

Math Placement of Language Minority High School Students

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This study explored the opportunities students had when they were placed in the proper initial math course. The focus was on examining how the Initial Math Course Placement Level impacted the math course final grades of language minority immigrant high school students (LMIHS) and the relationship between the Initial Math Course Placement Level and English Language Development (ELD) Placement. In addition, the study investigated the relationship between Math Course Final Grades and ELD Placement. This study involved 54 LMIHS participants from the English Language Development (ELD) program at a suburban California high school. Quantitative correlation methods were used to analyze data from two Initial Math Course Placement Level tests, course final grades, and a survey. The results of this study indicate that the two Initial Math Placement Level tests were the significant predictors of student math success. Furthermore, the data analysis revealed significant relationships between Initial Math Course Placement Level and ELD placement. To ensure accurate placement in the right math courses, this study suggests using simplified English instructions and minimal vocabularies, incorporating several native languages in the math placement tests, and assessing LMIHS students at least twice with initial math placement.

Keywords: Mathematics placement, English language learners, language minority immigrant high school students

The number of English Language Learners (ELLs) in the United States has steadily increased over the past ten years. According to the National Center for Education Statistics (NCES, 2020), the number of ELL students in public schools in the United States increased from 4.5 million in 2010-2011 to 5.1 million in 2018-2019. California is one of the states with the highest percentages of ELL students in their public school populations (The National Center for Education Statistics [NCES], 2020). At the high school level, during the 2018-2019 school year, approximately 1.2 million ELL students were enrolled in U.S. high schools, representing about 8% of the total high school enrollment (NCES, 2020). ELLs in high schools have lower graduation rates than non-ELLs. The high school graduation rate for ELLs was 67% in the 2018-2019 school year, compared to a rate of 87% for non-ELLs (NCES, 2020). In

addition to lower graduation rates, ELLs in high schools also tend to have lower academic achievement than non-ELLs. According to the NCES, in the 2018-2019 school year, only 15% of ELL high school students were proficient in math, compared to 42% of non-ELLs (NCES, 2020). As the number of ELLs in U.S. public schools continues to increase, the initial placements for ELLs are important “because these placements tend to follow students for the rest of their academic lives” (Celedón-Pattichis, 2004, p. 188). When these Language Minority Immigrant High School (LMIHS) students first arrive, the school must go through the induction process.

There is an evaluation process when LMIHS students register to ensure proper academic course placement. Many assessment tools are available to evaluate English language proficiency, and these tools work well for language arts placement. However, few studies have reported the appropriate placement of ELLs in mathematics (Celedón-Pattichis, 2004). To place these students in mathematics, there usually needs to be an evaluation of transcripts and ability in the subject. Due to a lack of appropriate mathematics placement tools, immigrant students are often assigned lower level math classes than their ability would dictate (Conger, 2013). Specifically regarding math and considering the traditional course sequencing to meet college entrance (A-G) requirements, an immigrant student placed below his/her ability level is a disadvantage from which recovery is difficult (Callahan & Humphries, 2016).

As a result, the education of these immigrant students falls short of the ideal. The immigrant student population is becoming the major minority student group in the United States, yet few studies have examined whether immigrant high school students receive equal opportunities to learn mathematics using appropriate mathematics placement. To promote equity and improve Language Minority LMIHS students’ mathematics achievement and mathematics placement, it is urgent to investigate the relationship between appropriate mathematics placement and LMIHS students’ mathematics learning.

The purpose of this study was to examine the impact of appropriate Initial Math Course Placement on the math course final scores of LMIHS students. Additionally, it aimed to explore the correlation between appropriate Initial Math Course Placement and English Language Development (ELD) Placement for LMIHS students, as well as the correlation between the Math Course Grade and ELD Placement. The following research questions were addressed:

1. Does the Initial Math Course Placement test predict the success of language minority immigrant students in math learning, as measured by math course final scores?
2. Is there an association between the Initial Math Course Placement Level of language minority immigrant students and their ELD placement?
3. Is there an association between the Math Course Final Grade of

language minority immigrant students and their ELD placement?

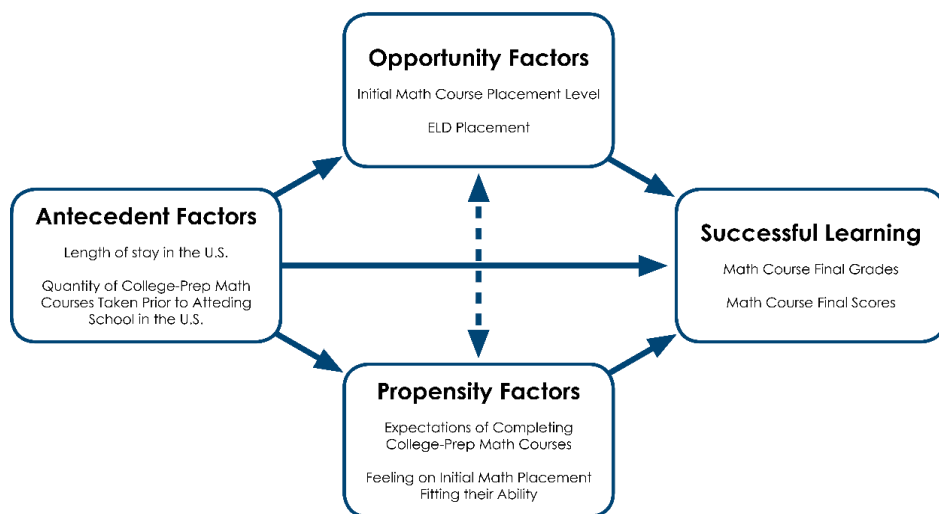
Theoretical Framework

Opportunity to Learn

According to Reyes (2016), course placement and access to rigorous content knowledge affect a student's opportunity to learn. Reyes' asserts that an ELL's language classification influences their access to rigorous content area coursework. In Reyes' (2016) adaptation of the opportunity-propensity framework, it is referred to as "Opportunity to Learn" or OTL. The original Opportunity-Propensity Framework, proposed by Byrnes and Miller (2007), aims to explain academic achievement by examining the interaction between individual characteristics and educational opportunities. It consists of three major components: (a) Antecedent Factors (factors that students bring into the school system and are out of their control), (b) Opportunity Factors (factors controlled by the school system), and (c) Propensity Factors (factors that individual students can control). These components include categories of possible predictors and their interconnects (see Figure 1).

Figure 1

The Opportunity-Propensity Framework for LMIHSS Math Learning



Note: Adapted from Byrnes and Miller's Opportunity-Propensity Model (2007).

These possible predictors or factors have been used in the studies to predict and examine student success in learning. For example, a study by Yu and Pong (2010) examined whether immigrant high school students receive equal opportunities to learn mathematics by applying the opportunity to learn (OTL) framework. They investigated immigrant high school students' OTL in terms of their odds of being assigned to the academic mathematics course track

and to highly qualified mathematics teachers, as well as of their mathematics achievement. In another study, Callahan (2005) indicated that if a student only takes English Language Placement and is placed in a beginning ELD course, they may be automatically placed in a beginning math class. Unfortunately, this decreases their opportunity to finish high school having completed the high-level math course needed to be prepared for a STEM major. This becomes a lost opportunity for the students.

This study applies the opportunity to learn (OTL) framework for LMIHSS to investigate immigrant high school students' opportunity to learn mathematics. In this article, we only included the investigation on the relationship between opportunity factors (i.e., appropriate math placement and ELD placement) and student success (i.e., math course final scores and grades), which is a part of a large study on LMIHSS students' OTL related to other factors.

Denied Access to Rigorous Curriculum for English Language Learners

Many immigrant students start their math learning in lower levels because it is assumed that they lacked the math skills necessary for academic success in the United States (Soto, 2016). These assumptions are part of an attitude that often exists among educators that if an ELL student is put in a lower level class it will help develop their English skills (Soto, 2016). This deficit view of immigrants is contrary to the fact that first-generation immigrants have more academic success than their peers born in the United States (Soto, 2016).

Several studies have explored the correlation between the ELL designation and access to higher level academic courses. Slama (2014) conducted a longitudinal quantitative study involving 5,354 ELL students. The report evaluated whether ELL students remained in an ELD program for an extended period. According to Slama, this extended duration occurs when students fail to develop "the requisite skills to succeed in mainstream classrooms" (Slama, 2014, p. 224). Callahan et al. (2010) conducted a quantitative study to investigate the correlation between placement in an ELD program and access and achievement in academic preparatory classes. The study included a sample of 2,352 students from 523 schools. The results revealed that language minority students placed in ESL are less likely than non-ESL counterparts to enroll in college preparatory coursework by the end of high school (Callahan et al., 2010). The language placement directly impacts placement into college preparatory coursework. Low achievement among many Latinx is linked to limited access to mathematics and other content area courses. Mosqueda and Maldonado (2013) collected data from a sample of 15,362 students. Their study aimed to explore the relationship between Latinx students' language proficiency and their achievement in high school mathematics.

The researchers found that the low achievement of many Latinx is

attributed to their lack of access to rigorous mathematics coursework (Mosqueda & Maldonado, 2013). More than 80% of the ELL population in California consists of Latinx (California Department of Education, 2022). Consequently, the access that Latinx have to rigorous content significantly affects the general ELL population. Long-term ELL placement creates barriers to a rigorous education (Callahan et al., 2010). Long-Term English Language Learners (LTELL) who are in the English Language Development (ELD) program for an extended period often experience math misplacement due to the length of time spent in ELD.

The Needs of Appropriate Mathematics Placement

Many studies provide evidence that ELL students in US high schools often do not receive appropriate math placement. Rios-Aguilar et al. (2012) indicated ELL students are often placed in lower-level math courses than their non-ELL peers, even when they demonstrated similar levels of math proficiency. The study also found that ELL students placed in these lower-level math courses are less likely to complete higher-level math courses, such as Algebra II. Another study by Kanno and Cromley (2015) found that ELL students in urban high schools were significantly more likely to be placed in remedial math courses than their non-ELL peers, even after controlling for their prior math achievement and other demographic factors. Furthermore, this study also found that inappropriate math placement was associated with lower math achievement and a reduced likelihood of high school graduation.

Currently there is no standardized way to place Language Minority Immigrant High School students into their initial high school math class. Placement usually depends on the guidance specialist and the assistant principal of guidance in some schools in California. Even if they have access to the LMIHS student's foreign transcripts there is still difficulty in translating and evaluating them. An assessment tool that offers proper math placement, despite the LMIHS students' ability to comprehend English, needs to be developed. Since math is a universal language, it is possible to develop assessments that are not embedded in the English language (Abedi & Lord, 2001).

There are limited studies on the effect of math initial placements on newcomers to U.S. schools. It is important to investigate the effect of using the appropriate placement test on LMIHS students' success in their math learning. Identifying relationships between Initial Math Course Placement Level and ELD placement, as well as between Math Course Grade and ELD placement are also vital tasks for LMIHS students' opportunity to learn. These considerations highlight the need for equitable math placement practices that account for the unique linguistic and educational backgrounds of LMIHS students.

Research Methods

Research Design

The research design of this study employed a correlation design, as it studied the predication and association between student success in math learning and initial placement. According to Creswell (2008), correlation designs provide researchers with an opportunity to predict scores and explain the relationship among variables.

Research Site

This study was conducted at Beachside High School (pseudonym), a suburban high school in Southern California. The school has 2,452 students with a diverse population, including 49% students of color. The highest ethnic groups are 21% Asian and 21% Hispanic. Approximately 4% of the school's population consists English Language Learners, compared to the state average of 15%. Additionally, 27% of the student population is eligible for free and reduced lunches, which is lower than the state average, indicating a higher socioeconomic status. The immigrant student population comprises 25% of the school's total population.

At this high school, students met or exceeded the standards in math (57%) and English language arts (76%) during 2017-2018 academic year. The researchers chose this school because one of them works there and has observed the misplacement of many immigrant students in math courses. This observation sparked an interest in further investigating the process in which immigrant students are placed in their math courses.

Subjects

A total of 54 high school students enrolled in an English Language Development program at this high school participated in the study. The students spanned ninth through twelfth grade. The subjects of the ELL population were 50% native Spanish speakers, 30% native Vietnamese speakers and 10% Arabic speakers. The remaining 10% consisted of native speakers of Portuguese, Turkish, Filipino and Japanese. The gender breakdown of ELD students was 48% female and 52% male. These subjects were selected based on Beachside High's enrollment records, which classify them into three distinct groups: English Only (EO), Reclassified Fluent English Proficient (RFEP), and English Language Learners (ELL). Students classified as ELL were recruited as subjects of this study.

Procedure of Developing Appropriate Math Placement Tests

Math Placement Tests

Two Initial Math Course Placement Level assessments were created by the researcher who taught at this high school. The assessments were designed without English embedded directions. The first assessment consisted of 10 basic arithmetic and basic algebra problems and is administered to all students in the ELD program. The second assessment consisted of 15 different types of algebra questions and was given to students who scored 80-100% on the first test in this study.

These two levels of math placement tests were developed by the first researcher, drawing upon her years of experience teaching all levels of mathematics. The researcher conducted focus groups with other math teachers at two high schools where she had taught. The tests were used for both LMIHS students and non-LMIHS students over a space of 25 years, with the aim of developing an appropriate math placement tool. In spring 2019, these tests were used in a pilot study with 28 LMIHS students enrolled in the Algebra I SDAIE course. The results of the pilot study demonstrated that the Initial Math Course Placement Level assessments accurately placed the students in a math class that aligned with their ability 90% of the time. Based on the success of the pilot study, the Initial Math Course Placement Level assessments were discussed and approved by the Beachside math department. These assessments will serve as Initial Math Course Placement Level tests to be administered to all ELD students at the beginning of each academic year ensuring proper placement starting Fall 2019.

Reliability Test

To assess whether the 10 items that were summed to create the test score formed a reliable scale for Math Placement Test 1, Cronbach's Alpha was computed. The alpha for the 10 items was .818, which indicates that the items form a scale that has good internal consistency reliability. Similarly, the alpha for the 15 items in Test 2 was .872, indicating relatively high internal consistency.

Data Collection

Initial Math Course Placement Level Test

The 87 ELL students at Beachside High School took the Initial Math Course Placement Level tests on the first day of the Fall 2019 semester in their math classes. Those students were given a second Initial Math Course Placement Level test, consisting of 15 algebra-based questions. If the students scored 80-100% on the second assessment, they were placed in Geometry, Algebra 2, or Algebra 2/Trig based on their language ability. Those that scored 0 to 8 on the first assessment were placed in Algebra I which serves as the beginning math class at Beachside High. Many of the students who scored less than 90% were already placed in Geometry because they had successfully

completed and passed Algebra I (with a D or better) in the previous year. Their placement remained unchanged regardless of their score on the test. A few students were enrolled in precalculus, honors precalculus, and A.P. calculus because they had completed prerequisite courses.

Math Final Course Scores and Grades

The math course final scores of ELL student participants were collected at the end of the semester that concluded in January 2020. These scores were categorized into five levels of letter grades A to F, and quantified on a scale from 5 to 1 for data analysis.

Survey

The participants completed a survey regarding their experiences with placement and success in their high school math classes. The survey also included questions about their length of stay in the United States and their math experiences in their home countries. The ELD placement data from the survey were used in this report.

Instruments

Two Initial Math Course Placement Level assessments without English embedded directions were developed and used in this study. A pilot study with Specially Designed Instruction in an English Algebra I class was conducted to refine the math placement assessments. The results of the pilot study show that the Initial Math Course Placement Level assessments accurately placed the students in math classes that matched their ability 90% of the time. The first assessment consisted of 10 basic arithmetic questions with a Cronbach's Alpha .818, and the second assessment consisted of 15 algebra questions with a Cronbach's Alpha .872, which indicates that the items form a scale that has good internal consistency reliability. Based on the success of the pilot study, the math department approved administering the Initial Math Course Placement Level assessments to all ELD students at the beginning of each year to ensure proper placement.

The survey instrument was created by the researchers and consists of seven questions. The questions inquire about students' grade level, length of time in the United States, ELD placement, Initial Math Course Placement Level upon entering high school, college preparation math classes they plan to complete by graduation and their feelings regarding the accuracy of their placement. The answers provided a combination of multiple choice and Likert scale formats. The ELD placement data from the survey were collected to explore correlations between ELD placement and math placement, and ELD placement and students' math course grades.

Validity

Content Validity. The math placement instruments have content validity because they were reviewed by members of the math department who have ELL students in their math classes. These reviewers contributed to changes in the instruments. The instruments were also reviewed by math colleagues and exporters at the 2019 Classroom Teaching Research for All Students Conference (CTRAS), resulting in further refinements. In addition, the Initial Math Course Placement Level assessment demonstrates content validity as its items align with the California Common Core Standards for Mathematics.

Face Validity. ELL students who took the test were asked if the test accurately measured their math ability in the survey. In this study, 86% of the students believed that it was indeed an accurate measure of their ability.

Data Analysis

Data analysis was conducted using the quantitative method SPSS 19.0. Linear regression tests were used to determine the correlation between Initial Math Course Placement Level and math course final grade. Kendall’s tau-b tests were used to examine the relationships between Initial Math Course Placement Levels and ELD Placements, as well as the relationships between the ELD Placement and Math Course Final Grades.

Results

Relationship between Final Scores and Initial Placement Tests

To investigate whether the tests of Initial Math Course Placement are significant predictors of the Math Course Final Scores, the linear regression tests were calculated. The results of Tables 1-6 show that Initial Math Course Placement tests were significant predictors of Math Course Final Scores.

Using Initial Placement Test 1 to Predict Final Scores

A linear regression was calculated to predict students’ math course final scores using the scores of Initial Math Test 1. The Adjusted Square R value was .340 (see Table 1), indicating that about 34% of the variance in math final scores was explained by the Initial Math Course Placement Test 1. According to Cohen (1988), this is a large effect.

Table 1
Model Summary Placement Test 1 and Math Course Final Scores

Model	R	R Square	Adjusted R Square	Error of the Estimate
1	.594a	.353	.340	14.927

a. Predictors: (Constant), 1st Placement Test

Table 2*ANOVA Placement Test 1 and Math Course Final Scores*

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	6309.885	1	6309.885	28.317	.000 ^b
Residual	11587.152	52	222.830		
Total	17897.037	53			

a. Dependent Variable: Math Final Score

b. Predictors: (Constant), 1st Placement Test

The regression equation was statistically significant with $F(1, 52) = 28.317$, $p < .001$ (see Table 2). The predicted math course final scores for participants can be calculated as $47 + .416*$ (see Table 3). Specifically, the students' mean math course final scores increased by .416 points for each point increase in the Initial Math Course Placement Test 1 scores.

Table 3*Coefficients Placement Test 1 and Math Course Final Scores*

Model	Nonstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
1 (Constant)	47.405	5.993		7.910	.000
1 st Placement Test	.416	.078	.594	5.321	.000

a. Dependent Variable: Math Final Score

Using Initial Math Placement Test 2 to Predict Math Course Final Scores

A linear regression was conducted to investigate how initial math placement, as measured by the scores of Initial Math Course Placement Test 2, predicted student success in math learning, as measured by math course final grades. The Adjusted Square R value was .385 (see Table 4). This indicates that about 39% of the variance in math course final scores was explained by the initial math test 2. According to Cohen (1988), this effect size is considered large.

Table 4*Model Summary Placement Test 2 and Math Course Final Scores*

Model	R	R Square	Adjusted R Square	Error of the Estimate
1	.630 ^a	.396	.385	14.412

a. Predictors: (Constant), 2nd Placement Test

Table 5*ANOVA Placement Test 2 and Math Course Final Scores*

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	7095.640	1	7095.640	34.160	.000 ^b
Residual	10801.397	52	207.719		
Total	17897.037	53			

a. Dependent Variable: Math Final Score

b. Predictors: (Constant), 2nd Placement Test

The results in Table 5 show statistically significant $F(1, 52) = 34.160$, $p < .001$. The identified equation to understand the relationship (see Table 6) was math course final score = $60 + .353 \times$ (scores of initial math test 2).

Table 6*Coefficients Placement Test 2 and Math Course Final Scores*

Model	Nonstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
1 (Constant)	60.504	3.494		17.314	.000
2 nd Placement Test	.353	.060	.630	5.845	.000

a. Dependent Variable: Math Final Score

Relationship between Initial Placement Level and ELD placement

Kendall's tau-b tests were used to examine the relationships between Initial Math Course Placement Level of Math Courses and ELD Placement.

Table 7*Kendall's tau-b Symmetric Measures of Initial Math Placement and ELD Level*

Math P Course	ELD Level			
Kendall's	Math P Course	Correlation Coefficient	1.000	.290*

tau_b	Sig. (2-tailed)	.	.013
	N	54	54
ELDLevel	Correlation Coefficient	.290*	1.000
	Sig. (2-tailed)	.013	.
	N	54	54

*. Correlation is significant at the 0.05 level (2-tailed).

Table 7 shows a significant positive association between Initial Math Course Placement Level and ELD Placement, with tau-b (54) = .290, $p = .013$ (where $p < .05$). This means that the higher the level at which an ELL student was placed in their English Language Development (ELD) program, the more likely they were to be placed in a higher-level math class using the appropriate math placement in this study.

Relationship between Math Course Final Grade and ELD Placement

Kendall's tau-b tests were used to examine the relationships between Math Course Final Grade and ELD Placement. Table 8 shows no significant association between Math Course Final Grade and ELD Placement, with tau-b (54) = -.045, $p = .695$ (where $p > .05$). This means that an ELL student with a lower level of the ELD Placement was not necessarily associated with a lower level of mathematics achievement if using an appropriate math placement.

Table 8

Kendall's tau-b Symmetric Measures of Math Course Grade and ELD Level

		ELD Level		Math Final Grade
Kendall's tau_b	ELD Level	Correlation Coefficient	1.000	-.045
		Sig. (2-tailed)	.	.695
		N	54	54
	Math Course Final Grade	Correlation Coefficient	-.045	1.000
		Sig. (2-tailed)	.695	.
		N	54	54

Discussion

The results of this research study show that the two initial math placement tests were the significant predictors of student math success, as measured by the final scores in their math courses. The results of the data analysis of this study also show a significant relationship between Initial Math Course Placement Level and ELD placement, and no significant relationship between Math Course Final Grade and ELD placement.

Relationship between Initial Placement Level and Student Success

The results of the linear regression tests demonstrate that Initial Math Course Placement Level tests were significant predictors of the math course

final scores. Specifically, the higher the scores on the Initial Math Course Placement Level test were associated with the higher the student's math course final scores. This finding highlights that the Initial Math Course Placement Level tests served as effective predictors of math success, and accurate placement tools in this study.

According to Reyes (2016), language minority students are often placed in lower level math courses due to inaccurate assessments. Prior to the development of the assessment tools, the math placement tests used at Beachside High School heavily relied on English instructions, which posed challenges for students with limited English proficiency. Consequently, these tests provided an ineffective measure of students' math ability. Research studies have consistently shown that students perform better on math tests when language is not a barrier (Abedi & Lord, 2001; Robinson, 2010).

To address this issue, the researchers developed two initial math placement tests with simplified English instructions and minimal vocabulary incorporating several native languages for LMIHS students. This can be a main reason of the important finding of the current study that the appropriate initial math placement tests can significantly predict LMIHS students' math course final scores. Additionally LMIHS students were assessed by two initial math placements to ensure accurate placement tests, which is supported by a study that when making math placement decisions it is important to take multiple measures into consideration (Fong & Finkelstein, 2014).

Relationship between Initial Placement Level and ELD Placement

This study examined the relationship between the LMIHS students' Initial Math Course Placement Level and ELD placement using a Kendall's tau-b test. The study findings indicate a significant association between the Initial Math Course Placement Level and ELD Placement Level. This suggests that when appropriate math placement tests are used, students with higher ELD levels are placed in higher math courses. Essentially, the study found that the LMIHS students were appropriately placed in math classes that aligned well with their ELD class. This finding is consistent with the work of Fong and Finkelstein (2014), who emphasized the importance of placing students in the right course at the right time to enable complete math sequences throughout high school for all students. It's crucial to ensure equitable access to math courses, especially during transitions like the implementation of the Common Core State Standards in Mathematics.

Relationship between Math Course Final Grade and ELD Placement

This study also investigated the association between LMIHS students' Math Course Final Grades and their ELD placements using a Kendall's tau-b test. The results showed no significant correlation between the Math Course Final Grades and ELD levels. This suggests that a higher Math Course Grade does not necessarily align with a higher ELD Placement Level due to the

appropriate Initial Math Course Placement. For example, in this study, seven out of 11 level 1 ELD students received a B (4 out of 5 points) in their math course final grade. This finding demonstrates that LMIHS students' math ability should not be solely determined by ELD Placement. Without appropriate math placement, language minority students who are placed in low-level ELD classes are also placed in low-level math classes (Callahan, 2005; Reyes, 2016; Soto, 2016). Therefore, LMIHS students should be evaluated through appropriate Initial Math Course Placement to ensure that lower ELD level students do not miss opportunities for learning and access to rigorous mathematics coursework (Mosqueda & Maldonado, 2013).

Conclusion

This study aimed to investigate the relationship between LMIHS students' math placement and their math success. In addition to examining the correlation between math placement and ELD placement, this study also explored the association between LMIHS students' math course final grades and their ELD placements. The study's most important finding was that appropriate math placement predicts student math success. When LMIHS students take a math placement test that correctly assesses their math ability and the test results are used to place them in the appropriate math course, their final math scores reflect their placement scores. This highlights the importance of proper math placement for LMIHS students.

Furthermore, this study suggests an important feature of appropriate math placement for ELLs, which includes simplified English instructions and minimal vocabularies with several native languages, to meet the needs of LMIHS students. This study also recommends assessing LMIHS students at least twice with initial math placement tests to ensure accurate placement in the right math courses. Finally, this study suggests using a combination of appropriate math placement and ELD placement to evaluate LMIHS students and provide them with opportunity to learn and have access to rigorous mathematics coursework, ensuring their success in math.

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