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Planning to Take More Mathematics Courses in High School: Who Does and Who Doesn't?

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Abstract

What are the most common motives invoked by 9th graders when asked about their plans to take (or not) more mathematics courses during high school? How do beliefs about math course-taking affect students' actual planning? To what extent is planning of math course-taking associated with high school students' socio-demographic backgrounds? The study employs data from the High School Longitudinal Survey of 2009 to examine the issue of persistence in math course-taking during high school. The study shows that almost two-thirds of 9th graders plan to do math during all their high school years, although intentions to persist in math vary across racial and especially socioeconomic backgrounds. The study also demonstrates the importance of belief constructs such as math identity, internal motivation toward math learning and math utility on math course-taking planning. A better understanding of students' motives to engage in high school math may help develop classroom practices that emphasize the long-term benefits of math learning.

Introduction

There are clear expectations in the United States that youth should possess high levels of mathematics literacy and the science and technology skills needed for jobs in the knowledge economy (National Counselors of Teachers of Mathematics, 2018; National Governors Association, 2011). Educators and policy makers agree that tomorrow's knowledge worker cannot rely just on a high school diploma and that pursuing some post-secondary education requires mathematics literacy (Jerald, 2009; Mamedova et al., 2021). As described in the *Learning for tomorrow's world* OECD's (2004) report, mathematics literacy "is concerned with the capacity of students to apply knowledge and skills and to analyze, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations" (p.21). While goals are undisputable, the means to engage students in math learning and achieve the desired levels of math literacy are still insufficiently explored. Wilkins (2000) examined the status of quantitative literacy in the United States using TIMSS data to conclude that although students tend to possess positive attitudes toward mathematics, their content knowledge and reasoning abilities were deficient. However, Wilkins (2010) later recognized that quantitative literacy is a multifaceted construct that "is characterized by an interrelationship among a person's mathematical cognition, beliefs, and disposition" (p.286).

These findings suggest that students may understand the usefulness of mathematics in their life, but they often have difficulties building knowledge and skills through the practice of mathematics, so developing both cognitive and non-cognitive mathematics skills is crucial. In the Spring of 2022, the National Assessment of Educational Progress (NAEP) mathematics assessment was administered to representative samples of fourth- and eighth-grade students (NAEP, 2022). Data shows a drop of 5 and 8 points between 2019 and 2022, for the Grade 4 and Grade 8 students, respectively: with 25% of Grade 4 and 38% of Grade 8 students performing below NAEP Basic level. Overall, math proficiency levels in 2022 were low and comparable to the year 2003 levels, reaching in 2022 no more than 236 and 274 out of 500 scale score for Grade 4 and Grade 8, respectively. Not surprising, the 12th grade average score of 150 out of 300 has not significantly changed since 2005. The poor mathematical proficiency of 15-year-old students is clearly shown by the PISA 2018 results (NCES, 2020) with U. S. average score (478) lower than the OECD average score (489).

As noted in a 2001 National Research Council report, “practice is important in the development of mathematical proficiency. When students have multiple opportunities to use the computational procedures, reasoning processes, and problem-solving strategies they are learning, the methods they are using become smoother, more reliable, and better understood” (Kilpatrick et al., 2001, p.422). Practicing mathematics means that students learn how to persevere in solving a difficult math problem, become curious to search for elegant solutions, or challenge themselves by taking advanced high school math courses. One way of continuing math learning and practice is *persistence* in math course-taking (Froiland & Davison, 2016) that ensures students build knowledge and consolidate their math skills. Continuing participation is a necessary condition of success in mathematics. Stanic and Hart (1995) refer to the "achievement-related behavior of persistence" (p.259) and emphasize the role of persistence in learning mathematics. Research recognizes that building foundational skills and developing positive attitudes is essential in doing math, while lack of math skills affects persistence and limits future choices. For instance, many studies reveal that choice of advanced math and upper-level science courses in secondary school and beyond becomes problematic if students do not possess prior mathematics skills (Ayalon, 2003; Irizarry, 2021; Uerz et al., 2004; You & Sharkey, 2012).

However, school districts and states are still hesitant in taking a firm stance toward the issue of mandatory participation in math during the entire school cycle (Reys et al., 2007). In 2007, states varied by the number of required years of mathematics for high school graduation -- about 20% of states had a firm requirement of 4 years. In 2019, Algebra I, Geometry and Algebra II were the most popular high school math courses nationwide, with 85-92% completers, a rate higher than in 2009 (NCES, 2022). Persistence in math education during high school is often a student choice: taking mathematics even if not required and/or taking more challenging classes. Since choice is the result of prior achievement as well as the extent of challenge students experienced during their academic progression (Eccles, 2005; Ireson et al., 2002; Irizarry, 2021), many students are caught into a vicious circle that make them abandon formal math education as soon as the school curriculum permits: they either do not see the importance of math in their lives or do not possess the skills and ability to succeed in math courses. Giving up math learning too early and/or not taking challenging math courses (e.g., Algebra 1I or Calculus) have a negative effect on further choice of advanced math and science courses and limit post-secondary and career pathways (ACT Policy Report, 2005; Long et al., 2012; Ogut & Circi, 2023).

Research shows that the intention to give up math learning early in high school is related to lack of interest and motivation for the subject which obviously results in low achievement (Cleary & Chen, 2009; Grigg et al., 2018; Jansen et al., 2016). Meanwhile, students with high expectancy beliefs and values in mathematics and science are making an effort to engage with math learning, achieve well in high school and are more likely to pursue higher education (Fong et al., 2021). Math self-efficacy is also a factor of persistence because it impacts both motivation and performance, with some students being more affected than others by prior mastery experiences (Grigg et al., 2018). For instance, Hispanic students place more emphasis on prior mastery experiences than Caucasian students which may contribute to the math achievement gap (Stevens et al., 2004). Another effect of math withdrawal in junior high school is that some social groups continue to be underrepresented in advanced mathematics courses. Some studies find that girls are less likely to enroll in advanced mathematics courses (Leder, 2019; Mendick, 2005). Leder (2019) noted that "gender differences in participation in mathematics in favour of males emerge when the studying of mathematics is optional and are more pronounced in advanced mathematics subjects" (p.303) which suggests that math courses are easily avoided if not mandatory.

Ethnic differences in mathematics achievement and persistence in taking challenging math courses are also noted in the literature, usually in interaction with socio-economic status (SES) indicators (Riegle-Crumb & Grodsky, 2010; Stanic & Hart, 1995). When examining math achievement of Grade 12 students in the United States, Byrnes (2003) found that ethnicity explained about 5% out of 58% of the variance in proficiency scores, in a model that was controlled for demographic (e.g., parent education), exposure to learning opportunities (e.g., high school program, coursework, calculator use) and motivational factors (e.g., positive perceptions of one's ability in math). Larger proportions of White students were enrolled in advanced courses and college preparatory curriculum and obtained better results. Research indicates that besides gender and ethnic background, socio-economic status is a significant factor affecting students' mathematics performance and persistence (Huang, 2015; Signer & Beasley, 1997; Uerz et al., 2004). Huang (2015) found that time spent on learning a subject (school hours) and persistence on math tasks are associated with math achievement. However, low-SES students are less likely to perceive themselves as persistent and overall spent less time learning, so they cannot "manage to perform as well as high-SES students through increased learning time in school and persistent pursuit of their goals in schoolwork" (p.24).

Ethnic differences in mathematics achievement and persistence almost disappeared among higher achievers, which makes Byrnes (2003) assert that schools can do a great deal to close achievement discrepancies among White, Black, and Hispanic students. However, Riegle-Crumb and Grodsky (2010) found SES achievement gaps among advanced math high school students, with Hispanic students from low-income backgrounds and African American students attending highly segregated schools more likely to experience achievement gaps with their white peers. The authors concluded that equality of course participation is not enough to close math achievement gaps even among the "advanced math stratum" students.

In addition, the model of parent socialization developed by Eccles-Parsons et al. (1983) suggests that parents communicate to their children's beliefs and values about certain activities (e.g., mathematics and sciences importance) that impact their achievement and further course-taking planning. Wilkins and Ma (2003) report that students who perceive that their parents value mathematics are more likely to believe that mathematics is important and manifest a more positive attitude about its usefulness throughout high school. Andersen and Ward (2014) examined how demographic factors and expectancy-value variables such as math/science self-efficacy, math/science intrinsic interest (enjoyment, talent), math/science attainment (identity) values, and STEM utility (extrinsic) value, would affect “STEM persistence status” among high-ability students who planned more math and science courses and/or advanced curriculum courses in high school. The models reveal race/ethnicity differences: STEM utility value was a predictor of persistence for Hispanics, science interest value and math identity were likely predictors of persistence for White students, while science identity was a predictor for all groups. Kotok (2017) also expressed concerns for high-achieving minority students who may not close the achievement gap in math because attitudinal factors such as math identity beliefs were low. Overall, math self-efficacy and math identity, but also SES and immigrant status had positive effects on math performance for Grade 11 high-achieving students while being a minority student (e.g., Black or Hispanic) had a negative effect.

Many of the studies that examined course-taking patterns and high school math persistence in relation to non-cognitive factors such as beliefs and attitudes have focused on high-achieving students. The purpose of this study is to examine the issue of high school math course-taking planning for *all* 9th graders enrolled in American schools and the factors that affect their behavioral intentions to persist in high school math. This is an empirical study using data from the High School Longitudinal Survey of 2009 that is designed to explore the American youth's experiences with math and science. The study employs concepts from the Theory of Planned Behavior (TPB) (Ajzen, 1991; Fishbein & Ajzen, 2010), and recognizes the value of outcome expectations proposed by Lent et al. (1994) in the decision-making process. Compared to other theoretical approaches used to examine course-taking planning, TPB recognizes the process leading to the intentions that become behaviors.

Theoretical Framework

The conceptual framework of the study is the Theory of Planned Behavior (TPB) developed by Ajzen (1991) and further elaborated by Fishbein and Ajzen (2010). The theory was developed in the tradition of Fishbein's reasoned action approach that has emerged as the dominant framework for predicting, explaining, and changing human social behavior. TPB offers a general framework for the prediction of choice behaviors such as the decision to enroll in a math course. It can incorporate a range of contextual factors such as social structures or institutional practices in the prediction of behavior but places the individual’s intentions to perform the behavior at the center of the choice process. As proposed by Ajzen (1991), the TPB attempts to explain how people build intentions and how intentions become behaviors.

A central factor in the theory of planned behavior is the individual's *intention* to perform a given behavior (e.g., take more math courses in high school). “Intentions are assumed to capture the motivational factors that influence a behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior” (Ajzen, 1991, p.181). However, a behavioral intention can turn into behavior only if the person has actual control (e.g., skills, cooperation of others) over the behavior. Ajzen (1991) included the notion of perceived behavioral control to expand Ajzen and Fishbein's (1980) model based on other belief constructs: behavioral beliefs (i.e., one's belief about the consequences of behavior that can attach values to behavior and translate into positive or negative attitudes) and normative beliefs (i.e., individual perception about behavior influenced by the judgment of significant others, or by social normative pressures). The notion of perceived behavioral control is compatible with Bandura's (1997) concept of self-efficacy which is concerned with judgments of how well one can execute an action. The TPB model revised by Fishbein and Ajzen (2010) illustrates the complex relationships between behavioral beliefs (attitudes), normative beliefs, control beliefs as well as background factors such as individual (e.g., past behavior, general attitudes), social (e.g., age, gender, education) and information sources (e.g., knowledge, media).

Intentional behaviors are the result of a planning process in which students engage when they set up goals, formulate their own expectations and those of others, and make educational decisions. For a 9th grader, planning to take more math courses in high school is an expression of his/her *intentions* to engage with math learning. Intentional behaviors are shaped by student background and past experiences, by their attitudes and beliefs about the utility value of these behaviors (e.g., math useful for college education), by perceptions of others regarding the importance of taking more math courses, and by their own belief that they possess the skills and ability to succeed. Therefore, the Theory of Planned Behavior (TPB) provides an appropriate theoretical framework with which to examine issues related to educational planning. In this context, the research can be further informed by other theories. In particular, the notion of perceived control -- which is of primary concern in the TPB -- is consistent with Bandura’s (1997) notion of self-efficacy. The derivative notion of outcome expectations proposed by Lent et al. (1994) is also useful: outcome expectations (e.g., highest level of education desired) generate interest in the activity and further lead to the development of intentions to pursue the activity. The application of TPB to math coursework decisions shifts the focus of student intentions to persist in math course-taking to incorporate their broad beliefs about mathematics, perceived norms, and behavioral controls.

The TPB has been used in educational research over the past two decades (Hennesey, 2012). For instance, two multivariate studies examined the applicability of the TPB in exploring students' attitudes toward mathematics, and the predictive power of mathematics attitudes in explaining students' grades in mathematics (Lipnevich et. al., 2011). Zhang et al. (2018) employed TBP to understand how community college transfer students’ STEM degree attainment was shaped by their beliefs, intentions, contextual and socio-demographic factors.

Method

Data and Research Sample

This paper employs public-use data from the National Center for Education Statistics’ (NCES) High School Longitudinal Study of 2009 (HSLS: 09). This is a nationally representative longitudinal study of more than 21,000 9th graders in 944 schools. The NCES study followed students throughout their secondary and postsecondary years, the workforce, and beyond. HSLS:09 surveys include crucial questions regarding student academic trajectories especially, STEM high school courses, post-secondary majors, and careers. The paper is based on the first wave of HSLS data collection and uses only survey questions from the student questionnaire. The research sample consists of 20,286 respondents for whom there is no missing information for the variables included in the analysis.

Variables

The Appendix table introduces the survey questions that describe 9th graders' plans to take more math courses during high school and the factors hypothesized to influence their intentions. The dependent variable measures student behavioral intentions with respect to math course-taking intensity as a proxy to math persistence. Persistence is operationalized by a 3-category variable that indicates whether 9th graders plan to take math for a) one or two more years (including the Fall 2009 course), b) three years, c) four years or more.

The study seeks to explain students' intentions to persist in math course-taking by a variety of socio-demographic variables, beliefs about the behavior that describe student dispositions and long-term outcome expectations regarding educational attainment. The Appendix table includes the HSLS survey questions and the type of study variables and categories. The last column also includes descriptive statistics of the sample, percentages for categorical variables and means for continuous variables. Several constructs are defined based on the survey items that indicate student's reasons to take more math in high school: attitudes toward behavior (math utility), perceived norms (adult authority, peer example), perceived behavioral controls (internal motivation, math identity). All scales have good reliability with Cronbach's alpha varying between .570 (peer example) to .835 (math identity).

Statistical Procedures

The analyses consist in descriptive statistics, exploratory principal component analysis to guide the clustering of survey questions and reliability analysis to confirm internal consistency of scales, chi-square and ANOVA tests to further compare math course-taking groups by socio-demographic factors, student beliefs and expectations, multinomial logistic regression modeling to examine the relationship between math course-taking intentions and study variables. Rescaled (normalized) weights were computed for the research sample using Base year math-course enrollee analytic student survey weight (W1MATHTCH) and were used in estimating correct population proportions while reporting sample counts.

Research Questions

1. What are the most common motives (reasons) students reported when planning to take mathematics courses during high school and how do their motives differ by students' characteristics (e.g., gender, race/ethnicity, home language, socio-economic status) and outcome expectations?
2. What are the determinants and correlates of high school students' intentions with respect to math course-taking (i.e., proxy to math persistence), and what is the relative effect of socio-demographic factors, outcome expectations and students' motives on high school math persistence?

Analytical Model

Table 1 shows the analytical model for the study of students' intention to taking math coursework. The simplified version of TPB includes the effects of socio-demographic factors, student educational expectations (i.e., long-term outcomes) and the core of the TPB model constructs (i.e., attitudes toward behavior, perceived norms, perceived behavioral control) that are built on 9th graders' reported motives (reasons) to engage in math coursework. Reported motives are situated in the three core areas defining a) attitudes toward behavior as students' beliefs about school course requirements and math long-term utility value; b) perceived norms as response to parental authority and peer pressure; c) behavioral control as described by student internal motivation (i.e., enjoyment, talent) and math identity (attainment) belief that student perceive being able to control the behavior and identify with the task.

Table 1. Analytical Model for Intentional High School Math Course-taking Plans

Socio-demographic factors (categorical)	Beliefs about math course-taking (ordinal/categorical)	Expectations (categorical)	Math course-taking plans (categorical)
Gender Race/ethnicity First language SES	Attitudes toward behavior - graduation requirements - math utility value Perceived norms - adult authority - peer pressure Perceived behavioral control - internal motivation - math identity belief	Educational expectations (HS/below; DK; Assoc; Bach; Graduate)	Number of years HS math courses (1-2 years, G9-G10; 3years, G9-G11; 4 years, G9-G12)

Results

Students' Motives to Take High School Math Courses

This section presents students' responses to the question *Plans to take more math courses because..*, in order to identify who or what influences 9th grader decisions. Responses are compared by students' characteristics (e.g., gender, race/ethnicity, home language, socio-economic status) and educational expectations. The eleven survey questions (Appendix) are analyzed separately by reporting the percentage of positive responses (see Table 2).

For all students, the most popular reasons to plan to take more math courses in high school are related to long-term education plans that recognize the utility value of math instruction: ‘getting into college’ (53.5%), ‘usefulness in college’ (48.4%) and ‘required for graduation’ (42.0%). For about one quarter of students, math course-taking is viewed as ‘needed for career’ (29.9%), ‘parents want’ them to take math (29.1%) or they are ‘good at math’ (28.3%), the latter two reasons indicating perceived norms and math identity beliefs. About 18% of all students are ‘enjoying math’ and relatively fewer students plan to take math because of teachers, counselors, or friends.

Table 2. Percentage of Students Who Plan to Take More Math Courses Because.. (% Yes among each student group)

Student groups	Required for grad	Get into college	Useful in college	Needed for career	Parents want it	Teachers want it	Counselor wants it	Most students do	Friends are going to	Good at math	Enjoying math
ALL	42.0	53.5	48.4	29.9	29.1	13.4	8.4	5.4	4.7	28.3	17.8
Gender											
Male	39.6	48.2	43.2	28.6	26.1	12.1	7.6	5.3	5.2	29.4	16.8
Female	44.4	58.8	53.6	29.3	32.2	14.7	9.1	5.6	4.3	27.3	18.8
Race											
White	43.7	57.3	51.3	28.6	32.7	15.2	8.9	5.9	5.8	30.6	17.4
Hispanics	40.5	47.3	43.2	26.6	22.7	10.6	7.5	3.9	3.0	22.8	16.5
Black	36.0	44.6	42.5	30.6	20.3	10.1	7.1	4.9	1.7	27.2	20.0
Asian	40.1	70.6	62.1	35.0	47.9	18.2	10.1	13.8	10.6	38.6	26.2
Native American	40.3	40.3	39.1	25.8	26.2	8.2	3.9	2.1	3.0	17.2	17.2
Multiracial	45.9	55.6	49.2	32.7	30.3	13.1	9.4	4.1	5.3	28.3	17.3
First language											
English	42.2	54.2	48.4	28.9	29.7	13.4	8.2	5.3	4.8	28.7	17.4
Other	38.7	62.1	54.7	32.2	39.5	16.3	10.5	9.6	6.9	35.5	24.6
Spanish	41.9	46.0	46.5	28.1	21.6	12.2	8.3	4.5	3.5	23.0	18.1
SES											
Fifth	43.6	68.7	62.6	34.1	43.4	18.2	11.2	9.1	7.7	38.0	23.0
Fourth	43.9	58.4	52.5	30.1	32.7	15.5	8.8	6.3	5.9	31.2	18.4
Third	42.1	52.4	46.1	27.1	25.6	11.9	7.7	4.0	3.4	26.2	15.7
Second	41.4	45.1	39.8	27.0	22.5	10.0	6.6	3.8	3.1	23.7	15.1
First	39.6	41.5	39.8	26.0	20.1	10.7	7.2	3.7	3.4	21.7	16.5
Educational expectations											
Graduate	42.5	68.7	63.3	38.7	37.2	16.8	10.7	7.5	6.2	37.8	24.5
Bachelor	44.9	57.6	51.1	27.4	29.4	13.6	8.8	5.2	4.8	29.4	15.3
Associate	44.9	42.5	38.3	21.3	22.2	9.7	6.1	3.0	2.9	21.1	11.5
HS or less	39.4	25.4	23.3	16.8	16.3	8.7	5.3	2.8	2.7	14.5	9.6
Don't know	39.5	43.2	37.4	21.8	24.0	10.9	6.2	4.0	3.8	20.8	14.3

Female students show higher positive response rates on almost all motives, except being ‘good at math’ and taking courses because ‘friends are going to’. Race/ethnicity differences are also visible in responses. Notable results are the high rates of positive response regarding taking math for college purposes by Asian students: ‘get into college’ (70.6%) and ‘useful in college’ (62.1%). Asian students plan to take math courses because ‘parents want it’ (47.9%), they are ‘good at math’ (38.6%) and they ‘enjoy math’ (26.2%).

Similar response pattern is noticeable among students whose first language is Other (or Other and English) which indicate immigrant backgrounds. Low percentage of positive responses about being ‘good at math’ are exhibited by Native American and Hispanic students. Black students give more positive responses and are more likely to find a reason on continuing math because they ‘enjoy it’.

Not surprisingly, there is an almost perfect gradient of positive responses on all variables by socio-economic status with students from high-income families being more likely to identify all these reasons as positively affecting their behavioral intentions. A similar pattern is noticeable for educational expectations -- students who have higher expectations are in general more responsive to the various motivational factors. It is interesting to discuss where is situated the group of 9th graders who do not know how far in school they will go. About 20% of students are in this group (Appendix). They are among the least likely to take math courses for graduation. However, they acknowledge the importance of math for college and express enjoyment of math at the same level as students who expect to obtain Bachelor’s degrees. The responses provided by the group of students with undefined educational expectations are quite similar to those who expect to obtain an Associate degree.

Modeling Math Course-taking Intentions

As shown in the Appendix table that describes the research sample, almost 63% of 9th graders indicate they plan to take four or more years of mathematics courses (including grade 9) and are categorized as persistent in math course-taking. Another 28% intend to take 3 years of math and only 10% want to take only one or two years which is overall a good result. This section presents the multinomial logistic regression model predicting 9th graders’ math course-taking intentions. The odds ratios in Table 3 indicate the likelihood of planning to take less math courses (i.e., three years, Grade 9 to Grade 11; or only one-two years, Grade 9 to Grade 10) as compared to taking math over all high school years. The pseudo-R-square for the model is 18.7%.

As shown in Table 3, socio-demographic factors, particularly race and socio-economic status appear to be statistically significant across most categories. Female students are more likely than male students to express the intention to take more math courses including Grade 11 and 12. As compared to White and Asian students, all race/ethnic groups are significantly more likely to take less math courses, particularly the Native American students and Black students. For instance, compared to White students, the Black students are about 3 times and Native American about 4 times more likely to take math only in Grade 9 and 10 rather than during all high school years.

While students whose first language is English and those who speak Other language are equally likely to plan math classes during all years, Spanish-language speakers are more likely to plan taking less math in high school. A significant increase in odds ratios is noticeable for the low SES students coming from less affluent families (first SES quintile) being about 3.6 times more likely to stop math courses after Grade 9/10 as compared to students coming from affluent families (fifth SES quintile). This result can be associated with their low math self-concept (only 21.7% of low SES students believe they are good at math). The multinomial model also shows that students with lower educational expectations are less likely to plan taking more math courses in high school compared to those who expect to attain graduate degrees.

When controlling for socio-demographic and aspirational variables, some of the belief constructs contribute to the model. Beliefs about math utility to high school graduation are not a strong predictor of students’ intentional behaviors. Those who believe in the importance of math for graduation are less likely to abandon math after 1-2 years but only slightly more likely to take it only up to Grade11.

Table 3. Multinomial Logistic Regression Model Predicting Math Course-taking Intentions during High School (Four years or more=ref)

Variables/constructs	Categories	Odds ratios	
		Three years (Grade 9-11)	One/ two years (Grade 9/10)
Student sex	Male (ref)	-	-
	Female	.998	.808***
Student race	White (ref)	-	-
	Hispanics	1.365***	1.589**
	Black	1.830***	2.784***
	Asian	1.025	1.286
	Native American	2.325***	3.966***
	Multi-racial	1.551***	1.784***
First language	English only (ref)	-	-
	Other or Other/English	1.068	1.079
	Spanish or Spanish/English	1.200**	1.384**
Socio-economic status (5 quintiles)	Fifth (highest) (ref)	-	-
	Fourth	1.438***	1.616***
	Third	1.515***	2.439***
	Second	1.682***	2.519***
	First (lowest)	1.753***	3.577***
Educational expectations	Start/complete graduate degree (ref)	-	-
	Start/complete Bachelor degree	1.313***	1.471***
	Start/complete Associate degree	1.688***	2.090***
	High school or less	1.832***	3.155***
	Don't know	1.406***	2.137***
Math utility (graduation requirements)	No (ref)	-	-
	Yes	1.111**	.880**
Math utility (post-graduation)	Ordinal scale (0-1)	.532***	.266***
Adult authority	Ordinal scale (0-1)	.885+	.871
Peer example	Ordinal scale (0-1)	.977	1.182
Internal motivation	Ordinal scale (0-1)	.590***	.582***
Math identity	Ordinal scale (0-1)	.576***	.364***
N		20286	
R^2		.187	

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

However, belief constructs that affect the intentional behaviors are long-term math utility value (college and career benefits), internal motivation and math identity. Higher scores on these scales significantly decrease the likelihood that students will plan to take fewer math courses in high school. For instance, students who have a high perception of long-term math utility value (i.e., to enter college, succeed in college, use math for their careers) are almost 4 times more likely to take four years or more of high school math compared to those who plan to do math only for one or two years.Similarly, students with high math identity belief (i.e., as perceived by themselves or others) are about 2.5 times more likely to take four years or more of high school math compared to those who plan to do math only for one or two years. Finally, the internal motivation for doing math (i.e., being good at math or enjoying it) has a large positive effect on the likelihood of taking more math courses. However, the HSLS data show that students are not much likely to plan math course-taking to please the adults (i.e., parents, teachers, counselors), or due to requirement graduation, or following peer example. This is an interesting result because it shows that internal motivation and prior experiences are more important than external motivation factors in shaping math course-taking intentions.

Discussion

The overarching objective of this study was to explore 9th graders' intentions to take mathematics classes in high school and understand their motivations to engage in math learning. The study is guided by the Theory of Planned Behavior tenants that assert a behavioral intention can turn into behavior (i.e., actual course taking) if the student has positive attitudes toward behavior, support from others to engage in the behavior and control over the behavior (Ajzen, 1991; Lipnevich, et al., 2011; Zhang et al., 2019). Interest and persistence in the activity is also motivated by individual high outcome expectations (Lent et al.,1994). The study described the most common motives (reasons) students had in taking mathematics courses during high school, and examined if motives differ by students' characteristics and outcome expectations. The study also quantified the math course-taking intensity based on number of courses. as a proxy to math persistence, to explore the relative effect of socio-demographic factors, students' motives, and educational expectations.

This study makes two unique contributions to research on high school student persistence in mathematics. First, research findings demonstrate that students' plans are motivated by internal rather than external factors, so intentional behaviors are caused by students' own understanding of the role math could play in their lives. This finding aligns to Andersen and Ward (2014) who reinforced the importance of math/science intrinsic interest (enjoyment, talent), math/science attainment (identity) values, and STEM utility (extrinsic) value on maintaining a STEM persistence status among high-ability students engaged in advanced math/science curriculum. It also suggests that most students understand *why* it is beneficial to persist in taking math for their long-term academic plans. An understanding of outcome expectations is crucial in creating interest as suggested by Lent et al. (1994). Although data cannot capture the order in which different students' motives are constructed, it is likely that math utility values are built and strengthened by students' perceptions of their own abilities in doing math and the shaping of math identity attributes. The model also demonstrates that by Grade 9, students' plans and decisions are no longer influenced by authority figures or peers but are the result of understanding the broader context and consequences of their own decisions. It is remarkable that long-term plans about college and career play an important role in math course-taking planning as compared to high school graduation requirements. This suggests that students plan their future educational and career trajectories in a way that responds to the College Readiness policy goals (see e.g., Lee, 2012; Malin et al., 2017), although students' intentions in Grade 9 may not lead to actual behavior, and new experiences may change plans to enroll in math courses during high school.

Second, the study found socio-demographic effects, especially the significant contribution of socio-economic status, on math course-taking planning. Without accounting for other controls, the gap in planning to take advantage of math learning in high school is very large: only 49% of students in lowest SES quintile as compared to 79% of students in highest SES quintile have plans to continue math during all high school years. Less participation in math instruction has a negative effect on building math skills, self-efficacy, and identity, and could gradually reduce one's chances to stay on an academic track. The result is aligned with Huang's (2015) research who associated math achievement with time spent on learning a subject (school hours) and found low-SES students dedicate less time for math learning. In addition, the current study found systemic racial differences in terms of math course-taking planning: 42% of Native American, 51% of Black and 53% of Hispanic students plan to take math during all high school years as compared to 70% of White students and 74% of Asian students. Since math education is crucial to one's success in securing a job in the knowledge economy, study findings show that opportunity gaps occur at the intersection between race and socio-economic status, and these gaps are already large at the beginning of high school (Byrnes, 2003; Flores, 2007; Riegle-Crumb & Grodsky, 2010).

Limitations

This quantitative study focuses only on the number of math courses students intended to take during their high school years, without considering the type of math courses (e.g., advanced curriculum). One reason is that not all 9th graders are aware or understand advanced curriculum options in the first high school year, and those from less affluent backgrounds may not yet be prepared to even consider these options. However, most students are aware about their skills, interests, intentions based on their prior experiences with math learning. Second, math achievement in middle school should perhaps be included in an analysis of math course-taking planning, but HSLS:2009 does not provide this information. As suggested by TPB, prior academic experiences with a particular behavior are important in shaping beliefs that lead to behavioral intentions. If data was available, further studies focused on math persistence should include prior academic experiences.

Conclusions

As noted by Kilpatrick et al. (2001) building mathematical proficiency is a long process that requires practice in solving difficult problems and engaging in advanced high school courses. Persistence in math course-taking (Froiland & Davison, 2016) contributes to building foundational skills that are critical to gaining confidence in and enjoying doing math. There is no way to 'be good at math' without continuing participation and perseverance with the math school subject (Stanic & Hart, 1995). Without persisting in math during first years of high schools, access to advanced math and science courses in secondary school and beyond becomes problematic (Ayalon, 2003; Irizarry, 2021; Uerz et al., 2004; You & Sharkey, 2012). Although high school students should not be forced into taking mathematics courses, school districts and states may consider more options to include all students in some forms of math instruction during the entire school cycle (Reys et al., 2007). Educators should also find ways to help students improve their math skills prior to starting high school which would give them confidence in taking more math courses (Irizarry, 2021). The reality is that giving up math learning too early has a negative effect on further choice of advanced math and science courses and limits post-secondary and career pathways (ACT Policy Report, 2005; Long et al., 2012; Ogut & Circi, 2023).

Recommendations

Researchers, educators, and policy makers should consider how to develop in students the set of beliefs and values about math education to make them all understand its long-term effects on their educational and career opportunities. The study findings provide useful information for teachers, counselors, and school administrators on the importance of non-cognitive factors in math course-taking planning. Math teachers should certainly be first mathematically competent, but they should also possess teaching competency and interest to find strategies to develop both cognitive and non-cognitive math skills in students. Findings also suggest there could be a need for school districts and states to revise high school graduation requirements as to respond to college and career readiness goals promoted by policymakers.

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Appendix. Variables and Constructs, HSLS Survey Questions, and Descriptive Statistics of the Research Sample

Constructs/Vars	HSLS Survey Question	Variable Type	Mean/ %
Dependent variable			
Behavioral intention: Math course-taking	Number of years of math coursework 9th grader expects to take in HS (include Grade 9 course) (S1MYRS)	3-category variable:	
		Four years or more (ref)	62.8
		Three years	27.6
		One or two years	9.5
Socio-demographic variables			
Student sex	Student's sex (X1SEX)	2-category variable:	
		Male (ref)	49.6
		Female	50.4
Student race	Student's race/ethnicity-composite (X1RACE)	6-category variable:	
		White (ref)	52.3
		Hispanics	22.2
		Black	13.0
		Asian	3.5
		Native American	1.1
		Multi-racial	7.8
First language	Student dual-first language indicator (X1DUALLANG)	3-category variable:	
		English only (ref)	82.4
		Other or Other/English	5.0
		Spanish or Spanish/English	12.6
SES	Quintile coding of X1SES composite (X1SESQ5_U)	5-category variable:	
		Fifth (Highest, ref)	20.8
		Fourth	20.6
		Third	20.0
		Second	19.6
		First (Lowest)	18.9
Student beliefs (reasons): Plans to take more math courses because..			
Attitudes: Math graduation requirement	-It is required to graduate (S1MREASREQ)	2-category variable:	
		No (ref)	58.0
		Yes	42.0
Attitudes: Math utility value (post-grad)	-Will help to get into college (S1MREASCLG) -Will be useful in college (S1MREASUSE) -Needed for desired career (S1MREASJOB)	Derived ordinal scale (0-1), 3 items; Cronbach alpha=.706	.436
Perceived	-Parents want him/her to (S1MREASPAR)	Derived ordinal scale (0-1), 3	.170

norms: Adult authority	-Teachers want him/her to (S1MREASTCHR) -Counselor wants him/her to (S1MREASCNSL)	items; Cronbach alpha=.678	
Perceived norms: Peer example	-Most students like them do (S1MREASLIKE) -Friends are going to (S1MREASFRND)	Derived ordinal scale (0-1), 2 items; Cronbach alpha=.570	.051
Perceived control: Internal motivation	-He/she is good at math (S1MREASGOOD) -He/she enjoys studying math (S1MREASENJOY)	Derived ordinal scale (0-1), 2 items; Cronbach alpha=.692	.231
Student beliefs: Math identity			
Perceived control: Math identity	-9th grader sees himself/herself as a math person (S1MPERSON1) -Others see 9th grader as a math person (S1MPERSON2)	Derived ordinal scale (0-1), 2 items; Cronbach alpha=.835	.501
Outcome expectations: Educational expectations			
Educational expectations	How far in school 9th grader thinks he/she will get (X1STUEDEXPCT)	5-category variable: Start/complete Graduate (ref) Start/complete Bachelor Start/complete Associate High school or less Don't know	 41.0 16.9 6.8 14.1 21.2