The Differential Effects of Grouping Practices for Immigrant Students' Mathematical Achievement

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Abstract: American schools have many ethnically and linguistically diverse students. Recent immigrants make up approximately 14 percent of elementary students, and this percentage is growing dramatically every year. Language minority immigrant students have to overcome more difficulties than native-born students to succeed in school, including the tasks of learning a new language and cultural norms. The pedagogically appropriate classroom practices to help those students adapt to a new educational environment are needed now more than ever. In this paper, we identified beneficial classroom activities for kindergarten and elementary immigrant students of various ethnic groups. Specifically, we examined the effects of four mathematical grouping practices on the math performance of immigrant students: Teacher-directed whole class activity, Teacher-directed small group activity, Teacher-directed individual activity, and Child-selected activity. We used the Early Childhood Longitudinal Study (ECLS), a nationally representative dataset, composed 11,794 total students and 3,490 non-English-speaking students after deleting cases with missing values. We used hierarchical linear modeling (HLM) as a major analytical tool, and performed a series of longitudinal analyses. Our results indicate that the math scores of immigrant students were lower than those of native-born students, and the gap was reduced when teachers held math classes more frequently and for longer hours. The effects of teachers' grouping activities on the students' math scores displayed differential results for the four ethnic groups. Teacher-directed whole class activity was beneficial in raising the math scores of all students. Teacher-directed small group activity was good for Caucasian students, while it resulted in a negative effect on the achievement of non-English-speaking Asian students. Teacher-directed individual activity was beneficial in promoting the math achievement scores of African-American students and non-English-speaking Hispanic students. Child-selected activity did not show significant beneficial or negative effect on the math scores.

Keywords: Immigrant students, Math Achievement, Math Grouping, Ethnic Group, Longitudinal Analysis

Introduction

Immigrant students overcome multiple obstacles to succeed in school, including the task of learning a new language and cultural norms. Research has shown that the academic performance of immigrant students is significantly lower than that of US-born students (Chang & Singh, 2005), and that the rates of dropping out and delinquency are higher (Marks, 2005; Wang & Goldschmidt, 1999). There have been several theoretical explanations of the low performance of immigrant students in terms of cultural clashes, low social status, and schools' pedagogical practices.

Although there are many complex reasons for the underachievement of immigrant children we focus on the effects of school. Pedagogically appropriate classroom practices are critical for students who do not have educationally rich home environments and need beneficial school programs, or who lag behind the native-born students. Previous research

has found that class grouping can produce substantial gains for educationally disadvantaged students (Tieso, 2005). On the other hand, inappropriate grouping may limit students' motivation, disrupt their concentration and participation, and inhibit learning. The studies on grouping activities, however, have not provided empirical results, only describing grouping practices that teachers use in their classrooms, and failing to show a direct association with learning outcomes. Moreover, there has been little research on the effectiveness of grouping activities on the performance of immigrant students. This lack of research is particularly surprising considering that these instructional practices can be adopted with comparatively little effort.

In this paper, we investigated the effects of four class grouping practices on the mathematical performance of immigrant students: (1) Teacher-directed whole class activity, (2) Teacher-Directed small group activity, (3) Teacher-directed individual activity, and (4) Child-selected activity. Our focus was on the early learning experiences of kindergarten and first grade students because high-quality and appropriate early school programs have the potential of improving the achievement of young students without having to exert a great deal of effort and cost compared to interventions in later years.

Theoretical Framework

Why Is Immigrant Students' Performance Lower than that of Native-Born Students?

We have arranged the theories that explain low achievement of immigrant students into three categories: discontinuity of culture, economic and social difficulty, and pedagogical practices.

The discontinuity explanation holds that discontinuities of language, learning style, social norms, and expectations between school and home of immigrant students are enormous and they inhibit immigrant students from attaining academic success. For example, language minority students need to master the complex skill of code-switching from home- to school language (English). Until those students reach proficiency in bilingualism, the hard task of overcoming the discontinuities may interfere with their academic success (Krashen & Terrell, 1983; Scarcella, 1990; Teranishi, 2004).

The social and economic difficulty explanation attributes the low achievement of immigrant students to their low socioeconomic status and lack of resources and social networks. In general, the first-generation immigrants are less educated, earn lower salaries, and posses less wealth, and their children are raised in less academically stimulating home environments (Kao, 2004; Marks, 2005; Zhou, 1997; Zhou & Xiong, 2005).

The perspective of pedagogical practices ascribes the low achievement of language minority students to teachers' prejudice, ignorance and lack of experience, and lack of school support (Crosnoe, 2004, 2006; Portes, 1999). Immigrant students need intensive, specialized school curricula in order to perform at the same level as their U.S.-born counterparts. According to this explanation teachers need to differentiate the needs of diverse students and teach accordingly.

How Do Grouping Practices Help Students' Performance?

Psychological theories of instruction and development endorse class grouping that promote students' learning. Grouping, when used to support teaching, can be conducive to in-depth, collaborative and cooperative learning (Kutnick, Blatchford, Clark, MacIntyre, & Baines, 2005). Following are some common forms of class groupings.

Teacher-directed whole class activity: Previous studies on grouping practices indicate that teacher-directed whole class activities are linked with high performance of the whole class, and thus teachers heavily depend on this grouping practice in math classrooms (Kutnick, et al., 2005; Prais, 1997; Rathbun, Walston, & Hausken, 2000; Zahorik, Halbach, & Ehrle, 2003). In teacher-directed whole class activity, teachers focus on the uniformity of instruction while students are expected to reach the goal at the same pace using the same methods and materials. The practices, however, become difficult when there is great variability in the experiences, educational abilities and prior attainment of students (Lou, Abrami, Spence, Poulsen, Chambers, and d'Apolonia, 1996; Schumm, Moody, and Vaughn, 2000).

Teacher-directed small group activity: Research has shown that small-group activities have many advantages for students' learning over whole-class instruction (Lou, et al., 1996; Saleh, Lazonder, de Jong, 2005). Using small group activities, teachers have greater flexibility in the pace and objectives of instruction based on the performance, interest, and abilities of their students. With small grouping practice, students can benefit from exchanging and stimulating ideas, using words to clarify and improve understanding, and from cooperative learning (Kutnick, et al., 2005; Leonard, 2001; Lou, et al., 1996). Teacher-directed small group activity, however, can be harmful to language minority students because of their limited language proficiency and inability to participate in small group interaction.

Teacher-directed individual activity: In teacher-directed individual activities, teachers generally may or may not alter the curriculum for individual students and expect all students to master the same content. The major benefits of teacher-directed individual activities are that it allows teachers to assist educationally disadvantaged students and provides greater flexibility in adjusting the objectives and pace of instruction. The main shortcoming of this practice is that it requires small class size and teachers need specific knowledge of individual students (O'Connor, Harty, and Fulmer, 2005; Zahorik, 1999; Zahorik, et al., 2003).

Child-selected activity: In child-selected activities, teachers act as facilitators rather than instructors helping students with group discussions and presentations, while students choose their own individual or group projects (Horng, Hong, ChanLin, Chang, & Chu, 2005). This activity, however, requires teachers' creativity and discretion more than other activities do. Teachers should stimulate students' intrinsic motivation for learning, while teaching the core curriculum. Wang and Goldschmidt (1999) found that when immigrant students were allowed to choose their tasks, they tended to choose less demanding content areas, thereby reducing their opportunity to acquire the knowledge that they needed.

Method

Data Sources

This study used the ECLS, a nationwide longitudinal dataset, from the National Center for Education Statistics (NCES). The ECLS provides six waves of assessment of cognitive growth of children from kindergarten through the fifth grade from 1998 to 2003. Three waves of data were used to examine the longitudinal growth in the mathematics achievement of immigrant students from four ethnic backgrounds and the differential effect of math classroom activities. The four waves are fall 1998 kindergarten, spring 1999 kindergarten, and spring 2000 first grade. The initial data consists of 64,227 observations of 21,409 students. After deleting cases with missing values, the data contains 35,382 observations on 11,794 total students, and 10,470 observations on 3,490 non-English-speaking students. A

different weight was applied at each time point to represent the full samples. Since the ECLS-K over-represents Asian group, applying the weight is imperative to arrive at the accurate results. The weighted database is composed of 2,140,534 students and 604,126 non-English-speaking students.

Data files were prepared for Caucasian, African-American, Hispanic, and Asian groups to perform separate analyses. We designed a parsimonious model to examine the growth trajectory and the effect of predictor variables for each ethnic group.

Model Specification

We used a two-level longitudinal multilevel analysis as a main analytical tool for this study. The first level depicts how students' math performance (*Math),* the frequency of math classes (*Oftmath),* the duration of math class (*Timmath),* and the four class grouping arrangements change over time. The important contribution of this model is that we specify the grouping variables as time-varying covariates. Thus, we were able to examine the association of students' achievement and math class arrangements every year. Mathematics Item Response Theory (IRT) scale scores at three time points were used as a dependent variable.

The frequency of math classes is coded 1 though 5: 1-never, 2-less than one a week, 3-one or two times a week, 4-three or four times a week, and 5-daily. The duration of math class is coded as 1 for "1-30 minutes a day", 2 for "31-60 minutes a day", 3 for "61-90 minutes", and 4 for "more than 90 minutes".

Four class grouping variables were chosen as: Teacher-directed whole class activities *(Whole),* Teacher-directed small-group activity (*Small),* Teacher-directed individual activity *(Indiv),* and Child-selected activity *(Child*). These variables were originally categorized into non-equivalent five selections indicating the durations and frequencies of each grouping exercise. Although the HLM is flexible enough to handle non-equivalent distance scales, we transferred them into equidistant intervals. After recoding the categories of class grouping variables, 0 represents "no time", 1 "half hour or less", 2 "above one hour", 4 "about two hours", and 6 " three hours or more".

The level-1 model is specified as:

$$Y = \pi_0 + \pi_1(Time) + \pi_2(Oftmath) + \pi_3(Timmath) + \pi_4(Whole) + \pi_5(Small) + \pi_6(Indiv) + \pi_7(Child) + e$$

.

where Y is math achievement scores; *Time* is 0, 1, and 3 indicating the number of semesters the student has passed in the formal school setting; π_0 is the initial value of a math score; π_1 is a growth parameter indicating growth rates of three time points; π_2, π_3, π_4, π_5, π_6, and π_7 indicate the growth rates of math scores associated with *Oftmath, Timmath, Whole, Small, Indiv, and Child,* respectively; and e is an error.

The second level shows how students' math performance and class practices interact with student's contexts: Home language (*Hmlng*), and SES quintile score (*SESQ*). The variable of *Hmlng* is coded as 1 for the non-English-speaking group and 0 for the English-speaking group, and the variable of *SESQ* is coded as 1 for the lowest SES group and 5 for the highest SES group. Considering the academic achievement of young students, we controlled for the effect of age in months at the onset of schooling (*Age)* as well as gender (*Gender*).

The second level model is specified as:

$$\pi_0 = \beta_{00} + \beta_{01}(Hmlng) + \beta_{02}(SES) + \beta_{03}(Gender) + \beta_{04}(Age) + r_0 \quad ,$$

$$\pi_1 = \beta_{10} + \beta_{11}(Hmlng) + \beta_{12}(SES) + \beta_{13}(Gender) + \beta_{14}(Age) + r_1 \quad ,$$

$$\pi_2 = \beta_{20} + \beta_{21}(Hmlng) + \beta_{22}(SES) + \beta_{23}(Gender) + \beta_{24}(Age) \, , \ldots\ldots\ldots ,$$

$$\pi_7 = \beta_{70} + \beta_{71}(Hmlng) + \beta_{72}(SES) + \beta_{73}(Gender) + \beta_{74}(Age) \, .$$

where β_{00} is the intercept; β_{10} is the slope for the *Time* variable; $\beta_{01}, \beta_{02}, \ldots, \beta_{74}$ represent the effects of *Hmlng, SES, Gender, and Age* on π_0, $\pi_1, .., \pi_7$; and r_0 and r_1 are random errors. The random components are significant only in the intercept and the Time slope.

Results

Our results showed that the math scores of immigrant students were significantly lower than those of native-born students. Immigrant students began with a significantly lower math scores in the fall semester of kindergarten and this trend continued until the end of first grade, as shown Figure 1. Although this tendency was noticed in all students (β_{01} = -1.213, p<0.01), it was more conspicuous in the Hispanic group. Non-English speaking Hispanic students began with significantly lower math scores (2.562 points lower than that of English-speaking Hispanic students), and could not narrow the gap until the end of first grade.

We also noticed significant ethnic gaps in math achievement in other groups. Caucasian and Asian students began with a high level of performance and improved their performance faster compared to African-American and Hispanic students. Therefore, non-English-speaking Hispanic students are doubly disadvantaged. Moreover, Hispanic immigrant students make up a large proportion of the total students, that is, approximately 15.6% of all students. There is an obvious need to boost the achievement prospects of Hispanic immigrant students at the school level.

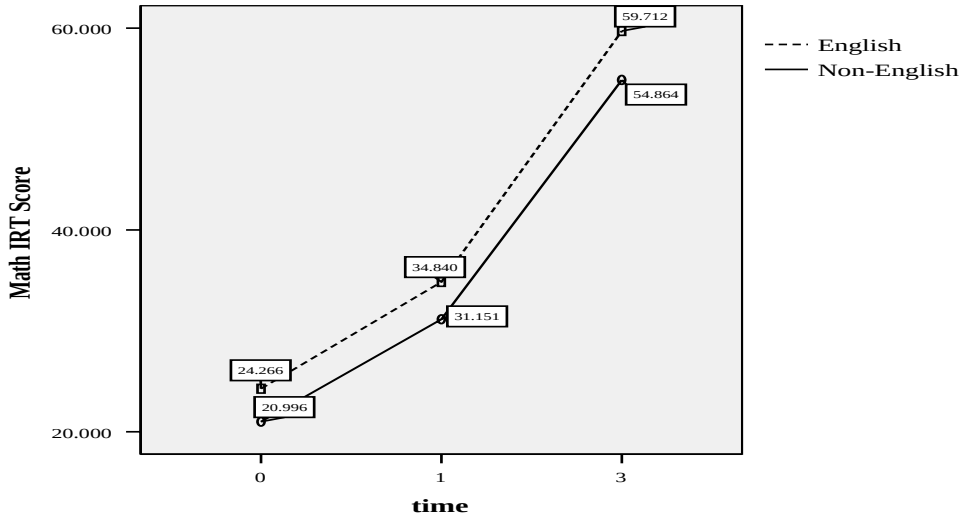

Figure1: *Math scores of English-speaking and non-English-speaking students*

Our first analysis relating to math activities examined the effects of the frequency (*Oftmath)* and the duration of math class (*Timmath)* on the math achievement of students. The frequency had a positive effect on the performance of non-English-speaking Asian students by showing a significant growth rate (π_6 = 4.747, p<0.01). In other words, non-English speaking Asian students improved their math scores significantly when they had math classes more frequently. The duration was significant for all students (π_7 = 0.347, p<0.01), Caucasian students (π_7 = 0.414, p<0.01), and Hispanic students (π_7 = 0.483, p<0.01), indicating that they improved their math achievement levels significantly faster when they had longer math classes. The detailed results are presented in Table 1.

The next analysis examined the effects of class grouping practices on the students' math achievement. The results of the HLM analysis demonstrated that a teacher-directed whole-class activity (*Whole*) is beneficial in raising the math scores of all students, displaying all significant parameters. Thus, when teachers increase whole-class activities, students tend to score higher.

The teacher-directed small-group activity (*Small*) indicated beneficial effects for all students (π_3 = 0.099, p < 0.05) and the Caucasian students (π_3 = 0.147, p < 0.05). Small group activity, however, showed a negative growth rate in the performance of non-English-speaking Asian students (π_3 = -1.226 p < 0.05). That means when teachers use small group activity frequently, non-English-speaking Asian students tend to improve their math scores more slowly, and it leads to a wider gap between English- and non-English-speaking groups. With this finding, we partially confirmed the positive effects of small grouping activities for Caucasian students. As the previous researchers (Kutnick, et al., 2005; Leonard, 2001; Lou, et al., 1996) noted in their studies, small grouping activities can promote students' learning by providing opportunities to stimulate cooperative learning and clarify understanding. This was true for Caucasian students who were raised in an educational culture in which active participation and discussion were strongly encouraged. However, our study indicated that small group activities can be harmful to language minority students, especially Asian immigrant students who were encouraged to follow their superior's guidance and who were not familiar with small group discussions.

The increased Teacher-Directed Individual Activity (*Indiv*) promoted the math achievement of African-American students and non-English-speaking Hispanic students. In particular, the growth rate of non-English-speaking Hispanic students (π_4 = 0.653, p < 0.05) was significantly higher than that of English-speaking Hispanic students. This is a very encouraging finding in that Hispanic immigrant students can benefit from teachers' individual efforts.

The Child-Selected Activity (*Child*) did not show significant beneficial or negative effect on the math scores. As Wang and Goldschmidt (1999) found, our study did not support child-selected activity in promoting immigrant students' math achievement.

Table 1. *The Effects of Grouping Activities on the Math Performance of Students by Ethnic Group*

	Overall (N=58,277)		Caucasian (N=5,570)		African-American (N=1,121)		Hispanic (N=1,760)		Asian (N=686)	
	β	*SE*	β	*SE*	β	*SE*	β	*SE*	β	*SE*

Intercept	*All*	23.049**	0.094	25.073**	0.124	18.913**	0.197	18.656**	0.172	24.781**	0.543
	Hmlng	-1.213**	0.216	-0.392	0.360	-0.473	0.590	-2.562**	0.423	-0.730	1.271
Time	*All*	11.579**	0.053	12.098**	0.069	9.747**	0.129	11.064**	0.109	11.250**	0.240
	Hmlng	-0.144	0.125	-0.282	0.207	-0.400	0.320	0.090	0.251	0.301	0.499
Oftmath	*All*	0.083	0.154	0.185	0.182	-0.420	0.408	-0.105	0.305	-0.229	0.714
	Hmlng	-0.370	0.362	-0.286	0.532	-0.088	1.118	-1.216	0.772	4.747**	1.589
Timmath	*All*	0.347**	0.090	0.414**	0.120	-0.001	0.180	0.483**	0.169	0.226	0.444
	Hmlng	0.243	0.208	0.493	0.335	-0.508	0.515	0.599	0.409	0.123	1.043
Whole	*All*	0.247**	0.040	0.268**	0.053	0.191*	0.085	0.184*	0.080	0.438*	0.202
	Hmlng	-0.071	0.094	0.009	0.161	-0.102	0.241	-0.270	0.192	-0.144	0.496
Small	*All*	0.099*	0.049	0.147*	0.065	-0.019	0.089	0.151	0.100	0.132	0.238
	Hmlng	-0.093	0.115	-0.148	0.187	0.187	0.220	-0.157	0.249	-1.226*	0.486
Indiv	*All*	0.036	0.064	0.008	0.083	0.258*	0.122	0.139	0.123	-0.117	0.308
	Hmlng	0.072	0.149	-0.041	0.251	0.129	0.338	0.653*	0.302	0.309	0.869
Child	*All*	-0.048	0.081	0.008	0.116	-0.222	0.129	-0.095	0.134	-0.337	0.352
	Hmlng	-0.133	0.165	-0.257	0.224	-0.480	0.303	0.433	0.358	0.557	0.723

$p < 0.05$, ** $p < 0.01$

We further investigated how often teachers use class activities in their math classes. As presented in Table 2, teachers use whole group activities most frequently, as previous studies have demonstrated (Kutnick, et al., 2005; Prais, 1997; Rathbun, Walston, & Hausken, 2000; Zahorik, Halbach, & Ehrle, 2003). The average frequency of whole-class activities in kindergarten year was approximately 3.3, indicating that teachers spend about 1 hour and 40 minutes of whole-class activities for their math classes every day. In first grade, the teachers' use of whole-class activities increased to about 2 hours and 10 minutes.

Teachers used individual activities the least, with about 41 minutes (an approximate average of 1.3) in kindergarten, which increased to 56 minutes (the average of 1.8) in first grade.

Small group activities amounted to about 1 hour and 6 minutes in kindergarten, and 1 hour and 22 minutes in first grade. Teachers used child selected activities about 51 minutes in kindergarten and 31 minutes in first grade. The detailed information is presented in Table 2.

Table 2. *Descriptive Statistics of Variables*

		Frequency (Weighted)	Mean	Standard Deviation
Math IRT Score (Math)	Fall Kinder.	2112757	22.967	8.847
	Spring Kinder.	2138745	33.199	11.454
	Spring 1st	2453897	57.387	16.807
Frequency of Math Class *(Oftmath)*	Fall Kinder.	2015402	4.770	0.483
	Spring Kinder.	2013961	4.775	0.481
	Spring 1st	2119215	4.933	0.329
Duration of Math Class *(Timmath)*	Fall Kinder.	1979289	1.815	0.752
	Spring Kinder.	1974146	1.816	0.748
	Spring 1st	1994779	2.290	0.622
Teacher-Directed Whole-Class Activity *(Whole)*	Fall Kinder.	1920854	3.317	1.624
	Spring Kinder.	2001373	3.313	1.618
	Spring 1st	2001257	4.326	1.566

Teacher-Directed Small-Group Activity *(Small)*	Fall Kinder.		1920854	2.214	1.317
	Spring Kinder.		2001373	2.225	1.325
	Spring 1st		2001257	2.740	1.427
Teacher-Directed Individual Activity (*Indiv)*	Fall Kinder.		1920854	1.370	0.909
	Spring Kinder.		2001373	1.382	0.936
	Spring 1st		2001257	1.791	1.154
Child-Selected Activity (*Child)*	Fall Kinder.		1920854	1.713	1.016
	Spring Kinder.		2001373	1.713	1.018
	Spring 1st		2001257	1.419	0.838
Home Language (HMlng)	English	Caucasian	1711654 (50.2%)		
		African-American	385419 (11.3%)		
		Hispanic	185442 (5.4%)		
		Asian	29151 (0.8%)		
	Non-English	Caucasian	269409 (7.8%)		
		African-American	63004 (1.8%)		
		Hispanic	536874 (15.6%)		
		Asian	84831 (2.5%)		
SESQ (SESQ)	1		698628 (20.1%)		
	2		685498 (19.7%)		
	3		691375 (19.9%)		
	4		802647 (23.1%)		
	5		589967 (17.0%)		
Gender (Gender)	Male		1788263 (51.4%)		
	Female		1690727 (48.6%)		
Age at Fall Kinder. (Age)			3478990	66.595	12.636

Table 3. *Inter-correlations for All Variables*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Math										
2. Oftmath	.115**									
3.Timmath	.202**	.246**								
4. Whole	.213**	.124**	.192**							
5. Small	.123**	.093**	.242**	-.015**						
6. Indiv	.141**	.080**	.181**	.034**	.212**					
7. Child	-.089**	.008**	.084**	-.127**	.129**	.193**				
8. Hmlng	-.085**	-.016**	.038**	-.024**	.032**	.024**	-.011*			
9. SESQ	.256**	-.057**	-.080**	-.026**	-.067**	-.003	.035**	-.221**		
10. Gender	-.027**	-.001	.016**	.012*	.008	.013*	.001	.008	.007	
11. Age	.140**	.011*	-.002	.027**	-.011	.023**	.007	-.086**	.020**	-.071**

p<0.05, ** p<0.01

Conclusion and Discussion

This study found that the math scores of immigrant students, especially Hispanic immigrant students, were lower than those of native-born students. This gap was reduced when teachers held math classes more frequently and for longer hours. Non-English speaking Asian students improved their math scores significantly when they had more math classes. Caucasian and Hispanic students improved their math scores significantly when they had longer math classes.

This study's main focus, the effects of teachers' grouping activities on the students' math scores, displayed differential results for the four ethnic groups in this study. Whole class activity was beneficial in raising the math scores of all students. Small group activity was beneficial for Caucasian students, while it resulted in a negative effect on the achievement of non-English-speaking Asian students. Individual activity was beneficial in promoting the math achievement scores of African-American students and non-English-speaking Hispanic students. Child selected activity did not show significant beneficial or negative effects on the math scores.

This paper explored a critical but under-researched policy issue -- the effect of class grouping practices on the math achievement of immigrant students. The findings of this study can help teachers and policy makers to understand how immigrant students' performance is affected by different class arrangements. Adopting appropriate grouping practices will enhance mathematics performance of the immigrant students and will also improve the school environment for minority students.

We hope this paper will stimulate further research on issues related to the instructional practices best suited for immigrant students and provide the foundation for better understanding of grouping practice for math learning. The long-term goal of this research is to lower barriers for immigrant students which prevent them from succeeding in school and living up to their potential.

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