GAMBLING BEHAVIOR AND MATH ACHIEVEMENT IN HIGH SCHOOL

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ABSTRACT

Math curricula have failed to engage students or improve their test scores over the last thirty years. Nearly two million students participate in some form of gambling, an illegal activity but one which frequently utilizes math skills. This paper will examine if there is a relationship between high school students who gamble and their performance on a math assessment. Perhaps participation in an otherwise ill-regarded activity provides some marginal benefit to those involved. Results from a regression analysis with a nationally representative set of data indicate that students who gambled experienced a small negative drop in math achievement compared to students who did not gamble, suggesting that any method to ground math teaching in a more stimulating or entertaining context may need teacher guidance to prove effective to boosting math achievement. The study was not able to separate risky behaviors, also highly correlated with negative academic achievement, from gambling behavior. Further research should focus on specific gambling contexts (i.e. poker, dice, etc.) and determine what aspects can be linked to math achievement and incorporated into classroom instruction, which could lead to a possible greater engagement into math curricula. Given that student engagement in math will play a significant role in education, it is important that educators and policymakers have a clear understanding of the everyday ways that students connect to math.
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INTRODUCTION

Alarmed by a weak U.S. economy, poor test scores among the nation’s students, and increasing international competition, President Obama and other lawmakers have begun to recognize the importance of high-quality math and science curricula for all students. In his State of the Union speech, President Obama declared, “This is our generation’s Sputnik moment.” Later in his speech, he stressed that America’s economic success depended on its leadership in research and technology, but that meant educating kids to excel in the science, technology, engineering, and mathematics (STEM) fields (Obama 2011). However, while lawmakers recognize the key to America’s long-term success will be a strong math and science education, few lawmakers have addressed the reform of math and science curricula, leaving the issue in the hands of teacher colleges and school districts. Despite the newfound emphasis and increased funding in STEM-related fields, math curricula have not changed quickly enough to meet the needs of the ever-changing global marketplace.

The current efforts around math education reform tend to focus on outcomes and goals, rather than the curriculum and specific classroom practices that lead to the strong analytic skills necessary for success in STEM-related occupations (Wu 1997). Rather, future scientists and engineers should not only solve problems, but more importantly, must be prepared to build problems (Meyer 2010). Indeed, American high schools have not prepared students for a rigorous college math curriculum, as evidenced by the fact that more postsecondary students require remedial math courses than in any other subject (Adelman 2004). Remedial courses come at a hefty price tag—the nation loses $3.7 billion a year in remediation for college students each year. These courses often teach high school math to catch students up to the standards of a college-level course. Colleges often must hire additional faculty to instruct these courses and
provide additional academic supports to students in remedial courses at the expense of providing resources to actual college-level courses (Alliance for Excellent Education 2006). An insufficient math education not only wastes billions of dollars, but it also affects our ability to create and innovate in the STEM fields that bolster national economies.

While math achievement has become stunted at higher levels of education, American elementary school students have shown significant improvements on national math assessments over the last thirty years. Up until 2009, fourth graders had posted a 24-point gain since the inception of the National Assessment of Educational Progress (NAEP) math tests in 1973. Eighth graders showed a smaller gain of 15 points since 1973 on the NAEP math tests. This progress stopped in 2009, when fourth graders showed no signs of progress for the first time in many years and eighth graders showed only minimal progress on their respective math performance. Most alarming, high school seniors have not shown any improvement on the NAEP math test since 1973. The older the cohort of test-takers, the more likely their performance appears to stagnate, suggesting that continual improvements in math achievement are not sustained past eighth grade (NAEP 2009). The consequences for this stagnation have implications for America’s international standing and performance. In 2006, thirty-one countries scored higher than the United States on the Program for International Student Assessment (PISA) for math literacy. In fact, the United States’ mean score on PISA fell below the mean of the participating 30 countries (NCES 2007). Despite spending $521.1 billion dollars on education in 2006, the United States’ scores were not measurably different from Croatia, which spends far less on education (Public Education Finances Report 2006; NCES 2007). The consequences for poor performances and weak foundations of math skills threaten America’s ability to produce a “competent corps of scientists, engineers, and mathematicians” (Wu 1997).
However, despite this lack of progress in high school math scores over four decades, little about the high school curriculum has changed in the last thirty years. Lectures, worksheets, and quizzes still dominate the high school math curriculum. Americans can no longer afford to “beat a dead horse” using the same whip of worksheets and lecture (Thompson 2009). Project-based learning is an approach to teaching that engages students through concrete, life-based applications of skills to solve problems or conduct scientific inquiry—encouraging hands-on approaches and developing real world skills to learn math—much like the work processes of real scientists (Curtis 2001). Improving math education may require not only a change in the curriculum, but it also requires a shift in classroom instruction away from rote memorization and abstract math, towards project-based learning, inquiry-driven and practical application of math skills (Papert 2008). For older students, colleges are moving away from the traditional lecture format and towards a more interactive teaching approach: for example, at the University of California, Santa Barbara, introductory economics courses are taught using game simulations and classroom experiments (Bergstrom 2007), which can be included under the general idea of project-based learning if such experiments and simulations are probed deeply, over time, in collaborative efforts.

Specifically, project-based learning has major implications in the area of probabilistic thinking (Greer 2001). Seymour Papert, a leading researcher on a project-based learning study sponsored by the Massachusetts Institute of Technology, argues that probabilistic thinking has major implications for abstract thought, but ridicules its current instruction in American classrooms.

“My favorite example these days is the way we think about probability. Like everybody talks about introducing more probability into the school curriculum because obviously probabilistic thinking is important. But the way they introduce
probability is some ridiculous calculating of fractions. It's not useful for anybody. You'd never suspect from that that probabilistic thinking was one of the most powerful and dramatic and far-reaching change agents in the history of science. It had made possible modern physics. It made possible social science. It made possible economics. It made it possible for us to understand evolution, which depends essentially on probability and randomness.” (Papert 2008, p. 2)

Unlike project-based learning approaches, current instruction on probabilistic thinking occurs with rote memorization of fractions, or flipping coins in class with no real consequence, context, or application. Yet, older students have found a way to apply probabilistic thinking skills in an illegal, albeit, useful way—gambling.

Based on the 2000 U.S. Census data, as many as 2 million students have gambled at some point during their adolescence (U.S. Census State and National Data 2000). Recent research demonstrates a positive correlation between adolescent gambling and substance abuse, presence of a family member with a gambling problem, impulsive behavior, and poor achievement in severe gamblers (Martins et al. 2008; Winters and Anderson 2000; Cronce et al. 2007). Despite these risky behaviors associated with gambling, there may be an indirect advantage to students from gambling behavior, specifically within the realm of probabilistic thinking. Differences in math achievement between adolescents who engage in gambling and those who do not remain relatively unexplored. Therefore, this study will examine the role of gambling behavior in the math outcomes of tenth graders from the 2002 Education Longitudinal Study, using a sample of 16,197 students, in hopes of uncovering the possible mechanisms through which gambling behavior may be related to high school math achievement.
POLICY QUESTION

Research has demonstrated that project-based learning, along with socioeconomic status, high school size, and motivation towards math, are significantly related to math achievement among high school students (Thompson 2009; Werblow 2009; Mason 2003). This study will explore if gambling behavior is related to high school math learning. If adolescents who engage in gambling behavior have greater gains in math achievement during high school than adolescents who do not engage in gambling behavior, then it may be important for educators and policy makers to consider the concrete applications of math, such as gambling, when revamping high school math curricula.

LITERATURE REVIEW

The Road to Project-Based Learning

The importance of math education did not gain traction until the 1957 launch of the Soviet Sputnik into space. Up until then, enrollment in advanced math classes across the country had declined in the first half of the twentieth century due in part to education movements that argued for the integration of math into other subjects or the encouragement of “basic skills” under the assumption that most students would not need advanced math in future vocational occupations (Kliebard 1988). However, with Soviets’ launch of Sputnik, education reformers and advocates seized the opportunity to bring attention to the poor quality of math and science education in America and exposed America’s vulnerability in these subject areas. In response, Congress passed the 1958 National Defense Education Act to increase the number of math, science, and foreign language majors to address these vulnerabilities in America’s public education system (Klein 2003).
In the aftermath of Sputnik, during the late 1950s and 1960s, math-centric organizations convened math professors and academics to evaluate the strength of U.S. math curricula and create a more rigorous framework for a new curriculum. These groups developed a new high school math curriculum that placed more emphasis on abstract concepts, such as calculus, over basic skills. By their reckoning, learning abstract math throughout elementary and high school would lead students to pursue math and science careers in college, thus, ultimately, becoming the scientists who would create the rockets and other space technology to win the “space race” against the Russians. These committees spurred the “New Math” movement. However, many parents could not understand the new content and pushed back against the abstract and high-concept math along with other mathematicians who argued that the New Math curriculum deemphasized basic computational skills. By the 1970s, the New Math curriculum and its influence declined as the average SAT math score dropped more than 10 points during the 1960s, the decade of its implementation (Herrera and Owens 2001).

After the demise of the New Math curriculum, math achievement has continued to decline over the last twenty years, but certainly not without national attempts to raise math test scores. In 1983, the National Commission for Excellence in Education published a report entitled *A Nation at Risk*, which chronicled the deficiencies in public education and equated America’s mediocre education to a national crisis of Sputnik proportions (Herrera and Owens 2001). Nearly 25 years after *A Nation at Risk*, the federal government implemented the No Child Left Behind Act, through which states created math standards with varying degrees of rigor that were tied to state assessments. However, as math scores on NAEP have increased at the elementary school level over the last 30 years, high school students have shown no improvement on national math assessments (NCES 2009). This suggests that while policy attention has shifted
to assessment mastery, high schools have not met the demands of national and state assessments, which may require a deeper understanding and mastery of the math curriculum. Traditional instruction, such as rote memorization of multiplication tables or simple algebra, may not develop the critical thinking skills necessary for the next century’s global demands for novel applications as well as innovative and creative thinking, not recitation (Schwartz, Bransford and Sears 2005). However, such a shift towards critical thinking would require instruction geared around the student and in-depth exploration of math on a deeper level.

What is Project-Based Learning?

Unlike traditional teaching approaches that emphasize rote memorization, project-based learning (PBL) is an instructional approach that focuses on student-directed inquiry into a curricular topic. The inquiry should take place over an extended period of time to encourage the development of in-depth research skills and a real world understanding of concepts. Teachers who practice PBL approaches ideally hold students accountable through presentations and discussions of results (Barron and Darling-Hammond 2008). Components of PBL include group work, use of technology, cross-curricular research and applications, experimentation, well-placed direct instruction, and ongoing assessments (Ravitz 2010). The intensity and multidimensionality of the PBL approach allows students to engage with the material more comprehensively than simply memorizing facts.

Such in-depth engagement appeals to adolescent desires for experimentation and risk-taking. The child’s motivation of “play” evolves among adolescents into a motivation for experimentation and encountering new experiences. Experimentation is the most effective form of learning for minds about to reach maturity. Through experimentation, adolescents shift from rapid absorption of information to a more nuanced understanding of information and increased
need for information processing. Experience-based knowledge, or experiential understanding, as that gained from PBL, helps adolescents to remember information and increase the capacity for prediction making—skills that are developed during these pivotal years (Chambers and Potenza 2003).

These benefits to adolescent cognitive development from PBL may translate to improvements in students’ academic outcomes. Yet, teachers approach PBL and its implementation in their own unique way, which makes it difficult for researchers to assess PBL’s effectiveness on student outcomes across contexts. Most research focuses on comparing between cohorts who receive PBL and with a control group who receives traditional lecture-based instruction. However, teacher quality and effectiveness in either type of instruction would be hard to capture in a statistical model. In addition, sample sizes for these comparative studies are small, mostly focusing on just a few classrooms from which results are hard to generalize.

Though this paper explores the possibility of PBL at the high school level, extant research examines the power of PBL at other grade levels. Research at the college level suggests promising student outcomes for PBL. Walker and Leary analyzed 201 outcomes reported across 82 different studies, focusing on the effect size of differences on standardized math tests between PBL students and non-PBL students. PBL students performed equally or significantly better than non-PBL students on standardized assessments, regardless of discipline (Walker and Leary 2008). In a much smaller study with much younger students, Shepard assessed a group of fourth and fifth graders who completed a nine-week project to find solutions to housing shortages in several countries while the control group received traditional lectures. The PBL group showed a significant increase on the critical-thinking test and reported higher self-confidence in learning compared to the group who faced traditional lectures. However, the study ran for only nine
weeks and did not assess the effect of PBL over time or the sustainability of learned content (Shepard 1998).

Just one study examined the importance of PBL to learning over longer periods of time than the previous two studies (Boaler 1997). This study analyzed three-year longitudinal data from two groups of British thirteen-year-old students with equivalent student achievement and socio-economic status (SES) to examine the relationship of PBL to learning over time. One school used the PBL curriculum that implemented open-ended curricular projects while the control group used a standard lecture-based curriculum. Using a pre-test/post-test design, Boaler (1997) found equivalent scores between the groups on basic math skills, but the PBL students had significantly greater gains on solving conceptual problems on standardized tests. In addition, more PBL students passed the U.K. National Exam in the third year of study compared to the non-PBL students (Boaler 1997). However, the study focused only on two schools, which might not represent the average student population, thus, its results may not be applicable outside of this school or neighborhood context. While PBL has great promise in engaging and increasing the in-depth comprehension and knowledge of adolescents, the research design around PBL makes it difficult to ascertain the reliability of this approach consistently. PBL also requires a significant amount of class time and uses skills and areas of knowledge that are often not assessed on high-stakes assessments.

Beyond the classroom, students also have multiple avenues to acquire math knowledge outside of school. Out-of-school activities, along with interactions with friends and family members, also provide opportunities to engage with math on a conceptual and abstract level (Schliemann et al. 1998). Given the proper context and setting, students can develop a more meaningful mathematical understanding for solving real world problems and engaging in real
probabilistic thinking outside conventional instruction. Thousands of students find a way to incorporate probabilistic thinking through illicit, and perhaps, less constructive ways through gambling.

*Out-of-School Probabilistic Thinking: Adolescent Gambling*

Adolescent gambling has garnered a significant amount of attention through studies that highlight the increasing prevalence of problem gamblers. Most studies attempt to explain the factors that are associated with gambling behavior rather than use gambling behavior to explain academic achievement or other behaviors. In analyzing over 20 studies related to adolescent gambling, Jacobs found that the most popular games were (1) cards and board games, (2) games of personal skills with peers, (3) sports betting with friends, and (4) bingo (2000). However, the study predates the proliferation of Internet gambling, which accounts for a greater share of adolescent gambling today (King, Delfabbro, and Griffiths 2010).

Differences across gender and ethnicity emerge in the gambling behavior of adolescents. Boys tend to gamble at earlier ages than girls and prefer games of skill that require some element of probabilistic thinking (Jacobs 2000). These results were based on adolescents’ self-reports of gambling behavior using the South Oaks Gambling Screen (Revised for Adolescents) as the primary survey instrument (Jacobs 2000). One concern is that self-reported behavior may produce an under-reporting of the behavior in question, especially if that behavior is illegal or may have negative connotations, such as gambling.

While many researchers acknowledge that minorities are more likely to engage in adolescent gambling, there are few studies available that track this trend (Jacobs 2000). Martins et al. (2008) found that gambling preferences from the past year significantly increased the probability of being at-risk for gambling in African-American boys. Using self-reported surveys
and teacher observations, Martins et al. (2008) assessed a sample of 452 African-American students annually since first grade. One group of first graders received interventions to increase achievement and reduce aggressive behavior while another group did not receive the interventions. In 2004, the then eleventh grade students were surveyed again to assess gambling behavior. Martins et al. (2008) found that parents’ education, first grade intervention status, and neighborhood disadvantage were not significantly associated with gambling behavior. However, Martins et al. (2008) did find that males were more likely than their female counterparts to gamble in the last year (Martins et al. 2008).

*Origins of Gambling Behavior*

Research has also attempted to pinpoint the factors associated with the onset of adolescent gambling. As previously noted, Jacobs (2000) found that boys gamble at earlier ages than girls. In a longitudinal study of impulsivity over six years on gambling propensity, Pagani (2009) looked at how kindergartner’s impulsive behavior related to patterns of gambling behavior in sixth grade. Kindergarten teachers identified early impulsive behaviors using a nine-item subscale that measures inattention, distractibility, and hyperactivity. While adjusting for differences in student gender, parents’ education, family structure, and parental gambling, Pagani (2009) found that early childhood impulsivity mattered significantly to self-reported gambling. In fact, each one-unit increase in kindergarten impulsivity was associated with a 25 percent increase in self-reported gambling in sixth grade (Pagani 2009). Ultimately, the results suggested the symptoms associated with Attention Deficit Hyperactivity Disorder (ADHD) are positively related to pre-adolescent gambling and could predict adolescent gamblers in a group of kindergartners. However, the study relies heavily on the non-professional assessments of teachers to determine “impulsive behavior,” which may not be an accurate clinical assessment,
instead conditioned on the personality of the teacher and varying types of instruction available. The Diagnostic and Statistical Manual refers to gambling specifically as an impulse-control disorder (Kluger 1999). Yet, if the identification comes from teachers without any formal training in psychiatry, it is unclear how valid a teacher assessment of “impulsivity” can be as an objective diagnosis and/or description of a child. The identification of hyperactive behaviors may be easily confused with interpersonal conflicts with the teacher and ineffective classroom management.

Over the last twenty years, gambling has become more socially acceptable and legal for adults, which may be due to the greater accessibility of gambling activities, e.g. online poker sites (Hyder and Juul 2008). However, often, the earliest exposure to gambling occurs a lot closer than the casino floor. Researchers at Iowa State found through surveys that most young gamblers were introduced to gambling by a relative or through family friends (Knickerbocker 1999). Youthful experimentation and dabbling in gambling can lead to problematic gambling behavior and other risky behaviors, which are often the focus of research (Gupta and Derevensky 1998).

*Gambling and Other Risky Behaviors*

Multiple surveys of middle and high school students have found that over sixty percent of students have engaged in some form of gambling in the past year (Gupta and Derevensky 1998). Most are considered to be social and recreational gamblers, but there are ten to fifteen percent of those students who are at risk of developing a serious gambling problem. Serious adolescent gamblers were defined as answering “yes” to four or more questions out of the possible twelve on the Diagnostic and Statistical Manual of Mental Disorders gambling assessment for
adolescents, which is geared toward gambling use over the past year (Gupta and Derevensky 1998). This type of serious problem gambling is linked to other risky behaviors.

Gupta and Derevensky (1998) found that early involvement in gambling is also significantly associated with onset of cigarette use, illegal drinking, and marijuana use. Identified serious gamblers were twice as likely to use tobacco as non-gamblers. The use of illegal substances can be less frequently reported but when reported, it is two to four times more present among serious gamblers than among non-gamblers (Jacobs 2000).

The available research suggests that poor academic performance is associated with gambling activity, but often, such research focuses exclusively on serious gamblers, not recreational gamblers. Often, serious problem gamblers have a host of issues including addictive personalities and hyperactivity that lead to poor academic performance, legal problems, and loss of interest in normal activities compared to non-gamblers (Borrell 1999). It is not clear whether the negative consequences are the direct consequences of gambling or the result from other risky behaviors such as substance abuse. It may be possible that gambling may rarely produce dramatic consequences unless encouraged by other addictive behaviors. But without more studies that link the consequences of adolescent gambling to poor grades and academic performance, it would be difficult to establish whether gambling leads to poor grades or vice versa (Winters and Anderson 2000).
RESEARCH HYPOTHESIS

This study is designed to assess the role, if any, that gambling plays in high school students’ math learning. The primary hypothesis of the study is that adolescents who engage in gambling behavior will have significantly different gains in math from those students who do not engage in gambling behavior. The analysis tests the hypothesis that adolescent gambling may increase math achievement scores. In this study “gambling” measures whether students gambled through any means. Additionally, the analysis delves further to determine if gambling with friends and family is related to math achievement. Given that gambling with friends and family comprise the majority of “yes” respondents to gambling, students with such proximal gambling behaviors may experience more consequential and longer gambling experiences than those students who gamble with a bookie or a website. Students who gamble with friends and family within the last year may show higher math achievement scores than gambling via other means. If allowed at home, then students are more likely to have discussions that involve more of the math behind gambling.
This study focuses on the role of gambling behavior in the math achievement gains over the span of two years in high school. Preliminary data analysis and prior research suggest a trend towards different academic outcomes between students who engaged in gambling behavior and those who did not engage in gambling behavior (Cronce et al. 2007). The conceptual model attempts to identify key student aspects that contribute to differences in math achievement and better isolate the relationship between gambling and math learning.

Student characteristics are related to both math achievement and gambling behavior. This study looks at how student characteristics are related to both gambling behavior and math achievement. Boys are more likely than girls to participate in gambling behavior, and minority adolescents tend to gamble more than white adolescents (Jacobs 2000). Students with lower SES tend to have lower math outcomes along with greater participation in gambling activity (Riegel-Crumb, 2006; Jacobs 2000).

Urbanicity is closely linked to math achievement. In particular, urban school achievement is well below the national average in math performance. While the gap between urban and national math achievement has decreased on NAEP tests since 2003, the percentage of students in urban districts in 2007 was 28%, which is about 11 percentage points less than the national proficiency average of 39% (Snipes 2008). In conjunction with lower socioeconomic status, students attending schools in urban areas ranked the lowest compared to suburban and rural schools (Williams 2005). Parents frequently play an indirect role in student achievement through establishing a culture of expectations and structure in the home environment (Jeynes 2007). However, the effect of parental expectations and discipline for the home environment varies by
race and gender (Hill, Castellino, and Lansford 2004; Muller 1998). Family structure, as captured by rules about homework, grades, and television, may be associated with math achievement and gambling or risky behaviors. Homework allows students to practice math skills on a regular basis and gain exposure to the sort of problems expected on a math achievement test. A review of studies has found that completing homework is associated with better performance on math standardized tests—a link that is stronger in the secondary grades (Cooper, Robinson, and Patall 2006). However, the ELS:2002 survey only focuses on rules about homework, so it is not possible to ascertain the importance of its completion.

In addition, the analysis should demonstrate whether an interest in math is associated with math achievement in gamblers. Interest in math should be linked to both achievement and gambling in that students who enjoy math may have different math outcomes from those students who do not enjoy math. Students who like math may experience a stronger interest in gambling because it piques their interest and engages their math skills. Alternatively, due to the disconnect between math instruction and applied probabilistic thinking, students may profess a dislike for math classes while engaging in applied math through other activities such as gambling. Students with stronger applied math skills that are not necessarily being used in the classroom may exhibit stronger math outcomes regardless of their interest in math as associated with “math class.” Students who use probabilistic and math skills in gambling may very well reject the notion of traditional “math class.”

**DATA DESCRIPTION AND SOURCE**
The nationally representative longitudinal data used in this study are taken from the Education Longitudinal Study of 2002 (ELS:2002), sponsored and produced by the U.S. Department of Education’s National Center for Education Statistics. The study provides trend data to monitor the transition of high school students starting in tenth grade through post-secondary and/or work experiences.

The overall sample consisted of 16,197 students in total. Beginning in 2002, schools were sampled to participate in the study to create a nationally representative set of schools, from which about 25 tenth graders were randomly selected to participate in the survey and assessments. Only Asians and Pacific Islanders were oversampled to ensure sufficient analytic power for comparative analysis. The cohort of tenth graders was surveyed over the next ten years during four collection periods. In 2002, the survey measured the students’ academic achievement during their sophomore year in high school and gathered information about students’ academic experiences and perspectives. These same students were surveyed and tested again in 2004 for any improvement in mathematics achievement, along with collecting their high school completion status. Researchers interviewed the same cohort in 2006 to obtain information about post-secondary plans and enrollment, along with employment and living situation information. The study will end with a final interview in 2012 that will measure the cohort’s post-secondary attainment and transition into the workforce.

The ELS:2002 collected information not only from students, but also from their parents, teachers, and administrators of their high schools. Information about the students from multiple data sources and perspectives give a more complete picture of the student’s home, school, and community than a single-source dataset. Teacher-supplied data provide information about each
ELS:2002 participant separately, their class in general, and the background of the teacher.

To be included in this analysis, sample members had to have been an in-school sophomore in 2001–02, participated in both the base-year (BY) and first follow-up (F1) interviews, completed the mathematics assessment in the BY and F1 interviews, and answered questions on gambling behavior. After these selections, the final analytic sample includes 9,725 respondents, who provided a valid response to the lead-in question about gambling (yes/no). Around 4,768 respondents answered yes to at least one of the five follow-up questions about gambling behavior: (1) bets were placed with friends (2) bets were placed with family members (3) bets were placed with bookie (4) bets were placed with a website (5) bets were placed through other means. The sample of 9,725 respondents have decidedly different characteristics from the entire ELS sample due, in part, to the fact that the analysis focuses on participants who responded to the initial gambling question and the follow-up questions about gambling behavior. Not only are the gambling questions somewhat sensitive in nature but were also placed at the end of the survey, and thus, were susceptible to skips and missing responses.

**Variables**

*Individual Social Characteristics: Entire ELS:2002 Sample*

Data on student characteristics were collected via surveys administered to a nationally representative sample of high school sophomores in 2002. Consequently, the entire ELS:2002 sample of 16,197 students consisted of 53.6% Caucasian, 12.5% African-American, 13.7% Hispanic, 9% Asian, 4.5% more than one race, and .8% American Indian. Almost 6% of the respondents did not indicate a race. The sample was split evenly by the gender of student. Around 47.3% of the respondents reported themselves as male while 47.6% reported themselves
as females. Nearly 5% of the respondents did not indicate a gender.

The data for constructing the socioeconomic status composite variable came from parents’ self-reported answers on the parent questionnaire when available and student substitutions when not provided by parents. The socioeconomic status (SES) composite variable was based on five equally weighted and standardized components: father/guardian’s education, mother/guardian’s education, family income, guardian/father’s occupation, and guardian/mother’s occupation. The values of the SES composite variable were then distributed into quartiles. Over 22.3% of the respondents were categorized into the lowest quartile, 22.3% of the respondents were categorized into the second quartile, 23.0% of the respondents were categorized into the third quartile, and 26.6% of the respondents were categorized into the highest quartile. Nearly 6% of the respondents were not classified into quartiles due to non-respondents and legitimate skips. Urbanicity was captured by school locale with over 34% of students coming from urban schools, 48% students coming from suburban schools, and 18% students coming from rural areas. Participants in the study seem more prevalent among the wealthier stratum and from suburban schools.

Individual Academic Characteristics: ELS:2002 Sample

Data for interest in math class came from student self-reported answers on the student questionnaire. A composite variable was created to demonstrate an interest in math from the following questions: frequently reviewing homework from the previous day’s math class (once or twice a week to every day), listening to the lecture material in math class on frequent basis (once or twice a week to every day), copying notes from the board on a frequent basis (once or twice a week to every day), and reporting of problem-solving activities (once or twice a week to
every day). Out of the entire survey sample of 16,197 students, over 74% of students reported being frequently engaged in math as determined by this composite variable.

Parents and guardians also answered questions about enforceable family rules for their tenth graders about grade point average, homework, chores, and watching television. Around 62.28% of parents and guardians responded that they enforced rules about grade point average, 70.28% about homework, 66.41% about chores, and 49.42% on television. In the creation of a composite variable, any student who answered at least one “yes” to questions about family rules was considered to have family rules and/or structure in the composite variables while students who answered “no” to all the questions were considered not to not have any rules or structure in the family. A composite variable was created to capture a broader picture of family discipline in rules using rules, GPA, chores, and television as the components. Around 74.6% of the entire survey sample of 16,197 students reported having rules for at least one of the above components.

A math assessment was administered to students during the base year and follow-up year survey. The base year test scores of the sophomore students serve as a “pretest” to the follow-up assessment (“post-test”) given to the same students in the twelfth grade. Administrators designed and scored the test using Item Response Theory (IRT), which used patterns of correct, incorrect, and missing answers to produce score estimates. The score reflects the estimated number of correct questions that the student would have earned had the student answered all 85 questions on the assessment. According to the mean for the entire ELS:2002 sample, on average, students would have answered 43 questions out of the total 85 questions correctly in the base year assessment. According to the follow-up assessment, students would have answered, on average, 50 of the 85 questions correctly. On average, students with base year and follow-up
math test scores increased their base year scores by 5.2 questions in the follow-up math assessment in 2004.

*Student, Demographic, and Achievement Characteristics: Missing Observations*

To create the analytic sample from ELS:2002 sample, selections were made by determining which students had legitimate responses to the survey items of most relevance to this paper’s research question, specifically, the gambling questions. Nearly 40% of the ELS:2002 sample did not answer the survey questions about gambling. Of those 6,472 students, more than 800 students did not answer any questions in the survey due to skips (179 students) or simple non-responses (648 students), thus, making up 13% of the overall missing responses. Comparing those included in the analytic sample to those excluded provides some degree of understanding of how the results may be biased. Table 1 presents results from bivariate comparisons of the analytic sample and those missing. Over 46% of students who did not answer the gambling question are male while 41% of the missing students were female. However, higher proportions of males and females answered the gambling lead-in question compared to the missing sample. The proportion of females was 11 percentage points higher in the analytic sample than the proportion of girls in the missing observations. The proportion of males in the analytic sample was 2 percentage points higher than the proportion of males among the missing observations (p<.000). African-Americans made up 15.7%, of the missing observations which is significantly more than the percentage of African-Americans in the analytic sample (10.3%), indicating that African-Americans are less represented in the analytic sample. Overall, the proportions of Asian and multiracial students among the missing data do not differ from the proportions of Asian and multiracial students in the analytic gambling
sample. The proportions of Hispanic, white, and American Indian students do differ from their respective proportions in the analytic sample (p<.01) with white students represented more heavily in the analytic sample than in the missing data. As a result, white students may be overrepresented in the analytic sample and minority students underrepresented, which, if minority students engage in gambling more than white students, may attenuate the relationship between gambling and learning.

Urbanicity also varies among the missing observations. There are significantly fewer students from urban and suburban schools among the missing data than in the analytic sample, suggesting the analytic sample comprises lower percentages of rural students. The analytic sample is more skewed towards the wealthier socioeconomic strata (31%) since more students in the lowest SES quartile are missing responses on the gambling survey items (21% versus 29%). Far more students in the analytic sample are interested in math compared to those students with missing data (81% versus 59%, p<.001). In addition, students with missing observations averaged 41 questions right on the base year math assessment, which is a significantly fewer number of questions right compared to the analytic sample’s average of 42 (p<.000). The same pattern held for the follow-up assessment, with students excluded due to missing data scoring on average 47 points and students included in the analytic sample 51 points (p<.001). This finding may not be surprising given that students with stronger cognitive skills in reading and math may be able to finish a lengthy survey as opposed to students with lower cognitive skills who may abandon the survey for a variety of reasons: completion due to frustration, not taking the survey seriously, or lack of motivation to complete the survey. Thus, the students in the analytic sample may be more likely to learn more in math from their mere interest in math than those excluded
from the sample, regardless of gambling behavior or other factors.

Student Social Characteristics: Analytic Sample (n=9,725 students)

Of the 16,197 respondents, 9,725 students responded to the gambling lead-in question. These 9,725 students comprise the analytic sample used in the primary analysis, of whom 29.5% of the ELS:2002 answered that they had gambled either through friends, family, a bookie or a website. Nearly 44% of the analytic sample reported they placed bets with friends. Around 15.2% of students reported placing bets with family members. Only 2.5% of all the 9,725 students reported placing bets with a bookie while 1.8% of students reported placing bets on a website. Around 3.9% of the students in the whole sample reported placing bets through other means.

Students in the highest SES quartile comprise the largest portion of the analytic sample with over 31% of the respondents coming from the highest (most socioeconomically advantaged) quartile and only 20.5% of the sample. Half of these students attend suburban schools (50%) with 31.9% and 18.1% of the sample attending schools in urban and rural areas, respectively. Of the analytic sample, 79.3% of students had at least one family rule about school performance (GPA, chores, homework, and television), suggesting that students in the analytic sample had more structure concerning academics than students in the whole sample. Based on the selection, i.e. math assessment scores for 2002 and 2004, and responses to the gambling questions, the sample was overrepresented with suburban white students from higher socioeconomic levels, thus, narrowing the representativeness of the sample.

Academic Characteristics: Analytic Sample (n=9,725)

Among the students in the analytic sample, the base year math score does not differ
significantly between students who gambled and those who did not. The sample for the entire survey for the following year has a standardized mean of 50.66%. The mean test score on the base year assessment for the analytic sample is 44.6 points. On the follow-up assessment, the mean test score on the follow up assessment was 51.1 points. Around 81%, in the gambling sample reported an interest in math.

**METHODODOLOGY**

Ordinary Least Squares (OLS) regression is used to estimate the relationship between gambling and math achievement. The dependent variable, rescaled to have a mean of zero and a standard deviation of one, equals the difference in the number correct on the base year assessment subtracted from the number correct on the follow up assessment. Any positive differences would suggest that if math achievement had increased between 2002 and 2004, i.e. a value of 0.50 SD would suggest that student had improved by a half a standard deviation above the mean. A negative value would suggest that students had answered fewer questions correctly in the base year than compared to the follow-up year, i.e. a -0.50 SD would suggest that a student had earned a half a standard deviation lower than the mean between the two years. The independent variables included demographic, achievement, gambling behavior, and parental characteristics of the students. By adjusting for differences in student characteristics related to the outcome the relationship between gambling and math achievement can be isolated.

The model is documented by the following equation:

\[ \text{achieve} = \beta_0 + \beta_{\text{studentcharacteristics}} + \beta_{\text{academiccharacteristics}} + \beta_{\text{gambling}} + \epsilon \]

\[ \text{achieve} = \text{standardized difference in math test score in base year survey from the math test score in following year survey.} \]
\[ \beta_{\text{student characteristics}} = \text{demographic variables accounting for other differences that may relate to student math learning, i.e., race, socioeconomic status, gender, and urbanicity.} \]

\[ \beta_{\text{achievement characteristics}} = \text{interest in math class as indicated by a frequency of greater than once a week along with a composite variable for family structure as indicated by a “yes” to any questions related to household rules and discipline.} \]

\[ \beta_{\text{gambling}} = \text{a composite variable indicates whether the student engaged in gambling through any of the following means: friends, family, bookie, a website, or through other means.} \]

 Each individual coefficient can be interpreted as the change in the outcome due to a one-unit increase in the corresponding independent variable. Three analyses were conducted for the same dependent variable, but each analysis included different combinations of the gambling variables. Model 1 consisted strictly of the demographic characteristics, academic characteristics, and the gambling composite variable. Model 2 included demographic and academic characteristics, but omitted the gambling composite variable in favor of including gambling with family and friends. Model 3 included each of the gambling methods along with the demographic and academic characteristics, but omitted the overall gambling composite.

 Additionally, while the models described above tried to account for most of the crucial characteristics associated with math achievement in high school students, alcohol and substance use was not included in the models. There is a strong association between alcohol and substance use and gambling behavior along with the negative association between substance use and academic achievement (Winters and Anderson 2000). However, little research exists about the direction of this relationship whether gambling causes the poor grades or vice versa, and the ELS:2002 survey did not ask students questions about alcohol and substance use. As a result,
this analysis does suffer from some degree of omitted variable bias, in that alcohol and substance use are positively related to gambling and negatively with overall student achievement, especially in identifying problem users of both alcohol or illicit substances and gambling (Jacobs 2000). This relationship between gambling and math learning may be nullified or pushed downward with the omission of whether students engage in alcohol and illicit substance use. Because of the high correlation between serious gambling and substance use, the gambling may be a proxy for these problem behaviors. As a result, the results may overemphasize the negative relationship between gambling and gains in math achievement. If it were possible to isolate the gambling behavior from the alcohol and substance use, there could be a positive link between gambling and learning.

**Results**

The results of the regression analyses presented in Tables 2 and 3 disprove the research hypothesis that gambling might improve math learning in high school. This hypothesis rested on the understanding that implicit learning of math concepts outside school, which may engage students more than rote math instruction, would benefit math learning as traditionally measured. However, the findings suggest otherwise.

**Model 1.** Model 1 (see Table 2) estimates the relationships among gender, race, socioeconomic status, family rules, interest in math, and most importantly, the gambling composite measure to explain the variation in math learning between the base year and follow-up year. The model as a whole explains 2.7% of the variation in the math scores. The gambling composite variable in Model 1 is significant with a coefficient of -.05 SD (p<.05). Gambling reduces math learning in high school by one twentieth of a standard deviation. The standard
deviation is about 6.5 correctly answered questions, so such a finding suggests that students who engaged in gambling behavior through any means answered a third of a question less correctly. In Table 3, the gambling composite variable was significant (p<.05), but the difference in the actual number of fewer questions between students who gambled and students who did not is minimal.

**Models 2 and 3.** Each of the variables associated with the method for gambling, i.e. students who gambled with friends, family, bookie, a website, and other means, are included in Model 2 and Model 3 found in Table 2. The explanatory power of Model 2, which includes only whether students gambled with family or friends, is slightly less than the explanatory power of Model 1 (2.7% to 2.5%). Model 2 did not capture the other means of gambling in the model such as a bookie or website as the gambling composite variable captures. Interestingly, gambling with friends and gambling with family members did not matter to math learning, neither boosting or lowering math learning in high school. No benefits from practicing math in such ways emerged on the gain score outcome.

In Model 3, located in Table 2, with the inclusion of the separate variables for gambling with friends, family, bookie, Internet, and other means, the coefficient for gambling with friends is the only gambling coefficient estimate that was significant at -0.05 standard deviations (p<.1), which indicates a small negative relationship; as students engage in gambling with friends, their math learning decreases. With the exclusion of gambling with a bookie or through the Internet in Model 2, the coefficient for gambling with friends is capturing some of the variability associated with the other omitted gambling variables. When accounting for these different modes of gambling, gambling with friends emerged as a significant, but negative influence on
math learning. Perhaps, students are more susceptible to negative peer influences that are associated with decreased math learning, like alcohol/substance use, which may not be associated with gambling with a bookie or over the Internet. Students who gamble with friends have an associated one-twentieth standard deviation drop in the number of questions correct compared to students who do not gamble with friends. Students who gamble with friends provide one third of a question fewer on average compared to the students who do not gamble with friends. However, with the exclusion of the gambling composite variable, the explanatory value for Model 3 dropped to 2.5 percent.

In all three models, the math interest coefficient is not significant. Boys experience a half standard deviation increase in math achievement compared to girls, which equates to about two-fifths of one question on average more correct than girls (p<.000). More socioeconomically advantaged students gained more between 10th and 12th grades on math tests than poorer students. Only Asian students differed significantly from white students in high school math learning: Asian students earned 0.17 standard deviation (p<.001) higher scores between 10th and 12th grades than white students. However, with the inclusion of gambling with family and friends in Model 2 and in Model 3 with the individual gambling coefficients, this Asian advantage increased to 0.20 standard deviations (p<.001).

**DISCUSSION**

The results disprove the hypothesis that students who gamble would learn more in math
during high school than students who do not gamble. On average, students who reported any gambling behavior had an associated one-twentieth standard deviation drop in test scores. Based on the specific mode of gambling, students who gambled with friends experienced a three-question drop compared to students who did not report gambling with friends. However, interestingly enough, students who reported gambling with a bookie, the Internet, or family, did not experience any advantage or disadvantage to their math learning. The lack of significance of these variables suggests that specific modes of gambling, such as gambling with family members, might not lead to the problematic outcomes associated with problem gamblers as indicated by the literature.

Contrary to the literature, these results do indicate that engaging in gambling behavior is not linked to great detriments to student achievement. However, the literature typically has not focused specifically on gambling behavior and its relationship to math achievement for non-problem gamblers. The literature typically focuses on problem gambling and its relationship to poor student achievement, but the results of this study do not discern between problem gamblers and occasional gamblers. The results of this study may be hampered by the inability to distinguish serious gamblers who may be engaging in other co-occurring risky behaviors associated with poor student achievement, like truancy and drug addiction. The results may be pushed downward as a result. Further research could benefit from isolating the effect of gambling on occasional gamblers rather than serious, albeit, infrequent gamblers.

The coefficients for gambling in Model 1 and gambling with friends and family in Model 2 may be biased downward in part because of the omission of an alcohol and substance use variable, which is closely and positively related to gambling (Jacobs 2000). However, without
this variable, the gambling coefficients may be taking on the negative associations of alcohol and substance use on math achievement, which may be biasing the coefficient downward, thus, hiding any possible association between gambling and math achievement. The current literature does not indicate whether gambling leads to alcohol/substance use or vice-versa. However, as both behaviors may be linked to math achievement, it may be necessary to tease out gambling’s separate relationship to the learning outcome from the relationship between alcohol/substance use and learning, rather than constantly overestimating gambling’s negative effect on math achievement.

The results are hampered because the survey questions were at the end of the survey, which resulted in an overall significantly different sample of students in terms of achievement compared to the entire sample. The gambling sample, as a whole, reflected a set of students who demonstrated higher achievement, came from a wealthier background, and were from primarily suburban schools.

While it’s important not to discount the problems with addiction, it’s also critical that policymakers not discount the possible benefits to teaching probabilistic thinking in a more practical and hands-on way. Educators and policymakers must use all paths necessary to direct students into fields that require probabilistic thinking, like economics, math, science, and engineering. While the results do not indicate that gambling improves math achievement, it also did not indicate a severe negative impact on math achievement. Perhaps, the inclusion of teacher supervision may ensure that the best aspects of gambling, such as risk, probability, and engagement, can be incorporated into the curriculum. As a result, teachers could use more project-based learning to connect with student desires to experiment and manipulate math
concepts. Students will have more a valuable academic experience that encourages a deeper level of understanding. However, federal and state assessments should measure abstract concepts of math more fully, rather than the superficial multiple-choice tests. The previous literature has little information about the usefulness of gambling and its outcomes on math achievement. As universities engage in risk-based simulations to increase engagement and understanding in undergraduate economics classes, research should assess the effects of such programs on student achievement in hopes of trickling down to high school curricula.

The initial survey with the gambling question was administered in 2002. Since 2002, increased accessibility, anonymity, and promotion of gambling through the Internet have increased gaming among adolescents (Tsitsika et al. 2010). Age restrictions attempt to limit access to youth, but students often are able to obscure their true age and participate more freely in gambling than face-to-face gambling scenarios like a bookie or a casino floor. An estimated 25% of North American students engage in Internet gambling (Derevensky & Gupta, 2007). However, this proportion represents a much larger proportion of Internet gambling than captured by the 2002 survey. Further research that relates gambling and math achievement should focus on the relationship between Internet gambling and math achievement, especially, as Internet gambling represents a new and more accessible way for students to engage in underage gambling without detection.

Ultimately, the findings of this study cannot confirm or refute the hypothesis that gambling is associated with math achievement. Unfortunately, the results of the study which relied on pool of wealthier students may skew the applicability of these findings to a wider and more nationally-representative student population. The findings of this study do suggest that more
research is required to truly understand gambling’s effect on math achievement on a broader sample of students. It will be necessary to ensure consistent implementation in teacher-supervising gambling instruction/project-based learning in these studies to preserve fidelity.

Underage gambling is illegal, however, the incorporation of aspects of gambling-simulations or games into teacher-supervised activities could be a fertile area for further research. To the extent that these findings can contribute to a better understanding of the relationship between the relatively unexplored connections between gambling and math achievement, they speak to the importance of the debate to improve math achievement and ultimately, to the type of the instruction and engagement in math. Given that student engagement in math will continue to play a significant role in education, it is important that policymakers and educators have a clear understanding of the everyday ways, including gambling, that students manipulate and connect to math. A failure to do so may very well further detach high students from math curricula.
### Table 1: Summary Statistics of Entire ELS:2002 Survey Participants versus Students Who Answered Questions about Gambling Behavior (Analytic Sample)

<table>
<thead>
<tr>
<th>Whole Sample (n=16,197)</th>
<th>Analytic Sample (n=9,725)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td>Male</td>
<td>8,090</td>
</tr>
<tr>
<td>Female</td>
<td>8,107</td>
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<tr>
<td>Hispanic</td>
<td>2,217</td>
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<tr>
<td>Black</td>
<td>2,020</td>
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<tr>
<td>Asian</td>
<td>1,460</td>
</tr>
<tr>
<td>White</td>
<td>8,682</td>
</tr>
<tr>
<td>American Indian</td>
<td>130</td>
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<tr>
<td>Two or More Races</td>
<td>735</td>
</tr>
<tr>
<td>Urban</td>
<td>5,486</td>
</tr>
<tr>
<td>Suburban</td>
<td>7,764</td>
</tr>
<tr>
<td>Rural</td>
<td>2,947</td>
</tr>
<tr>
<td>SES Lowest Quartile</td>
<td>3,875</td>
</tr>
<tr>
<td>SES Second Quartile</td>
<td>3,853</td>
</tr>
<tr>
<td>SES Third Quartile</td>
<td>3,925</td>
</tr>
<tr>
<td>SES Highest Quartile</td>
<td>4,507</td>
</tr>
<tr>
<td>Family Rules (Composite)</td>
<td>12,081</td>
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<tr>
<td>Math Interest (Composite)</td>
<td>11,709</td>
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<tr>
<td>Gambling (Bookie)</td>
<td>244</td>
</tr>
<tr>
<td>Gambling (Friends)</td>
<td>4,282</td>
</tr>
<tr>
<td>Gambling (Family)</td>
<td>1,475</td>
</tr>
<tr>
<td>Gambling (Internet)</td>
<td>179</td>
</tr>
<tr>
<td>Gambling (Other Means)</td>
<td>376</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Average</th>
<th>Frequency</th>
<th>Average</th>
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<tbody>
<tr>
<td>Math Achievement IRT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average (Base Year)</td>
<td>15, 892</td>
<td>43.2</td>
<td>9,725</td>
<td>44.6</td>
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<tr>
<td>Math Achievement IRT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average (Follow Up Year)</td>
<td>13,468</td>
<td>49.5</td>
<td>8, 281</td>
<td>51.1</td>
</tr>
</tbody>
</table>

~p<.10, * p<.05, **p<.01, ***p<001
Table 2: Estimated Coefficients for Math Achievement  
Model 1-3 Dependent Variable: Difference in Base Year Math Achievement from Follow-Up Math Achievement

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>.06***</td>
<td>.06***</td>
<td>.06***</td>
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<tr>
<td>Black</td>
<td>.006</td>
<td>-.036</td>
<td>-.034</td>
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<tr>
<td>Hispanic</td>
<td>-.004</td>
<td>-.020</td>
<td>-.019</td>
</tr>
<tr>
<td>Asian</td>
<td>.17***</td>
<td>.203***</td>
<td>.201*</td>
</tr>
<tr>
<td>American Indian</td>
<td>-.022</td>
<td>.044</td>
<td>.046</td>
</tr>
<tr>
<td>Two or More Races</td>
<td>.027</td>
<td>.037</td>
<td>.037</td>
</tr>
<tr>
<td>Low SES</td>
<td>-.021</td>
<td>-.047*</td>
<td>-.048*</td>
</tr>
<tr>
<td>Third Quartile SES</td>
<td>.12***</td>
<td>.122***</td>
<td>.121***</td>
</tr>
<tr>
<td>High SES</td>
<td>.252***</td>
<td>.255***</td>
<td>.255***</td>
</tr>
<tr>
<td>Urban</td>
<td>.008***</td>
<td>.075***</td>
<td>.075***</td>
</tr>
<tr>
<td>Rural</td>
<td>-.083***</td>
<td>-.091***</td>
<td>-.091***</td>
</tr>
<tr>
<td>Family Rules (Composite)</td>
<td>-.024</td>
<td>-.043</td>
<td>-.043</td>
</tr>
<tr>
<td>Math Interest (Composite)</td>
<td>.045</td>
<td>.008</td>
<td>.008</td>
</tr>
<tr>
<td>Gambling (Composite)</td>
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<td></td>
</tr>
<tr>
<td>Gambling (Bookie)</td>
<td></td>
<td></td>
<td>.041</td>
</tr>
<tr>
<td>Gambling (Friends)</td>
<td>-.019</td>
<td>-.052*</td>
<td></td>
</tr>
<tr>
<td>Gambling (Family)</td>
<td>.019</td>
<td>-.027</td>
<td></td>
</tr>
<tr>
<td>Gambling (Internet)</td>
<td></td>
<td>.057</td>
<td></td>
</tr>
<tr>
<td>Gambling (Other Means)</td>
<td></td>
<td>-.014</td>
<td></td>
</tr>
</tbody>
</table>

Overall R²  
0.0265  0.0252  0.0256  
Number of Observations  
6,995  10,779  10,779

*** p. <.01, ** p. <.05, * p. <.10 . Robust standard errors.
REFERENCES


