differentiation differ by ability group?

Table 2 presents the results from multinomial logistic regression models predicting postsecondary education enrollment using interaction term between the treatment of curriculum differentiation and student ability. Before matching, the effect of curriculum differentiation was significant in the model without controls (b = 0.319, $p < 0.05$). However, the effect of curriculum differentiation became non-significant when adding controls and/or using matched sample. No interaction effect between curriculum differentiation and student ability was observed across all models. Ability, among the key explanatory variables, was consistently the only significant predictor of pursuing any types of postsecondary education. In the final model with matched sample and controls, the effect of ability was significant for both university enrollment (b = 1.102, $p < 0.01$) and some college enrollment (b = 0.647, $p < 0.01$). This implies that curriculum differentiation has no effects on choosing postsecondary education, regardless of student ability.

Table 2. Results from multinomial logistic regression models predicting the postsecondary education enrollment using interaction term between curriculum differentiation and student ability

	Unmatched data				*Matched data*			
	Without controls		*With controls*		*Without controls*		*With controls*	
Variables	*Univ.*	*Col.*	*Univ.*	*Col.*	*Univ.*	*Col.*	*Univ.*	*Col.*
Curriculum differentiation	0.319**	-0.023	-0.065	-0.04	0.067	0.014	-0.062	-0.063
	(0.14)	(0.13)	(0.23)	(0.19)	(0.23)	(0.22)	(0.28)	(0.24)
High ability (vs. low ability)	2.373***	0.986***	0.758***	0.453**	2.434***	1.036***	1.102***	0.647**
	(0.16)	(0.16)	(0.23)	(0.21)	(0.28)	(0.28)	(0.34)	(0.32)
Differentiation × High ability	0.198	-0.129	0.408	-0.071	-0.012	-0.146	0.102	-0.18
	(0.24)	(0.25)	(0.35)	(0.33)	(0.39)	(0.40)	(0.46)	(0.43)
Covariates								
SES			1.036***	0.514***			1.091***	0.606***
			(0.13)	(0.12)			(0.18)	(0.17)
GPA at 12th grade			1.759***	0.490***			1.486***	0.256*
			(0.13)	(0.11)			(0.17)	(0.15)
Track placement (vs. general track)								
Academic track			0.535***	0.225			0.514**	0.411*
			(0.18)	(0.17)			(0.25)	(0.25)
Vocational track			-0.486**	0.002			-0.382	0.276
			(0.25)	(0.20)			(0.33)	(0.28)
Female (vs. male)			0.029	0.327**			0.217	0.574***
			(0.16)	(0.15)			(0.22)	(0.21)
Race/ethnicity (vs. White)								
Black			1.803***	0.996***			2.095***	1.263***
			(0.33)	(0.31)			(0.42)	(0.40)
Hispanic			0.128	0.344			0.143	0.42
			(0.24)	(0.21)			(0.33)	(0.29)
Asian			1.156***	0.553*			1.241***	0.546
			(0.34)	(0.32)			(0.46)	(0.44)
Others			-0.103	-0.427			0.217	-0.384
			(0.35)	(0.31)			(0.50)	(0.46)
Family structure (vs. broken family)			0.301*	0.176			0.358	0.251
			(0.16)	(0.15)			(0.22)	(0.20)
Educational expectation (vs. high school diploma)								
College degree			0.235	0.183			0.750*	0.5
			(0.28)	(0.21)			(0.39)	(0.31)
University degree or higher			1.074***	0.786***			1.272***	0.999***
			(0.21)	(0.18)			(0.29)	(0.25)
Discussion with parents (vs. no discussion)								
Some discussions			0.061	-0.088			-0.128	0.051
			(0.24)	(0.20)			(0.32)	(0.27)
Frequent discussions			0.405	0.062			0.332	0.266
			(0.26)	(0.22)			(0.35)	(0.30)

(Continued on next page)

	Unmatched data				*Matched data*			
	Without controls		*With controls*		*Without controls*		*With controls*	
Variables	*Univ.*	*Col.*	*Univ.*	*Col.*	*Univ.*	*Col.*	*Univ.*	*Col.*
School type (vs. public school)								
Catholic school			1.351^{***}	1.109^{***}			1.245^{***}	0.886^{*}
			(0.33)	(0.32)			(0.48)	(0.48)
Private school			0.849^{***}	0.329			0.606	0.06
			(0.32)	(0.32)			(0.49)	(0.49)
School urbanicity (vs. urban area)								
Suburban area			-0.542^{***}	-0.062			-0.445	0.131
			(0.20)	(0.19)			(0.29)	(0.28)
Rural area			-0.863^{***}	0.071			-0.938^{**}	-0.243
			(0.26)	(0.24)			(0.37)	(0.35)
Geographical Region of school (vs. Northwest)								
Midwest			-0.346	-0.07			-0.136	0.204
			(0.23)	(0.22)			(0.32)	(0.30)
South			-0.384	-0.16			-0.371	-0.018
			(0.24)	(0.22)			(0.31)	(0.29)
West			-0.594^{**}	0.144			-0.131	0.493
			(0.26)	(0.24)			(0.41)	(0.38)
Constant	0.172^{*}	0.737^{***}	-4.567^{***}	-1.096^{***}	0.339^{**}	0.647^{***}	-4.343^{***}	-1.416^{***}
	(0.09)	(0.08)	(0.46)	(0.38)	(0.16)	(0.15)	(0.62)	(0.52)
Log likelihood	-3,417.33		-1,939.16		-1,273.23		-1,029.90	
McFadden's R^2	0.73		0.85		0.09		0.27	
Number of observations	4,071		2,993		1,518		1,518	
Treated	1,956		1,503		759		759	
Control	2,115		1,490		759		759	

Note. *p < 0.1; **p < 0.05; ***p < 0.01 (two-tailed tests).

Does the effect of curriculum differentiation differ by SES?

Table 3 presents the results from multinomial logistic regression models predicting postsecondary education enrollment using interaction term between the treatment of curriculum differentiation and student SES. In the initial models, the effect of curriculum differentiation appeared not significant. However, the estimations from the final model with matched sample and control variables show that the main effect of the treatment of receiving differentiated instructions on enrolling postsecondary education institutions other than four-year university education is significant (b = -0.505, $p < 0.05$), and the effect on enrolling in a four-year university is marginally significant (b = -0.507, $p < 0.1$). The main effect of SES was significant in the initial models, but the effect became less pronounced with matched sample and controls.

A significant interaction effect between curriculum differentiation and student SES was observed across all models. In the final model with matched sample and control variables, low SES students who receive the treatment of differentiated curriculum are 0.6 times less likely to enroll in a four-year university and also 0.6 times less likely to enroll in postsecondary institutions other than four-year university as opposed to not enrolling in postsecondary education, compared to low SES students who do not receive treatment (OR for four-year university = exp(-0.507) = 0.60, OR for other institutions = exp(-0.505) = 0.60).

On the contrary, when high SES students receive differentiated instructions, they are 2.39 times more likely to enroll in a four-year university as opposed to not enrolling in postsecondary education, compared to high SES students who do not receive differentiated instructions (OR = exp(-0.507 + 1.378) = 2.39). Moreover, high SES students who receive differentiated instructions are 1.94 times more likely to enroll in postsecondary education institutions other than four-year university as opposed to not enrolling postsecondary education, compared to high SES students who do not receive treatment (OR = exp(-0.505 + 1.167) = 1.94).

The results can also be evaluated in terms of estimated probability of choosing different types of postsecondary education. Table 4 and Figure 3 present the changes in estimated probability by students' treatment and SES status. For low SES students, receiving differentiated instruction increases the probability of pursuing no further education beyond high school and lowers the probability of enrolling any types of postsecondary institutions. However, for high SES students, treatment of receiving differentiated instructions considerably increases the probability of going to four-year university while decreasing probabilities for other choices.

Table 3. Results from multinomial logistic regression models predicting the postsecondary education enrollment using interaction term between curriculum differentiation and student SES

	Unmatched data				*Matched data*			
	Without controls		*With controls*		*Without controls*		*With controls*	
Variables	*Univ.*	*Col.*	*Univ.*	*Col.*	*Univ.*	*Col.*	*Univ.*	*Col.*
Curriculum differentiation	0.136	-0.273**	-0.34	-0.321*	-0.277	-0.341	-0.507*	-0.505**
	(0.14)	(0.13)	(0.23)	(0.20)	(0.22)	(0.22)	(0.28)	(0.24)
High SES (vs. low SES)	1.875***	0.810***	0.499**	0.284	1.727***	0.644**	0.552*	0.218
	(0.16)	(0.16)	(0.22)	(0.20)	(0.26)	(0.27)	(0.32)	(0.30)
Differentiation × High SES	0.757***	0.590**	1.216***	0.790**	0.890**	0.916**	1.378***	1.167***
	(0.25)	(0.26)	(0.35)	(0.33)	(0.39)	(0.41)	(0.47)	(0.44)
Covariates								
Ability			0.085***	0.031***			0.094***	0.037***
			(0.01)	(0.01)			(0.02)	(0.01)
GPA at 12th grade			1.635***	0.480***			1.398***	0.289*
			(0.13)	(0.11)			(0.18)	(0.16)
Track placement (vs. general track)								
Academic track			0.553***	0.252			0.559**	0.463*
			(0.18)	(0.17)			(0.26)	(0.25)
Vocational track			-0.458*	0.013			-0.31	0.286
			(0.25)	(0.20)			(0.33)	(0.28)
Female (vs. male)			0.057	0.321**			0.262	0.576***
			(0.16)	(0.15)			(0.22)	(0.21)
Race/ethnicity (vs. White)								
Black			1.907***	1.029***			2.225***	1.306***
			(0.33)	(0.31)			(0.43)	(0.40)
Hispanic			0.043	0.301			0.149	0.411
			(0.24)	(0.21)			(0.33)	(0.29)
Asian			0.951***	0.442			1.051**	0.382
			(0.33)	(0.32)			(0.44)	(0.43)
Others			-0.101	-0.445			0.116	-0.462
			(0.35)	(0.32)			(0.50)	(0.47)
Family structure (vs. broken family)			0.359**	0.184			0.414*	0.26
			(0.16)	(0.15)			(0.22)	(0.21)
Educational expectation (vs. high school diploma)								
College degree			0.315	0.208			0.835**	0.531*
			(0.28)	(0.21)			(0.39)	(0.32)
University degree or higher			0.997***	0.742***			1.233***	0.952***
			(0.22)	(0.18)			(0.29)	(0.25)
Discussion with parents (vs. no discussion)								
Some discussions			0.044	-0.112			-0.207	0.003
			(0.24)	(0.20)			(0.33)	(0.28)
Frequent discussions			0.411	0.05			0.249	0.201
			(0.27)	(0.22)			(0.35)	(0.31)

(Continued on next page)

	Unmatched data				*Matched data*			
	Without controls		*With controls*		*Without controls*		*With controls*	
Variables	*Univ.*	*Col.*	*Univ.*	*Col.*	*Univ.*	*Col.*	*Univ.*	*Col.*
School type (vs. public school)								
Catholic school			1.418***	1.113***			1.212**	0.785*
			(0.33)	(0.32)			(0.48)	(0.48)
Private school			0.998***	0.387			0.735	0.072
			(0.32)	(0.32)			(0.50)	(0.50)
School urbanicity (vs. urban area)								
Suburban area			-0.487**	-0.011			-0.531*	0.072
			(0.21)	(0.19)			(0.29)	(0.28)
Rural area			-0.956***	0.038			-1.047***	-0.349
			(0.26)	(0.24)			(0.37)	(0.35)
Geographical region of school (vs. Northwest)								
Midwest			-0.379	-0.091			-0.187	0.18
			(0.23)	(0.22)			(0.32)	(0.30)
South			-0.433*	-0.227			-0.483	-0.111
			(0.24)	(0.22)			(0.31)	(0.29)
West			-0.608**	0.125			-0.335	0.348
			(0.26)	(0.24)			(0.41)	(0.39)
Constant	0.435***	0.769***	-8.454***	-2.583***	0.725***	0.771***	-8.516***	-3.034***
	(0.09)	(0.08)	(0.63)	(0.54)	(0.16)	(0.15)	(0.86)	(0.74)
Log likelihood	-3,399.14		-1,928.51		-1,309.61		-1,017.16	
McFadden's R^2	0.73		0.85		0.07		0.28	
Number of observations	3,929		2,993		1,518		1,518	
Treated	1,879		1,490		759		759	
Control	2,050		1,503		759		759	

Note. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$ (two-tailed tests).

According to the McFadden and Train's (2000) random utility approach for the multinomial regression models, the probability of choosing each category in the outcome variable is inferred as the probability that the maximum expected utility from choosing such category, U_{ik}, is greater than maximum expected utility from choosing any other categories, U_{il}, as follow:

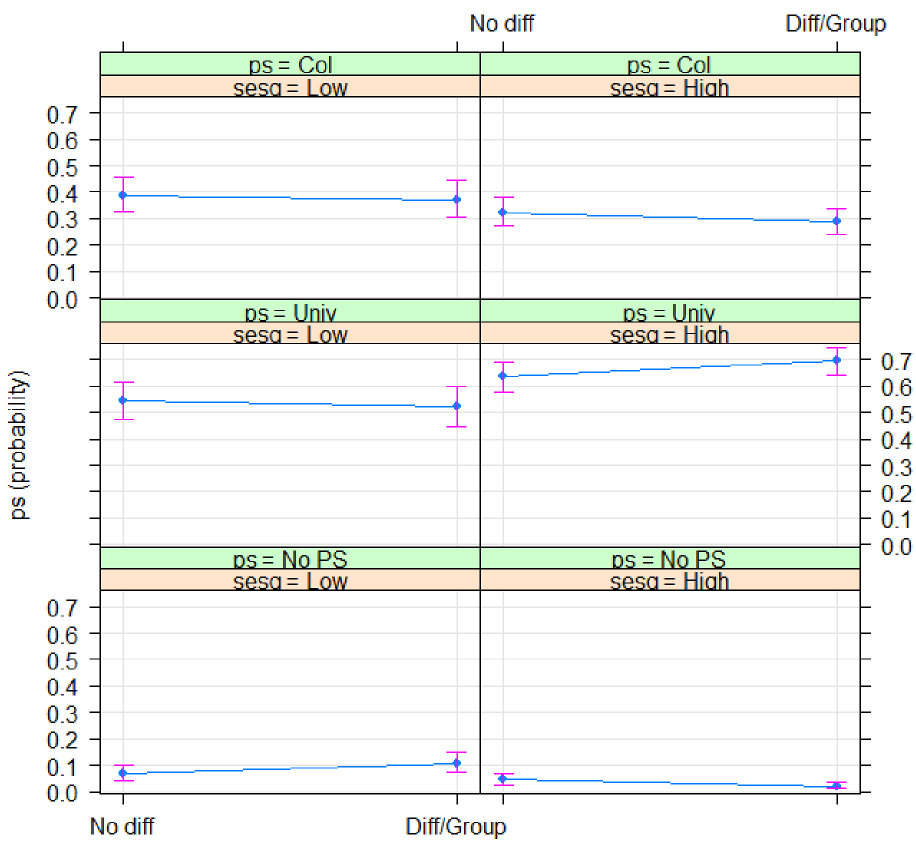
$$\Pr(y_i = k) = \Pr(U_{ik} - U_{il} > 0) \text{ for any category of outcomes } k \neq l.$$

Therefore, based on this approach, the changes of probability structure about the choice of postsecondary education imply that the treatment of receiving differentiated instructions possibly changes expected utility of students, but in different ways corresponding to students' SES. For high SES group, curriculum differentiation leads to expectation of increased utility of going to a four-year university whereas curriculum differentiation decreases the utility of going to a four-year university for low SES group.

Table 4. Estimated probability of choosing different types of postsecondary education by students' treatment status and SES

	Low SES students		*High SES students*	
Type of postsecondary education	*Common curriculum (control)*	*Differentiated Curriculum (treated)*	*Common Curriculum (control)*	*Differentiated Curriculum (treated)*
No postsecondary education	0.066	0.104 (Δ = +0.038)	0.044	0.020 (Δ = -0.024)
Four-year university	0.547	0.524 (Δ = -0.023)	0.634	0.694 (Δ = +0.060)
Other than four-year university	0.387	0.372 (Δ = -0.015)	0.322	0.286 (Δ = -0.036)

Figure 3. Graphical representation of the changes in estimated probability provided in Table 4



Discussion and conclusion

This study employed a quasi-experimental design which near-randomly assigned a nationally representative sample of U.S. high school students to differentiated curriculum by using propensity score matching method. This approach enabled a causal inference about the effects of differentiated curriculum on college enrollment of students, which has implications on existing literature. However, the current analyses also have several limitations that need to be addressed in the future research.

On the one hand, this study found no evidence that curriculum differentiation affects the choice of postsecondary education for students in any ability groups. This finding supports the hypothesis that curriculum differentiation by ability group has no overall effect on students' educational outcomes. However, on the other hand, observed evidence indicates that the influence of curriculum differentiation on students' choice of pursuing postsecondary education differs by student SES. This provides evidence for the argument that curriculum differentiation is an institutionalized mechanism reproducing educational inequality. Ayalon and Gamoran (2000) showed diversifying curriculum was likely to widen the math achievement gap between high school students in different SES groups. The present study further suggested that curriculum differentiation might widen the inequality in postsecondary education enrollment beyond test score. With this regard, the finding of this study resonates with Hattie's (2002) argument that differential instruction affects students' educational outcomes primarily indirectly through changing expectations of students, teachers, and parents.

Especially, the interaction effect between curriculum differentiation and student SES on enrolling in a four-year institution has significant implications since the theory emphasizes the role of four-year university as the "great equalizer." According to the analysis results, treatment for high SES increase the probability of enrolling in a four-year university whereas it decreases the probability for low SES students. Hout (1988) argued that once students receive bachelor's degree, the effect of prior factors, such as family background or demographic characteristics, on occupational choice mostly disappears. Later studies confirmed that this "Hout effect" is consistent in the U.S. society (Torche, 2011). Therefore, the differential influence of curriculum differentiation on the probability of enrolling in a four-year university by SES has significant implications for education as a social equalizer.

However, this study has several limitations. First, some school-level predictors that are likely to be correlated with a school's provision of differentiated curriculum were not included in the model since the information was suppressed in the publicly available version of ELS 2002 dataset that this study used. For example, Figlio and Page (2002) suggested that variables such as student-teacher ratio, average teacher salary, and proportion of students who are eligible for free lunch were significantly correlated with provision of differentiated curriculum. However, those variables were restricted in the current dataset. Second, using the propensity score matching method considerably compromised the sample sizes. Though the initial unmatched sample contained more than 5,000 observations, this number was reduced to approximately 1,500 in the matched sample. Multiple imputation could be a possible solution to this limitation. Lastly, the level of the ability variable may not correspond with the level of the differentiated curriculum that the student actually received. This is a fundamental problem of using large-scale dataset. Since curriculum differentiation is a complicated, flexible practice varying vastly across schools, which student receives what instruction cannot be fully traced through a large-scale longitudinal data collection. Therefore, the findings of this study can be further corroborated by similar evidence collected through small-size studies with detailed information.

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