Education Policy Analysis Archives/Archivos Analíticos de Políticas Educativas
ISSN: 1068-2341
EPAA@asu.edu
Arizona State University
Estados Unidos

Gottfried, Michael; Owens, Ann; Williams, Darryl; Kim, Hui Yon; Musto, Michela
Friends and Family: A Literature Review on How High School Social Groups Influence Advanced Math and Science Coursetaking
Education Policy Analysis Archives/Archivos Analíticos de Políticas Educativas, vol. 25, 2017, pp. 1-23
Arizona State University
Arizona, Estados Unidos

education policy analysis archives

A peer-reviewed, independent, open access, multilingual journal

epaa aape

Arizona State University

Volume 25 Number 62 June 12, 2017 ISSN 1068-2341

Friends and Family: A Literature Review on How High School Social Groups Influence Advanced Math and Science Coursetaking

Michael Gottfried
UC Santa Barbara

Ann Owens
University of Southern California

Darryl Williams
Tufts University

Hui Yon Kim
UC Santa Barbara

&

Michela Musto
University of Southern California
United States

Citation: Gottfried, M., Owens, A., Williams, D.N., Kim, H. Y., & Musto, M. (2017). Friends and family: A literature review on how high school social groups influence advanced math and science coursetaking. *Education Policy Analysis Archives, 25*(62). http://dx.doi.org/10.14507/epaa.25.2857

Abstract: In this study, we synthesized the literature on how informal contexts, namely friends and family social groups, shape high school students' likelihood of pursuing advanced

Journal website: http://epaa.asu.edu/ojs/
Facebook: /EPAAA
Twitter: @epaa_aape

Manuscript received: 6/12/2016
Revisions received: 1/5/2017
Accepted: 4/5/2017

math and science coursework. Extending scholarly understandings of STEM education, we turned to the body of literature with three guiding questions: (1) What influence do friends have on advanced math and science coursetaking? (2) What influence does family, particularly parents, have on advanced math and science coursetaking? (3) Do the effects vary by gender among each social group? By synthesizing existing literature on the influence of family and friends on advanced math and science coursetaking in high school, we find that both friends and families can influence the number of advanced math and science courses students complete, but the amount of advanced coursework students complete also varies based on the gender of the individual student, the gender of his/her friends, as well as by mother or father. Implications and limitations are discussed.
Keywords: STEM education; family influence; peer influence; secondary education

Amigos y familia: Una revisión en la literatura sobre cómo los grupos sociales de la escuela secundaria influencian cursos avanzados de matemáticas y ciencias
Resumen: En este estudio, sintetizamos la literatura sobre cómo los contextos informales, denominados amigos y los grupos sociales familiares, forman la probabilidad de que los alumnos de la enseñanza media de proseguir cursos avanzados de matemáticas y ciencias. La extensión de entendimientos académicas de la educación "STEM", nos dirigimos a la cantidad de literatura con tres preguntas de orientación: (1) ¿Qué influir amigos han avanzado cursos de matemáticas y ciencias? (2) ¿Qué influencia tiene la familia, particularmente los padres, en cursos avanzados de matemáticas y ciencias? (3) ¿Los efectos varían de acuerdo con el género entre cada grupo social? Al sintetizar la literatura existente sobre la influencia de la familia y de los amigos en cursos avanzados de matemáticas y ciencias en la enseñanza media, descubrimos que tanto los amigos como las familias pueden influir en el número de cursos de matemáticas y ciencias avanzadas que los estudiantes concluyen, pero La cantidad de estudiantes de cursos avanzados completos también varía de acuerdo con el género del alumno individual, el género de sus amigos, así como por madre o padre. Se discuten las implicaciones y limitaciones.
Palabras-clave: educación "STEM"; influencia familiar; influencias iguales; educación secundaria

Amigos e família: Uma revisão na literatura sobre como os grupos sociais da escola secundária influenciam cursos avançados de matemática e ciências
Resumo: Neste estudo, sintetizamos a literatura sobre como os contextos informais, nomeados amigos e os grupos sociais familiares, formam a probabilidade dos alunos do ensino médio de prosseguir cursos avançados de matemática e ciências. Extendendo os entendimentos acadêmicos da educação "STEM", recorremos ao corpo da literatura com três perguntas orientadoras: (1) Que influência os amigos têm em cursos avançados de matemática e ciências? (2) Qual influência a família, particularmente os pais, tem em cursos avançados de matemática e ciências? (3) Os efeitos variam de acordo com o gênero entre cada grupo social? Ao sintetizar a literatura existente sobre a influência da família e dos amigos em cursos avançados de matemática e ciências no ensino médio, descobrimos que tanto os amigos quanto as famílias podem influenciar o número de cursos de matemática e ciências avançados que os estudantes concluem, mas a quantidade de estudantes de cursos avançados completa também varia de acordo com o gênero do aluno individual, o gênero de seus amigos, bem como por mãe ou pai. Implicações e limitações são discutidas.
Palavras-chave: educação "STEM"; influência familiar; influências iguais; educação secundária

Friends and Family: A Literature Review on How High School Social Groups Influence Advanced Math and Science Coursetaking

If U.S. high school graduates lack interest in STEM-related areas, then they may not be adequately prepared for the challenges of scientifically-driven college majors and occupations. Hence, many are concerned about a 'leaky' STEM pipeline[1]. In college, the percentage of undergraduates pursuing degrees in engineering, physical science, and math has remained stagnant over the past several decades, and the percentage pursuing computer science has declined, with the largest decline among the highest-achieving students (Lowell, Salzman, Bernstein, & Henderson, 2009; National Science Board, 2010). In regards to career opportunities, although STEM careers present a potential pathway to high-paying, in-demand jobs in the United States (U.S. Bureau of Labor Statistics 2014), students are not garnering the appropriate skills to be competitive in an increasingly scientific labor market (Tyson et el., 2007; U.S. Department of Education, 2010) or to reap the financial benefits of securing STEM jobs (Beede et al., 2011; Melguizo & Wolniak, 2012; Olitsky, 2013).

Proficiency and skills in high school STEM courses, as well as students' perceptions of their STEM skills, are among the best predictors of STEM study in college (Nicholls et al., 2007), but American adolescents are currently ill-prepared to pursue STEM careers relative to their global counterparts. For example, 15 year-olds in the US ranked 16 out of 26 developed countries in science literacy and 19 out of 26 developed countries in mathematical literacy in 2010 (National Science Board, 2010). Due to these concerns, the US has enacted a number of federal policy initiatives to enhance the high school STEM curriculum. For example, the Carl D. Perkins Career and Technical Education Improvement Act of 2006 provides funds for the development of STEM curricula for both college and non-college bound youth, and the America COMPETES Act of 2007 supports programs that increase the number of teachers qualified to teach STEM areas in high school. More recently, the President's Council of Advisors on Science and Technology (PCAST) prepared a report with a number of recommendations for STEM education in grades K-12 (PCAST, 2010).

There is certainly significant dialogue surrounding changing curriculum and recruiting higher quality teachers. Beyond addressing these formal initiatives, however, one burgeoning area of interest in considering how to improve STEM outcomes has been the role of context, such as social groups. For instance, researchers across multiple disciplines in the social sciences have examined whether one particular social group might influence STEM outcomes in high school. Many findings have emerged as significant, as we describe throughout this literature review. However, a consensus has not yet emerged on the role of social groups, partially due to the fact that researchers have examined these factors in isolation from one other. That is, much of the research available to date is compartmentalized into narrow research agendas, with researchers across a number of disciplines examining the same research question without communication. Therefore, the purpose of our research is to synthesize the literature on the influence of social groups on students' advanced math and science coursetaking in high school.

---

[1] We here acknowledge that some scholars do not support the presence of a leaky STEM pipeline (e.g., Stevenson, 2014). However, for the purposes of this study, our goal is to acknowledge the potential presence of a leaky STEM pipeline in order to establish the importance of garnering STEM skills in high school as a way to boost the pathway to STEM in college and beyond.

Conceptual Framework

Our study represents a systematic narrative review of the literature. Therefore, we do not review past literature here, as the body of the article serves as a systematic review of the literature. Our systematic review of the literature focuses on the role of key social groups in high school – friends and family – in influencing STEM outcomes. We focus on these groups because they are two of the most influential contexts in adolescents' lives, contexts within which students look for support, guidance, and examples (Crosnoe, 2011; Lareau, 2003; Milner, 2006). We consider friends in addition to family to acknowledge the particular importance of peers during adolescence. Before analyzing the literature relevant to our specific focus, we briefly review the more general knowledge about the importance of each social group for academic outcomes, and we discuss the importance of our outcome variable, advanced STEM coursetaking.

Friends. Friends are an important influence on students' academic achievement. Past research indicates that having reciprocated friendships was positively associated with academic outcomes, while students without friends had lower academic outcomes (Wentzel, Barry & Caldwell, 2004; Wentzel & Caldwell, 1997). Studies generally show that peers matter for both girls' and boys' GPA, though results occasionally differ by gender depending on the measurement of friendship groups. A key mechanism for this relationship is motivation, which can potentially be improved by peer group engagement. For instance, Kinderman (2007) found that peer group engagement levels (as perceived by teachers) predicted changes in students' motivation across time. Evidence for group influences persisted when controlling for peer selection and the influence of teacher and parent involvement.

Family. The family context – in this study we focus on parents – has the potential to affect STEM outcomes in several ways. Parents' behaviors and attitudes may nurture or hinder the development of interest in math and science throughout a child's education. Parents who promote math and science activities and express positive values regarding math and science tend to have children who are also more interested and involved in math and science activities (Eccles et al., 1982; Jacob & Bleeker, 2004; Tenenbaum & Leaper, 2003). Even as students enter into college, parent encouragement has significant effects on math and science college outcomes (Ferry, Fouad & Smith 2007). Additionally, gender (of both the child and parent) comes into play – although mothers have been shown to be more likely to purchase math and science toys for their sons than for their daughters, parents are nonetheless more likely to be involved with their daughters' math and science activities than with their sons' (Jacob & Bleeker 2004). Researchers have interpreted this as reflecting the fact that parents are likely to believe that science is less interesting but more difficult for their daughters (Tenenbaum & Leaper, 2003). In our review, we explore whether friends or parents differentially affect male or female adolescents' coursetaking.

Advanced coursetaking. The STEM outcome of interest is advanced math and science coursetaking in high school, in which further STEM and general educational pursuits are scaffolded (Tyson et al., 2007; Wang, 2013). For example, just having completed advanced math and science courses (holding performance constant) has been associated with higher math and science achievement scores in high school (Adelman, 2006; Brody & Benbow, 1990; Burkam & Lee, 2003; Riegle-Crumb, 2006). Beyond high school, advanced math and science coursetaking links to better success in STEM college courses (Wimberly & Noeth, 2005), higher chances of majoring in STEM in college (Federman, 2007; Trusty, 2002) and to increased college graduation rates (Schneider, Swanson, & Riegle-Crumb, 1997). Furthermore, *advanced* coursetaking represents the first time in high school when students are electing to pursue STEM areas, as opposed to simply completing required courses, so focusing on advanced STEM coursetaking during high schools captures the degree to which adolescents' STEM coursetaking *decisions* can be shaped by family and friends (Pearson, Crissey, Riegle-Crumb, 2009; U.S. Department of Education, 2002, 2003).

Literature Review: Guiding Questions

To explore the link between social groups and STEM outcomes in high school, we surveyed the literature with three guiding questions in mind:

1. What influence do friends have on advanced math and science coursetaking?
2. What influence does family, particularly parents, have on advanced math and science coursetaking?
3. Do the effects vary by gender among each social group?

As discussed, some studies of family and friend influence on STEM-related outcomes revealed different patterns by gender, motivating the third research question. The focus on gender is also motivated by disparities in STEM pursuit between men and women. Women comprised 52% of bachelor's degree recipients in 2012 but were underrepresented among those with degrees in STEM fields. Among women interested in STEM, a significant proportion are likely to pursue both degrees and jobs in the health and social sciences rather than in the physical sciences, computer science or engineering (National Science Foundation, 2011; Pryor et al., 2009) – only 1 out of 7 engineers is female. Therefore, we consider whether social contexts experienced during high school are one factor contributing to disparities in STEM outcomes by gender.

Addressing these questions aligns with the conversations that have been taking place at the national, state, and district levels regarding increasing the number of students who develop an interest in pursuing STEM-related coursework and, subsequently, STEM careers. We synthesize the evidence to draw new conclusions regarding the significance of youth social contexts on STEM outcomes that will assist policy makers and educators in evaluating productive educational environments. Understanding the role of contexts is crucial to implementing policies that serve as an avenue for students to have equal opportunities and access in pursuing STEM careers.

Method

To address our research questions on how friends and family influence advanced math and science coursetaking in high school, we conducted a broad systematic literature search. We carried out these searches using the following electronic databases: JSTOR, Academic Search Premier, Web of Science, ERIC, PsycInfo, and Google Scholar. The search terms for literature on our outcome, high school STEM coursetaking, included the following terms: "high school", "advanced math", "advanced science", "advanced STEM", "math coursetaking", "science coursetaking", "STEM coursetaking", "advanced curriculum", "STEM curriculum", "coursetaking", and "courses". To locate studies on the influence of friends and family, search terms included the following: "peers", "friends", "influence", "positive influence", "negative influence", "parent", "support", "encouragement", "factors", "predictors", "environment", "male", "boys", "female", "girls", and "gender". These search terms emerged iteratively as searches were conducted and were used alone and in various combinations with one another. Searches were run using a combination of search terms and phrases until the process no longer yielded additional studies to include in the initial sample. Following these online searches, we used the references in this initial set of articles to find additional articles. Searching electronic databases and using references to locate additional studies resulted in an initial pool of over 200 articles for consideration.

From this first broad sample, the following criteria had to be met in order for articles to be included in the final sample. First, articles had to be published in the prior two decades (1994 onward). However, any articles that were highly referenced and deemed important to the field were considered in the initial pool, even if published prior to 1994. Second, each study must be focused on advanced STEM coursetaking in high school as an outcome. We defined advanced coursetaking as enrolling in science or math courses that are likely optional for graduation, including algebra II or advanced algebra, trigonometry, pre-calculus, calculus, statistics, chemistry, and physics—whereas biology, earth science, algebra, and geometry were considered foundational courses. Studies used different definitions of advanced coursetaking; several studies self-identified their outcome variable as advanced math coursetaking and included geometry, and we included these studies. Some studies only predicted the number of math or science credits, so students who take more courses are considered to engage in advanced coursetaking. Articles that focused on STEM coursetaking as a predictor of other outcomes, like majoring in STEM in college, were outside the scope of this synthesis. Moreover, the authors of each study must have directly measured friends or family relationships as predictors of advanced math and science coursetaking. Third, articles must have used a method to account for individual differences and selection on observable variables, such as using comparison groups and/or accounting for the nested structure of educational/schooling data. Fourth, any sample under 30 students was considered a small sample per the synthesis rubric outlined in Buysse et al. (2013). Fifth, only peer-reviewed journal articles or reports written in English were considered, though relaxing this restriction did not yield other articles.

The articles from the initial broad sample were flagged based on information available from the titles and abstracts using the scholarly search engines listed above. Articles were deemed as potentially relevant if the title, abstract, or article text alluded to research pertaining to our outcomes or key predictors if they met the criteria listed above. Ultimately, our literature search and inclusion criteria led to a total of 11 studies. Within this set, six focused on friends' influence and ten focused on family influence (five studies included measures of both family and friend influences, typically considered in separate analyses). While each of these studies directly measures the associated influence of friend and family contexts on advanced math and science coursetaking, these studies differ in their measurement of friend and family contexts. Discussion of these studies will specify the distinct operational definition of the key predictors, and this information is also included in Tables 1 and 2. Secondly, each of the studies focuses on different aspects of STEM coursetaking. Some studies defined coursetaking in the math or science subjects, or both. But the language of the outcomes in the findings below remains faithful to the terminology used in the original work. Given the final number of studies, we chose to report our findings as a review synthesis.

Findings

Spanning from 2001 to 2015, these 11 studies assessed primarily large-scale datasets (seven studies included samples exceeding 10,000 students), including the National Education Longitudinal Study (NELS), Education Longitudinal Study (ELS), Third International Mathematics and Science Study (TIMSS), Adolescent Health and Academic Achievement (AHAA) and the linked Add Health data. Smaller, more local data included information from the Wisconsin Study of Families and Work (WSFW).

Tables 1 and 2 summarize these findings as well as the authors' definitions of advanced math and science coursetaking. Below, we summarize the evidence on the influence of friends and parents on advanced coursetaking. We report the standardized betas, such that the findings can be interpreted as effect sizes. Often, these were reported directly in the studies themselves. When they were not, we converted an unstandardized coefficient into a standardized beta. For the cases when the outcomes were continuous (e.g., the number of advanced courses taken), we multiplied the unstandardized coefficient by the ratio of the standard deviations of the independent variable and dependent variable. In the cases when the outcome was binary (e.g., whether a student did or did not take an advanced math course), we converted the coefficients from odds ratios into effect sizes using the Cox Transformation (Cox, 1970). If information on the standard deviations was not available, we can only present the unstandardized results.

Friends and Advanced STEM Coursetaking

Findings across these studies indicated that students' friends play an important role in shaping students' interest in and pursuit of advanced math and science coursetaking in high school. These studies relied on subjects' own conceptions and definitions of friends. For example, in the studies using Add Health data, students self-nominated their friends, whereas in the other studies, students reported their own perceptions of activities and norms of their friend group. The authors of this study conceptualized friends' influence on advanced STEM coursetaking in several different ways, including: academic attitudes, aspirations, and academic ability. Interestingly, these associations between social groups and advanced coursetaking differed by gender, as we discuss below.

Friends' academic attitudes were statistically-significantly related to an individual student's enrollment in advanced math and science courses. Using NELS data, a nationally representative sample following a cohort of U.S. students beginning in grade 8 and through four follow-up periods, Muller and Ellison (2001) examined whether students' advanced math coursetaking was linked to their perceptions of their friends' academic attitudes. Perceptions of friends' academic values were measured by the sum of the standardized scores of five items measuring students' perceptions of how important attending classes, studying, getting good grades, finishing high school, and continuing education past high school were to their friends, each ranging on a 3-category scale from "not important" to "very important". The authors found that perceptions of friends' holding higher academic values significantly increased advanced math coursetaking from 10^{th} and 12^{th} grades. Though this measure was associated with a statistically-significant increase in advanced math coursetaking, the practical significance may be limited in this study (the standardized effect was only 0.02 in both grades).

As for academic aspirations, Ozturk and Singh (2006) examined whether friends' educational aspirations, including importance of getting good grades and attaining postsecondary education, mediated the effect of SES and prior math achievement on advanced coursetaking. Like Muller and Ellison (2001), the authors used NELS data. Applying structural equation modeling (SEM), the authors found that the educational aspirations of friends' contributed over 10% of the indirect effects on math coursetaking. However, this effect was smaller than parental involvement, SES, or prior math achievement.

Gender differences. Four studies of peer effects examined gender differences in some way—either whether boys or girls are more affected by friends, or whether the gender of one's friends created larger or smaller effects. Similar to Muller and Ellison (2001), You and Sharkey (2012) explored how friends' academic attitudes were linked to advanced math coursetaking and how this link varied by gender. They did so by drawing on ELS, a nationally representative dataset that first collected baseline data from sophomores in high schools in 2002. For girls, friends' value of education was associated with greater odds (1.16 odds ratio; Cox effect size of 0.09) of taking advanced mathematics courses. For boys, friends' value of education was not a statistically-significant predictor. Overall, while the authors do determine that the above are all small effect sizes, they nonetheless conclude that expectations from friend relationships are a primary source of social influence when it comes to advanced math coursetaking.

Like Ozturk and Singh (2001) described above, Ercikan, McCreith, and Lapointe (2005) also examined the link between friends' aspirations and individual-level advanced math coursetaking. Using TIMSS, which is a cross-national survey that includes variables about mathematics achievement and participation in advanced mathematics courses in 45 countries, the authors used discriminant function analysis to examine how students' self-reported perceptions of their friends' expectations of college attendance were linked to advanced math coursetaking. The authors found that friends being a strong predictor of advanced math coursetaking varied by gender. Although friends' college expectations (correlation of 0.54) were a strong predictor of individual participation in advanced math courses for girls, their own attitudes towards math were more strongly correlated with advanced math coursetaking (correlation of 0.63). Friends' college expectations were a stronger predictor of boys' than girls' advanced math coursetaking (correlation of 0.62 for boys) and mattered almost as much as their own expectations about college (correlation of 0.63).

Rather than focusing on attitudes or aspirations, Crosnoe, Riegle-Crumb, Field, Frank, and Muller (2008) examined friends' academic ability. Using Add Health and AHAA datasets, which together combined to be a nationally representative longitudinal sample of high school students (and their transcripts) beginning in the 1994-1995, the authors explored the effects of friends on coursetaking by gender throughout their analyses as well as comparing the role of friend influences among higher-achieving and lower-achieving students (as measured by course failure rates). The findings indicated that friends' average grade point averages (GPAs) were linked with advanced math coursetaking across all grades (9-11) for both girls and boys, with the strongest effects occurring in grade 11. Furthermore, the GPA of students' classmates—students that shared clusters of courses with the focal student (based on transcript data)—was also linked to advanced math coursetaking for both genders, suggesting that students' friends and classmates who they may have less strong relationships with both play a significant role in increasing students' likelihood of pursuing advanced math coursework. The authors pointed out that friends' influence, for the most part, outweighed classmates' influence; the "friend hypothesis" was consistently supported across both genders. It should be noted, however, that both friends' and classmates' average GPA had a small effect on math coursetaking in this study, with effect sizes ranging between 0.13 and 0.16 for girls and between 0.18 and 0.22 for boys. Lastly, when examining the effects of classmates among students that did not fail any classes versus those that failed at least one, classmates' academic levels had greater influence among students that were not already struggling in school.

Riegle-Crumb, Farkas, and Muller (2006) also examined peer influences by gender, but from a slightly different perspective. Rather than examining how girls and boys responded differently to peer expectations, the authors of this study utilized the national AHAA and Add Health datasets to examine the influence of friends' gender on individual outcomes. The dataset allowed for students to self-report up to 10 friends, from which the gender composition of students' friends was calculated. Additionally, students self-reported whether they spent time with each identified friend in the preceding week and responses were averaged across all friends. From this, the authors compared how the gender composition of students' friendship groups shaped students' advanced math and science coursetaking. For both boys and girls, having predominantly same-sex friends in high school was linked to greater odds of advanced math and science coursetaking, and the effect of same-sex friends was greater for girls, with an estimated effect size of 0.96; the effect sizes of same-sex friends for boys was 0.39 and 0.38 on math and science coursetaking, respectively. The authors also explored how the average grades of same-sex friends affected advanced coursetaking given that the researchers were able to link information across students in a school and determine the average grades of the identified friends for a given student. Although there was no significant relationship for boys, friends' grades were positively associated with the odds of advanced math and science coursetaking for girls, with effect sizes ranging from 0.88 to 0.91. When interacted with whether girls predominantly had same-sex friends, the effect size for friends' grades increased (1.12 and 1.01 for math and science, respectively).

Summary. The studies above generally identified friends' academic attitudes, aspirations, or abilities as positive, shaping students' advanced math and science coursetaking; however, these findings were not always consistent. Several studies found that some friend influences were more influential for girls rather than for boys—which, in two studies, experienced no significant effects at all. On the other hand, other studies found larger effects for boys, though in these studies, the gender gap was not as large. Another caveat is that several studies confer positive significant findings, but note the small effect size, with one study (Ozturk & Singh, 2006) noting that peer influences were not as strong a predictor as parental ones. Regardless, these studies did conclude that students' friends do influence whether students pursue advanced STEM coursework.

Parent Influences

The extant research overwhelmingly identified significant relationships between aspects of parent and family contexts and advanced math and science coursetaking, with 10 studies finding positive effects and only one finding negative effects. In fact, the authors of one study explicitly found that parental effects were greater than influences of friends (Ozturk & Singh, 2006). Only one finding suggested that parental involvement discouraged students from taking advanced math and science courses, possibly because overly involved parents may actually deter a student from developing independence. Table 2 summarizes the studies we reviewed.

Main findings. Studies of parental influence focused on the role of parental expectations or parental involvement. We begin by discussing studies on parental expectations.

Expectations. In addition to addressing the role of peers as described in the previous section, Muller and Ellison (2001) also explored the influence of student-reported parental academic expectations, talking with parents about school, and an intergenerational closure measure (i.e., when parents know the parents of their child's friends). These three parental measures significantly predicted advanced math coursetaking in grade 10. However, parental expectations were the only significant parent-based predictor persisting into grade 12. The effect sizes of these measures ranged from 0.02 to 0.06 – which does not indicate great practical significance.

Sciarra (2010), using ELS data, examined the role of parent-reported educational expectations for their children on advanced mathematics coursetaking in high school. Sciarra found a positive link between parental college expectations and students' advanced math coursetaking in high school. Students whose parents expected them to complete a bachelors degree or higher were 1.5 times more likely to enroll in advanced mathematics courses (Cox effect size of 0.24).

While the studies above looked at the general influence of parents' expectations on student's advanced coursetaking, two studies examined differential influences of expectation by gender. Ercikan, McCreith, and Lapointe's (2005) aforementioned study also assessed parental influence on advanced coursetaking, in addition to peer influence. The authors of this study examined students' self-reported perceptions of their parents' expectations of their educational attainment. Recall that effects were provided as correlation coefficients. For girls, their perceptions of their mothers' expectations (0.52) were strongly associated with participation in advanced math courses, but perceptions of fathers' expectations were not. In contrast, for boys, their perceptions of both mothers' (0.53) and fathers' (0.53) expectations mattered to approximately the same degree. For girls, relationships with women seem particularly important, consistent with the results for the study of same-sex peer groups.

Riegle-Crumb, Farkas, and Muller (2006) assessed the influence of parent expectations (measured as students' perceived parental disappointment if student did not attend college) on girls' and boys' advanced math and science coursetaking. Parental expectations had a similarly-sized effect on students' advanced math coursetaking as the influence of having same-sex friends (described above). The effect on girls' enrollment in advanced science courses significant increased, with an effect size of 0.88, and the effect on boys' enrollment in advanced math also increased, with a smaller effect size of 0.33.

Involvement. Several studies found a positive and significant relationship between parent involvement, rather than expectations, and students' advanced science and math coursetaking. Valadez (2002) used NELS data to explore the following traits of parental involvement: students reporting having discussions with their parents about school, their parents being engaged in school intervention strategies (e.g. attending school meetings), and parental monitoring (e.g. parents' checking homework or limiting television time) as well as parents reporting being involved in parent-teacher organizations (PTO). The author found that PTO involvement increased student odds of enrolling in advanced mathematics by 1.05; parental discussion (1.04) and school intervention (1.07) strategies were associated with increases in advanced mathematics coursetaking. The effect sizes of these three predictors ranged from 0.02 to 0.04. The exception was monitoring behaviors, which did not have any statistically-significant association with advanced math enrollment.

Like Valdez (2002), Ozturk and Singh (2006) also examined the role of student-reported parental involvement—parents' discussion of course selection or college with their children—in addition to peer influence on student's math coursetaking. The analytic model indicated that parental involvement was a key contributor to math coursetaking. For instance, the authors found that parental involvement accounted for 36% of the role SES had on advanced math coursetaking. Additionally, the authors noted the high association of parental educational expectations with student's own education aspirations, the latter of which was a key and direct predictor of math coursetaking. The authors conclude that parental influence likely has a much greater and stronger impact on student coursetaking than simply these indirect effects.

Two studies used experimental data to examine how parental influences affect advanced coursetaking. Harackiewicz, Rozek, Hulleman, and Hyde (2012) drew on the Wisconsin Study of Families and Work (WSFW), which identified pregnant women across areas of Wisconsin in 1990 and 1991 and followed their child through the finals years of high school. The sample in their experimental study included 188 students (88 girls, 100 boys), who were mostly White (90% compared to 2% African American, 1% Native American, and 7% multiracial). Students were randomly selected to receive an intervention over a 15-month period during grades 10 and 11. The intervention included: 1) a brochure titled "Making Connections: Helping Your Teen Find Value in School", which discussed the importance of math and science for various careers and guidance for parents on how to talk to their children about it; 2) a second brochure titled "Making Connections: Helping Your Teen With the Choices Ahead", which continued similar information from the prior brochure but with an added focus of the relevancy of math and science in everyday life as well as in college and career planning; and 3) having parents complete an online questionnaire evaluating a "Choices Ahead" website, which included information like interviews with current students discussing the importance of math and science courses. Parents in the control group did not receive these materials. The authors found a significant difference in the level of advanced math and science coursetaking between those in the intervention and control groups, with the former taking nearly a full semester more of mathematics and science (8.31 vs. 7.50 semesters).

Rozek et al. (2015) also used the WSFW data to examine how parents influenced their children's math coursetaking patterns in high school. Parents were randomly assigned to one of two groups. Those in the experimental group were provided information about the relevance of math and science whereas parents in the control group received no information. Students were then followed during the last two years of high school. The same 188 adolescents were included in the study mentioned above. The authors found that the intervention increased the amount of value mothers placed on STEM, which then led adolescents to believe their parents placed higher levels of value in STEM, which increased the amount of future value adolescents perceived in STEM education.

You and Sharkey (2012) examined differences by gender: For girls, the odds of taking advanced mathematics courses were positively associated with greater parental communication (1.19; effect size of 0.11) and their perceptions of their father's expectations about their educational attainment (1.12; effect size of 0.07). For boys, parents' self-reported answers about their participation in school (1.18; effect size of 0.10) and students' perceptions about their mother's expectations about their educational attainment (1.09; effect size of 0.05) were significantly correlated with advanced mathematics coursetaking. This is the first study in our sample that emphasized the importance of cross-gender relationships. Interestingly, there were no social predictors that significantly influenced both genders in coursetaking.

Mixed Findings. Using NELS, Crosnoe and Huston (2007) examined the role of parental consultation in advanced math coursetaking in high school. This regression analysis evaluated NELS data, and parental consultation in this dataset measured how frequently students consulted with their parents regarding coursetaking. The analyses suggested that, generally, students with higher levels of parental consultation completed more math credits in high school (note that the effect size was not available nor was it possible to calculate given the tables in the study). Though the coefficients were not reported, the authors noted that similar trends were observed for science coursetaking. However, with the exception of a few findings that indicated parental involvement improved student's math coursetaking, the bulk of their results indicated null findings—and even negative findings between parental consultation on student's math coursetaking. The most notable trends observed in the data were what was ineffective in encouraging math coursetaking—rather than what did work. Those that fared worse compared to their peers were students who had strong parental consultation; the authors believed overly involved parents may actually impede scholarly independence in their children and stunt motivation towards academic achievement.

Summary. Like our analysis of studies on friends' influence on coursetaking, the studies in this section lean towards the positive influence of parents' expectations and involvement on individual students' advanced math and science coursetaking. Several studies noted differences in the effect sizes by gender, but nonetheless the overall positive effects held for all students. Certainly, a concern noted by a couple of studies is that, while the outcomes are associated with higher STEM coursetaking, the effects sizes reveal that not all studies are consistently finding practical significance. Finally, one study contained null and some negative findings, indicating that overly involved parents could be detrimental to students' individual pursuit of advanced STEM coursework, drawing to attention threshold effects of how overt parental involvement may yield negative outcomes for students.

Discussion

One burgeoning area of research on the improvement of STEM outcomes looks beyond formal initiatives in order to consider the effect of informal contexts – what we have defined in this synthesis as friends and family contextual influences. A large number of studies in multiple disciplines have examined whether one particular group might have an influence on advanced STEM coursetaking. But as mentioned above, a consensus had not yet emerged. Much work is therefore needed to understand the foundational dynamics at play that might predict an early trajectory towards STEM outside of the curricular changes. Therefore, the purpose of our research was to synthesize the research on the link between social groupings and persistence into STEM courses.

As for friends, the available data point to a clear distinction between perceived peer relationships versus friend relationships, and that these two social constructs influence student behavior in different ways. Peers or classmates (those who are grouped together because of similar factors, such as age, ability, status) provide a social support structure that has less influence on math and science coursetaking patterns than friendships. However, the data supports the "friend hypothesis"—friendship relationships, as found in many of the studies, have consistently beneficial impact on students. Friends' academic attitudes, aspirations, and abilities are overwhelming positively associated with students' advanced math and science course enrollment.

These influences are also differentiated based on gender. For girls, friends' values of education and college expectations play a role in how they select and persist in advanced science and math courses, but to a lesser degree than girls' own personal attitudes towards math. The results are different for boys, as friends' values have less of an effect on boys' math coursetaking, and boys appear to be equally influenced by their friends' college expectations as they are by their own attitudes towards college in this regard. However, girls' advanced STEM coursetaking appears to be more influenced by same-sex friends and friends' grades than boys, for whom the sex composition and grades of friends matters less.

With regard to parents, our synthesis shows that a number of factors contribute to how expectations (whether perceived or real) influence math and science coursetaking for both girls and boys. Some studies indicated that parental expectations have similar effect sizes as same-sex friends' expectations, indicating that these close social contexts are both important contexts within which students make coursetaking decisions. The findings also highlight that parental involvement has a greater impact than parental expectations on math coursetaking for both gender groups. Note one study included findings of a negative association of parental consultation on student coursetaking, and this may indicate a threshold effect whereby overly involved parents may impede scholarly independence and motivation towards academic achievement.

Several studies examined differences in parental influence by gender. For girls, their mothers' perceived expectations have a greater effect on coursetaking; whereas for boys, there is evidence that shows the contribution of both the father and mother's perceived expectations carries greater weight in terms of coursetaking. When focusing on the effects of parental expectations on course enrollment, parental expectations have a larger impact on girls with respect to science courses than boys. In contrast, parental expectations affect how boys enroll in math courses to a greater degree than girls.

Implications for Policy and Practice

Looking at these findings aggregately, there are several concluding implications. First, the findings from our research have implications for schooling policy and practice. This synthesis has identified successful friend/peer and family social influences that cultivate the pursuit of advanced STEM courses. By differentiating when friends versus peers matter and when parents might exert an influence, this provides a guiding framework by which schools and districts can develop ways to capitalize on the influence of informal contexts to shape how they engage students and parents in formal learning contexts. For instance, there might be capacity for schools to build a stronger platform for which teacher professional development models can be designed and implemented to help teachers facilitate pedagogical practices that foster and nurture STEM learning behaviors as they relate to friendship effects, perhaps by instituting single-sex learning opportunities as an example. Additionally, as states and districts consider how to best train and assess new teachers, perhaps close attention ought to be paid to ensuring that rising cohorts of teachers understand and can capitalize on the benefits of the social side of schooling. Finally, friends' academic achievement seems to have a particularly important influence on advanced coursetaking; school and district administrators might further encourage mixed-ability classrooms where high-achieving students positively influence less academically engaged peers. Many current practices do not rely on such a format, but rather pinpoint and track students based on their abilities and segregate students accordingly. Hence, our study calls for a reconsideration of these policies and practices.

Second, as for parental influence, the patterns that emerged can guide ways in which schools and districts can cultivate stronger alignment between school and parents, particularly as a way to address STEM pursuits. It might also be advantageous for schools to target guidance counselors for professional development to help them incorporate strategies to engage parents in a more substantive way around science and math coursetaking for their students. As part of the professional development, teachers and guidance counselors should be provided opportunities to understand the research findings that articulate the critical role family, friends, and peers can play in student coursetaking, and to use what is known from the research to cultivate more inclusive learning environments that support all students, regardless of demographics. Additionally, intervention work has emphasized that when the link between parents and schools is strong, academic outcomes improve. Therefore, schools and districts could consider how to best allocate resources to improve this linkage when it comes to improving STEM outcomes. Programs that involve parents in STEM activities, such as robotics and science fairs or increasing parent involvement in science classes, might increase STEM participation. This might be especially poignant, when considering both parent and student gender in terms of these participation activities.

Third, the findings from our research have implications for research on broadening participation in STEM. From a policy perspective, this work aligns with the conversations that have been taking place at the national, state, and district levels around increasing the number of students who develop the interest, motivation, and academic tenacity to pursue STEM related coursework and, subsequently, STEM careers. Our synthesis can help schools understand the nuances by which students navigate through social groups and how these contexts might facilitate the advancement of STEM coursetaking, particularly outside of the traditional and formal policy levers, such as changing curriculum and altering standards. The results of this synthesis provide an impetus for districts to broaden policy beyond development of curriculum and teacher qualifications and consider which school programs might be able to capitalize on networks of friends, peers, and parents.

For example, there is growing interest for working models of networks in which districts engage parents and peers as a result of the burgeoning community-based charter school movement across the country. Networks of peers and parents might potentially be serving as the backbone of how some charter schools are able to cultivate and foster inclusive learning in ways that traditional public schools might not (Warren et al., 2009). With this concept in mind, here lies an opportunity to further study these working models to understand what aspects of these networks are transferrable to wider contexts, looking at local school districts to rethink public education as a whole. Moreover, our synthesis generally finds small effects of peer and parent influence, motivating research on what models of community-based learning might be more effective.

Fourth, another aspect of this synthesis that begs consideration is the fact that there is still much to study about the intersection of the structural and behavioral components of the public education system that either inhibit or promote successful STEM coursetaking among students, and to what degree friends, peers, and family social groups fold into and influence these dynamics. Understanding the intersectionality of the system from these perspectives will allow researchers and policymakers to pinpoint the salient factors that contribute to how students develop and sustain STEM identities, agency, and pursuit of STEM-related courses that increase the likelihood they will pursue and persist in STEM. A better holistic view of these structural and behavioral components can lead to more effective and supportive STEM learning opportunities for our most vulnerable student populations and increase their level of STEM achievement.

In sum, our work provides the field with evidence from which researchers, policymakers, and practitioners can draw upon when considering issues pertaining to STEM persistence. The contexts in which youth develop and sustain their STEM academic pursuits is a growing area of research, particularly from the standpoint of the intersection between curricular and contextual domains. More emphasis is being placed on curricular aspects of student learning that are influenced by contextual factors, and our findings will add to the tapestry of knowledge being developed and disseminated in regards to the latter. We intend for our research to provide yet another layer of evidence that will give the field a rigorous sense of what is known about the influence of social groups and what still needs to be learned.

Limitations and Future Research

There are several limitations of this study that can inform further research and additional syntheses in this area. One limitation was that the operationalization of the treatment, whether in an experimental design or otherwise, was not uniform across studies. That is, there was not necessarily a single 'treatment' effect across studies in this line of research. In particular, the definition of friends varied somewhat across studies. Only Crosnoe et al. (2008) explicitly differentiated between nominated friends and school peers – classmates with whom the subject had weaker, if any, personal relationship. Other studies that did not rely on Add Health data (where subjects named their closest friends) asked subjects their perceptions of their friend group but did not measure closeness of these social relationships. This would stand in contrast to other more clear-cut programmatic effects in education, such as the role of full-day versus part-day kindergarten attendance on child outcomes or the implementation of a new math curriculum on math achievement. Though no single strategy emerged to develop a clear-cut 'friends treatment' or 'family treatment', we nonetheless encourage future research to continue developing an agenda in this area. Findings that establish the existence of a social group effect still have implications for policy and practice, even in the absence of a singular definition of friend of family influences.

As a second limitation, we only evaluated quantitative studies given our requirement for a control group. Therefore, additional details pertaining to the mechanisms by which friends or family members influence coursetaking might have been absent without considering qualitative work. That said, relaxing the criteria to include qualitative work did not yield a sufficient enough number of studies to merit a qualitative synthesis. These studies do remain important, as they add richness to the conclusions developed in this synthesis. Perhaps this calls for additional primary research to be conducted from a qualitative perspective, such that, at a future time, a qualitative synthesis could in fact be conducted.

Third, the studies examined in this synthesis explored positive attributes of friends and families and their influence on advanced STEM coursetaking. Our inclusion criteria were set to have picked up negative influences, such as friends' delinquency, suspension, or truancy. However, no study emerged on the effects of negative influences on advanced STEM coursetaking. Therefore, while our synthesis can make conclusions about the role of positive-framed influences, such as aspirations, there is an absence in the field on the effect sizes of any detrimental-seeming influences. This perhaps sheds light on a limitation of the field, more so than a limitation of our synthesis. Nonetheless, future research might examine the role of negative influences to develop a broader portrait of social groupings from both positive and negative perspectives.

Fourth, while all of the research articles examined in this study fit the criterion of being published within the last decade, the dataset on which those articles relied were based on high school cohorts from decades prior. However, to truly conduct a longitudinal study, researchers must observe youth over time. With these parameters in mind, many of the datasets examined in the research articles in this study reflect the most recently available data to address the questions posed by the authors. Future data collection efforts might also update questions on course-taking to reflect rapidly modernizing curricula, such as specific types of computer and data science courses. The extant literature also did not distinguish AP or IB courses from advanced course-taking, and future analyses and data collection could address this to understand the implications of these curriculum programs. We feel there is still much to be gleaned from these data that are of relevance to the current policy and research dialogue on these issues, even with information on students attending high school in previous decades.

Finally, while we were able to discuss gender differences, we were not able to examine differences by race/ethnicity nor socioeconomic status. Though our criteria would have picked up studies based on these subgroups, less than a handful of studies talked about race and socioeconomic status in the context of social groups and advanced STEM coursetaking. This highlights a limitation in the field that needs to be addressed moving forward, such that researchers, policymakers, and practitioners can identify what social influences might be best suited to address the needs of all students, thereby ensuring successful persistence in STEM.

References

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. Washington, DC.

Beede, D., Julian, T., Langdon, D., McKittrick, G., Khan, B., & Doms, M. (2011). *Women in STEM: A gender gap to innovation*. Washington, DC. https://doi.org/10.2139/ssrn.1964782

Blanchard, S., & Muller, C. (2015). Gatekeepers of the American Dream: How teachers' perceptions shape the academic outcomes of immigrant and language-minority students. *Social Science Research*, *51*, 262-275. https://doi.org/10.1016/j.ssresearch.2014.10.003

Brody, L. E., & Benbow, C. P. (1990). Effects of high school coursework and time on SAT scores. *Journal of Educational Psychology*, *82*, 866–875. https://doi.org/10.1037/0022-0663.82.4.866

Burkam, D. T., & Lee, V. E. (2002). *Inequality at the starting gate: Social background differences in achievement as children begin school*. Washington, DC.

Cox, D. R. (1970). *Analysis of binary data* (2nd ed.). New York, NY: Chapman & Hall/CRC.

Crosnoe, R. (2009). Family–school connections and the transitions of low-income youths and English language learners from middle school to high school. *Developmental Psychology*, *45*, 1061–1076. https://doi.org/10.1037/a0016131

Crosnoe, R. (2011). *Fitting in, standing out: Navigating the social challenges of high school to get an education.* Cambridge, England: Cambridge University Press. https://doi.org/10.1017/CBO9780511793264

Crosnoe, R., & Huston, A. C. (2007). Socioeconomic status, schooling, and the developmental trajectories of adolescents. *Developmental Psychology*, *43*, 1097-1110. https://doi.org/10.1037/0012-1649.43.5.1097

Crosnoe, R., Riegle‐Crumb, C., Field, S., Frank, K., & Muller, C. (2008). Peer group contexts of girls' and boys' academic experiences. *Child Development*, *79*, 139-155. https://doi.org/10.1111/j.1467-8624.2007.01116.x

Dunham, C., & Frome, P. (2003). Guidance and advisement: Influences on students' motivation and course-taking choices (Research Brief). Atlanta, GA: Southern Regional Education Board.

Eccles (Parsons), J., Adler, T. F., & Kaczala, C. M. (1982). Socialization of achievement attitudes and beliefs: Parental influences. *Child Development*, 53, 322–339. https://doi.org/10.2307/1128974

Ercikan, K., McCreith, T., & Lapointe, V. (2005). Factors associated with mathematics achievement and participation in advanced mathematics courses: An examination of gender differences from an international perspective. *School Science and Mathematics*, *105*, 5–14. https://doi.org/10.1111/j.1949-8594.2005.tb18031.x

Federman, M. (2007). State graduation requirements, high school course taking, and choosing a technical college major. *The B.E. Journal of Economic Analysis & Policy*, *7*. https://doi.org/10.2202/1935-1682.1521

Ferry, T. R., Fouad, N. A., & Smith, P. L. (2000). The role of family context in a social cognitive model for career-related choice behavior: A math and science perspective. *Journal of Vocational Behavior*, *57*, 348-364. https://doi.org/10.1006/jvbe.1999.1743

Hanson, S. L., & Kraus, R. S. (1998). Women, sports, and science: Do female athletes have an advantage? *Sociology of Education, 71*, 93-110. https://doi.org/10.2307/2673243

Hanson, S. L., & Kraus, R. S. (2003). Science experiences among female athletes: Race makes a difference. *Journal of Women and Minorities in Science and Engineering*, *9*, 287-323.

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science an experimental test of a utility-value intervention. *Psychological Science*, *23*, 899-906. https://doi.org/10.1177/0956797611435530

Jacobs, J. E., & Bleeker, M. M. (2004). Girls' and boys' developing interests in math and science: Do parents matter? *New Directions for Child and Adolescent Development*, (106), 5-21. https://doi.org/10.1002/cd.113

Kelly, S. (2001). Do increased levels of parental involvement account for the social class difference in track placement? *Social Science Research*, *33*, 626–659. https://doi.org/10.1016/j.ssresearch.2003.11.002

Kindermann, T.A. (2007). Effects of naturally-existing peer groups on changes in academic engagement in a cohort of sixth graders. *Child Development*, *78*, 1186-1203. https://doi.org/10.1111/j.1467-8624.2007.01060.x

Lareau, A. (2003). *Unequal childhoods: Class, race, and family life.* Berkeley, CA: University of California Press.

Lowell, B. L., Salzman, H., Bernstein, H., & Henderson, E. (2009). Steady as she goes? Three generations of students through the science and engineering pipeline. New Brunswick, NJ: Rutgers University.

Ma, X., & Willms, J. D. (1999). Dropping out of advanced mathematics: How much do students and schools contribute to the problem? *Educational Evaluation and Policy Analysis*, *21*, 365-383. https://doi.org/10.3102/01623737021004365

Melguizo, T., & Wolniak, G. C. (2011). The earnings benefits of majoring in STEM fields among high achieving minority students. *Research in Higher Education*, *53*, 383–405. https://doi.org/10.1007/s11162-011-9238-z

Milner, M. (2006). *Freaks, geeks, and cool kids: American teenagers, schools, and the culture of consumption.* New York, NY: Routledge.

Muller, C., & Ellison, C. G. (2001). Religious involvement, social capital, and adolescents' academic progress: Evidence from the National Education Longitudinal Study of 1988. *Sociological Focus*, *34*, 155-183. https://doi.org/10.1080/00380237.2001.10571189National Science Board. (2010). Science and Engineering Indicators 2010 (NSB 10–01). National Science Foundation. Arlington, VA: Retrieved from http://www.nsf.gov/statistics/seind10/pdf/seind10.pdf

National Science Foundation. (2011). *Women, minorities, and persons with disabilities in science and engineering: 2011 (NSF 11-309).* Arlington, VA.

Nicholls, G. M., Wolfe, H., Besterfield-Sacre, M., Shuman, L. J., & Larpkiattaworn, S. (2007). A method for identifying variables for predicting STEM enrollment. *Journal of Engineering Education,* 96, 33-44. https://doi.org/10.1002/j.2168-9830.2007.tb00913.x

Olitsky, N. H. (2013). How do academic achievement and gender affect the earnings of STEM majors? A propensity score matching approach. *Research in Higher Education*, *55*, 245–271. https://doi.org/10.1007/s11162-013-9310-y

Ozturk, M. A., & Singh, K. (2006). Direct and indirect effects of socioeconomic status and previous mathematics achievement on high school advanced mathematics course taking. *The Mathematics Educator*, *16*, 25-34.

Pearson, J., Crissey, S. R., & Riegle-Crumb, C. (2009). Gendered fields: Sports and advanced course taking in high school. *Sex Roles*, *61*, 519-535. https://doi.org/10.1007/s11199-009-9647-z

President's Council of Advisors on Science and Technology (PCAST). (2010). Prepare and inspire: K–12 education in Science, Technology, Engineering, and Math (STEM) for America's future. Washington, DC: Retrieved from http://www.whitehouse.gov/administration/eop/ostp/pcast/docsreports

Pryor, J. H., Hurtado, S., DeAngelo, L., Blake, L. P., & Tran, S. (2009). *The American freshman: National norms for fall 2009, expanded edition.* Los Angeles, CA.

Riegle-Crumb, C. (2006). The path through math: Course sequences and academic performance at the intersection of race-ethnicity and gender. *American Journal of Education*, *113*, 101–122. https://doi.org/10.1086/506495

Riegle-Crumb, C., Farkas, G., & Muller, C. (2006). The role of gender and friendship in advanced course taking. *Sociology of Education*, *79*, 206-228. https://doi.org/10.1177/003804070607900302

Riegle-Crumb, C., & Moore, C. (2014). The gender gap in high school physics: Considering the context of local communities. *Social Science Quarterly*, *95*, 253-268. https://doi.org/10.1111/ssqu.12022

Rozek, C. S., Hyde, J. S., Svoboda, R. C., Hulleman, C. S., & Harackiewicz, J. M. (2015). Gender differences in the effects of a utility-value intervention to help parents motivate adolescents in mathematics and science. *Journal of Educational Psychology*, *107*, 195–206. https://doi.org/10.1037/a0036981

Sciarra, D. (2010). Predictive factors in intensive math course-taking in high school. *Professional School Counseling*, *13*, 196-207. https://doi.org/10.5330/PSC.n.2010-13.196

Schneider, B., Swanson, C. B., & Riegle-Crumb, C. (1997). Opportunities for learning: Course sequences and positional advantages. *Social Psychology of Education*, *2*, 25–53. https://doi.org/10.1023/A:1009601517753

Stevenson, H.J. 2014. "Myths and Motives behind STEM (Science, Technology, Engineering, and Mathematics) Education and the STEM-Worker Shortage Narrative." *Issues in Teacher Education* 23(1): 133-146.

Tenenbaum, H. R., & Leaper, C. (2003). Parent-child conversations about science: The socialization of gender inequities? *Developmental Psychology*, *39*, 34. https://doi.org/10.1037/0012-1649.39.1.34

Trusty, J. (2002). Effects of high school course-taking and other variables on choice of science and mathematics college majors. *Journal of Counseling & Development*, *80*, 464–474. https://doi.org/10.1002/j.1556-6678.2002.tb00213.x

U.S. Department of Education. (2002). *Dear colleague letter to education officials regarding implentation of No Child Left Behind.* Washington, DC. Retrieved from http://www2.ed.gov/policy/elsec/guid/secletter/020724.html

U.S. Department of Education. (2010). *Science, technology, engineering, and math: Education for global leadership*. Washington, DC. Retrieved from http://www.ed.gov/sites/default/files/stem-overview.pdf

U.S. Department of Education, N. C. for E. S. (2003). *The Condition of Education 2003*. Washington, DC. Retrieved from http://nces.ed.gov/pubs2003/2003067.pdf

Valadez, J. R. (2002). The influence of social capital on mathematics course selection by Latino high school students. *Hispanic Journal of Behavioral Sciences*, *24*, 319-339. https://doi.org/10.1177/0739986302024003004

Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal*, *50*, 1081–1121. https://doi.org/10.3102/0002831213488622

Warren, M. R., Hong, S., Rubin, C. L., & Uy, P. S. (2009). Beyond the bake sale: A community-based relational approach to parent engagement in schools. *Teachers college record*, *111*(9), 2209-2254.

Wentzel, K. R., & Caldwell, K. (1997). Friendships, peer acceptance, and group membership: Relations to academic achievement in middle school. *Child Development*, *68*, 1198–1209. https://doi.org/10.2307/1132301

Wentzel, K. R., McNamara Barry, C., & Caldwell, K. A. (2004). Friendships in middle school: Influences on motivation and school adjustment. *Journal of Educational Psychology*, *96*, 195–203. https://doi.org/10.1037/0022-0663.96.2.195

Wimberly, G. L., & Noeth, R. J. (2005). *College readiness begins in middle school.* ACT Policy Report. Retrieved from http://files.eric.ed.gov/fulltext/ED483849.pdf

Wood, B. S., & Brown, L. A. (1997). Participation in an all-female algebra I class: Effects on high school math and science course selection. *Journal of Women and Minorities in Science and Engineering*, *3*, 265-277. https://doi.org/10.1615/JWomenMinorScienEng.v3.i4.40

You, S., & Sharkey, J. D. (2012). Advanced mathematics course-taking: A focus on gender equifinality. *Learning and Individual Differences*, *22*, 484-448. https://doi.org/10.1016/j.lindif.2012.03.005

Appendix

Table 1
Summary of Friends' Influence Studies

Author	Year	Data	Sample	Method	Peer Influence Measure	Coursetaking Measure	Outcomes
Crosnoe, Riegle-Crumb, Field, Frank, & Muller	2008	Add Health; AHAA	6,457	Regression analysis	Academic achievement of friends and coursemates	Highest level of math taken	0.13-0.16 SD for girls; 0.18-.22 SD for boys
Ercikan, McCreith & Lapointe	2005	TIMSS	13,530	Discriminant function analysis	Friends' educational expectations	Algebra II, Geometry, Trigonometry, Calculus	Correlation of 0.54 for girls; 0.62 for boys*
Muller & Ellison	2001	NELS	Not provided	OLS regression analysis	Friends' educational values	Algebra II, Geometry, Trigonometry, or Calculus	.02 SD
Ozturk & Singh	2006	NELS	1,699	SEM	Friends' aspirations	Algebra II, Geometry, Trigonometry, or Calculus	10% of indirect effects*
Riegle-Crumb, Farkas, & Muller	2006	Add Health; AHAA	2,573	Logistic regression analysis	Friends' academic performance	Pre-calculus and Calculus; Physics	0.88 to 0.91 SD for girls; non-significant for boys
You & Sharkey	2012	ELS	15,518	Multiple-group logistic regression	Friend educational values	Trigonometry, Algebra II, Pre-calculus, or Calculus	0.09 SD for girls; non-significant for boys

Note. * effect sizes could not be calculated with the provided information.

Table 2
Summary of Family Influence Studies

Author	Year	Data	Sample	Method	Parent Influence Measure	Coursetaking Measure	Outcomes
Crosnoe & Huston	2007	NELS	10,601	Regression analysis	Parental consultation	Math and science credits earned by the end of high school	Coefficients of -0.10 - -0.26*
Ercikan, McCreith & Lapointe	2005	TIMSS	13,530	Discriminant function analysis	Parents' expectations; home support for learning	Algebra II, Geometry, Trigonometry, Calculus	Correlation of 0.52 for girls and 0.53 for boys*
Harackiewicz, Rozek, Hulleman, & Hyde	2012	WSFW	188	Regression analysis	Intervention (parents' awareness of the importance of math/science)	Algebra II, Trigonometry, Precalculus, Calculus, Statistics, Chemistry, Physics	Increase of 1 full semester of math/science*
Muller & Ellison	2001	NELS	Not provided	Regression analysis	Parents' expectations on educational attainment, talking with parents about school activities and class content, parents knowing child's friends' parents	Algebra II, Geometry, Trigonometry, or Calculus	0.02 to 0.06 SD
Ozturk & Singh	2006	NELS	1,699	SEM	Parental involvement	Algebra II, Geometry, Trigonometry, and Calculus	Parental involvement mediates between SES on advanced math coursetaking, accounting for 36%*

Riegle-Crumb, Farkas, & Muller	2006	Add Health; AHAA	2,573	Logistic regression analysis	Parental expectations	Precalculus and Calculus; Physics	0.88 SD for girls; 0.33 SD for boys
Rozek, Hyde, Svoboda, Hulleman, & Harackiewicz	2015	WSFW	188	Regression and structural equation modeling	Intervention (parents' awareness of the importance of math/science)	Number of semesters of math and science coursework in grade 12	Mother's STEM utility value is associated with a direct effect ($\beta=0.29$) as well as an indirect effect (via adolescent's perception of parent's utility value; $\beta=0.37$) on adolescent's STEM utility value. The adolescent's STEM utility value is associated with a 0.22 increase in 12^{th} grade STEM coursetaking
Sciarra	2010	ELS	11,909	Logistic regression analysis	Parental expectations	Algebra II or higher	0.24 SD
Valadez	2002	NELS	11,787	Logistic regression analysis	Parental involvement	Math coursetaking	0.02-0.04 SD
You & Sharkey	2012	ELS	15,518	Multiple-group logistic regression	Parental involvement	Trigonometry, Algebra II, Precalculus, or Calculus	0.07-0.11 SD for girls; 0.05-0.10 SD for boys

Note. * effect sizes could not be calculated with the provided information.

About the Authors

Michael Gottfried
University of California, Santa Barbara
mgottfried@education.ucsb.edu
Michael Gottfried is an Associate Professor in the Gevirtz Graduate School of Education at the University of California Santa Barbara. His research focuses on the economics of education and education policy.

Ann Owens
University of Southern California
annowens@usc.edu
Ann Owens is Assistant Professor of Sociology at the University of Southern California. Her research focuses on contextual inequalities in children's neighborhoods and schools.

Darryl N. Williams
Tufts University
Darryl.Williams@tufts.edu
Darryl Williams is Associate Dean for Undergraduate Education for Tufts School of Engineering. His research focuses on understanding how learning environments influence STEM pursuit and persistence.

Hui Yon Kim
University of California, Santa Barbara
hkim@education.ucsb.edu
Hui Kim is a PhD. Candidate in Education, with a concentration in Quantitative Methods and Education Policy. Her research interests include early education, teacher quality, and social equity.

Michela Musto
University of Southern California
mmusto@usc.edu
Michela is a Ph.D. Candidate in sociology and gender studies at the University of Southern California. Her research interests include gender, education, families, children & youth, and social stratification.

education policy analysis archives

Volume 25 Number 62 June 12, 2017 ISSN 1068-2341