

EDUCATION

Interest in STEM is contagious for students in biology, chemistry, and physics classes

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We report on a study of the effect of peers' interest in high school biology, chemistry, and physics classes on students' STEM (science, technology, engineering, and mathematics)-related career intentions and course achievement. We define an interest quorum as a science class where students perceive a high level of interest for the subject matter from their classmates. We hypothesized that students who experience such an interest quorum are more likely to choose STEM careers. Using data from a national survey study of students' experiences in high school science, we compared the effect of five levels of peer interest reported in biology, chemistry, and physics courses on students' STEM career intentions. The results support our hypothesis, showing a strong, positive effect of an interest quorum even after controlling for differences between students that pose competing hypotheses such as previous STEM career interest, academic achievement, family support for mathematics and science, and gender. Smaller positive effects of interest quorums were observed for course performance in some cases, with no detrimental effects observed across the study. Last, significant effects persisted even after controlling for differences in teaching quality. This work emphasizes the likely importance of interest quorums for creating classroom environments that increase students' intentions toward STEM careers while enhancing or maintaining course performance.

INTRODUCTION

In the past several years, there has been considerable national attention given to increasing the talent pool in STEM (science, technology, engineering, and mathematics) to address the growing concerns of sustainability, maintaining America's competitiveness in the global economy, and ensuring access to highly-paid, highly-rewarding fields for all students (1, 2). Recent studies indicate that many capable high school students are opting out of STEM careers in favor of other preferences and that the underrepresentation of women and marginalized racial/ethnic groups in STEM jobs is still a major concern (3, 4). One report also estimates that STEM jobs will grow as a fraction of the labor market and that these jobs will increasingly require bachelor's degrees in STEM (3). Thus, there continues to be a need to attract greater numbers of students to STEM careers to ensure economic and social equity as well as to maximize the potential for STEM innovation. This study focuses on how classroom peers can affect these choices for students, including those students who were not previously interested in STEM.

The focus on classroom environments is particularly important given the shifting emphasis on reform-based active learning in undergraduate STEM courses. Although strong evidence exists for the advantage of these learning environments for student performance (5), there is little understanding of how classrooms that incorporate active learning affect STEM career intentions for general populations of students. Some might assume that with higher performance levels, increases in career interest will automatically follow, but this is not necessarily the case. For example, active learning in introductory physics courses has been found to show larger performance gains than traditional lecture courses but also larger drops in attitudes/interest (6). In addition, being able to perform well in

courses does not necessarily equate to interest in the subject matter or vice versa, particularly for underrepresented groups in STEM (7–10). This fact warrants focused research on how features of classroom environments influence the development of STEM interests, because all students need to have “widespread opportunity to engage in authentic, inspiring STEM learning” (4).

STEM educators are often concerned that they only reach the few select students who they interact with individually and do not reach most of the students in their classes. A promising feature of active learning environments is that they can promote a more communal approach to learning, where students no longer need to rely solely on their instructor but can rely on each other, at least in part, to motivate and facilitate learning. Although there has been research on the effect of a few peers (for example, group/team members) on students' educational outcomes (11, 12), the collective effect of peers in science classroom environments has largely been unstudied using quantitative methods. However, qualitative research has demonstrated the ways in which peers in a classroom setting can facilitate or inhibit students' identifying with science (13–15). Furthermore, identifying with science is highly predictive of science career intentions (16, 17). “The practices of the science classroom or the peer culture as informed by dominant norms and routines position youth in particular ways” that have implications for their choice of STEM (15). Other research has shown that presenting oneself to others as identifying with science can be “othering,” making one feel different from one's peer group (18).

Here, we hypothesized that students who perceive a high level of interest among their peers in science classes will be more likely to intend on pursuing STEM careers. Similar to quorum sensing in biological systems, in which individual organisms respond to stimulus from the entire population (based on threshold density levels) (19, 20), we posited an analogical system in which students respond to high levels of emotion among others by coordinating their emotions in response. This transfer of emotion has been referred to as emotional contagion; humans have been found to “readily ‘catch’ the emotions of others” (21). However, we do not treat emotional contagion as if it is binary, that is, there are different degrees to which emotion can be communicated that are dependent on the context and other variables in the system.

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Work on emotional contagion has examined how emotions are transferred between people, with a focus on the process by which this happens. For example, individuals mimic the expressions and actions of others (for example, smile when others smile), which produces feedback on their own emotional state and results in a contagion of emotion (21). Although the evidence for emotional contagion has appeared in psychology, neuroscience, sociology, and history, it has not been widely applied to classroom contexts within STEM education. One study examined interaction rituals in a science class, which were characterized by a synchrony among participants, including mutual focus and coordinated utterances, gestures, gaze direction, and movements (22). These interaction rituals led to higher levels of positive emotional response and engagement within the group. However, it is unclear how this heightened emotion within a class might affect future outcomes such as career choices. Our study offers evidence in this regard.

Focusing on emotional contagion between adolescents may be particularly important because both neurological and social research point to adolescent development being more susceptible to peer influence (23–25). However, much of the work on peer contagion in children and adolescents has focused on negative effects, such as aggressive and antisocial behaviors as well as depressive emotions (26). Also emerging from this work is the importance of perceiving a consensus among peers, even when this perception may be false (27). A review of the influence of peers on students' educational outcomes points to the importance of group consensus: "Collectively, the theory and evidence point toward a new theory—group-based contagion—in which students benefit from advantaged peers mainly when those peers are in the same group" (28). Here, we examine how perceptions about peers' science interest within science classes are related to students' intention for pursuing a STEM career. The focus on perceptions of students' peer groups within classes has implications for understanding classroom environments and the effect of emotional contagion on a potentially positive outcome—STEM career intentions.

Our study surveyed a nationally representative population of college students, including those who were interested in STEM and those who were not. We collected data from students in mandatory introductory English courses at 50 randomly selected colleges and universities across the United States. The survey asked participants to report their likelihood of pursuing a STEM career as well as demographic, background, and academic information. In addition, participants reported how interested their peers were in the content/topics during their last high school biology, chemistry, and physics courses. We defined high levels of reported interest as an interest quorum, an analogy to a density level of peers with an interest (stimulus). We hypothesized that individuals who experienced an interest quorum in their biology, chemistry, or physics classes would be more likely to choose a STEM career or a career in the discipline in which they experienced the quorum. However, there were several competing hypotheses that needed to be accounted for. In addition, we accounted for the effect of teaching quality. We considered the possibility that rather than being a function of the level of interest among classmates, classes with a high level of interest had higher achieving, more interested students to begin with. To address these alternate hypotheses, we accounted for academic achievement, family support for science and mathematics, and previous STEM career interests in middle school and high school as covariates. The analysis also accounted for gender, because previous work has shown that female students are less interested in the physical sciences (17) and two of the subjects included in this study are physical sciences (chemistry and physics). In addition, we accounted for the effect of teaching quality. However, we maintained

our hypothesis that peer interest quorums in science classes have a positive effect on STEM and discipline-specific career intentions even after accounting for these covariates. Finally, we also tested the effect of interest quorums on course performance in the associated discipline.

RESULTS

Effect of interest quorums on STEM career intentions

We first tested whether the interest quorum groups (five levels of interest perceived among peers from not interested to very interested: groups 0, 1, 2, 3, and 4) across all three subjects were significantly different in their STEM career intentions (Fig. 1, no covariates). As hypothesized, there was a significant difference between the interest quorum groups on their STEM career intentions [analysis of variance (ANOVA), $F_{4,2087} = 28.2, P < 0.0001$]. Tukey post hoc tests (table S1) indicated that the highest interest quorum condition (group 4—other students "very interested") was significantly higher than all the other quorum conditions (groups 0, 1, 2, and 3; $P < 0.0001$). The second highest interest quorum condition (group 3) also exhibited significantly higher likelihood of pursuing a STEM career than the two lowest conditions (groups 0 and 1; $P < 0.0001$ and $P < 0.05$, respectively). The middle interest quorum condition (group 2) was significantly higher than the lowest (group 0; $P < 0.0001$). The two lowest interest quorum conditions (groups 0 and 1) were also significantly different from each other ($P < 0.05$). The only nonsignificant differences were between adjacent groups in the middle interest quorum range, that is, groups 1 and 2 ($P = 0.78$) and groups 2 and 3 ($P = 0.20$).

Effect sizes for the difference between groups were also calculated (table S1). A large effect size (mean difference, 34; Cohen's $d = 0.98$) was observed for the difference between the highest (group 4) and the lowest (group 0) interest quorum condition. Other large effect sizes were observed for differences between groups 4 and 1, groups 3 and 0, and groups 2 and 0 (mean differences, 21 to 24; Cohen's $d = 0.58$ to 0.66). Medium effect sizes were observed for differences between groups 4 and 1, groups 3 and 0, and groups 2 and 0 (mean differences, 13 to 16; Cohen's $d = 0.39$ to 0.47).

Accounting for differences between students as alternative hypotheses

To assess whether the differences observed for the interest quorum groups were a result of preexisting differences between the groups (for example, students' interests in STEM careers before taking these science classes), we tested several covariates. These covariates accounted for competing hypotheses; for example, one hypothesis is that students who were already interested in STEM careers perceive a greater interest quorum. The covariates include gender, academic achievement, family support for mathematics and science, and previous interests in a STEM career during middle school and high school (see the Supplementary Materials for details). With all covariates included, there was still a significant difference between the interest quorum groups [analysis of covariance (ANCOVA), $F_{4,1988} = 14.6, P < 0.0001$] (Table 1). In particular, Tukey post hoc tests (table S1) revealed significant differences between group 4 and all the other groups, group 3 and group 0, and group 2 and group 0 ($P < 0.0001$ to 0.05) (Fig. 1).

Effect sizes for the difference between groups were again calculated (table S1). With covariates included, a large effect size was still observed for the difference between the highest (group 4) and the lowest (group 0) groups (mean difference, 23; Cohen's $d = 0.66$). Medium effect sizes were observed for differences between groups 4 and 1, groups 3 and 0,

and groups 2 and 0 (mean differences, 13 to 16; Cohen's $d = 0.39$ to 0.47). Small effect sizes were observed for differences between groups 4 and 3 and groups 4 and 2 (mean differences, 7; Cohen's $d = 0.22$ and 0.20). Figure 2 plots the effect sizes as a function of the gap between

the groups (that is, groups 1 and 2 have a gap of 1, whereas groups 1 and 3 have a gap of 2), both with and without covariates included. There is a clear positive trend even after accounting for covariates. Finally, we tested interaction effects between quorum conditions and covariates and found no significant interactions.

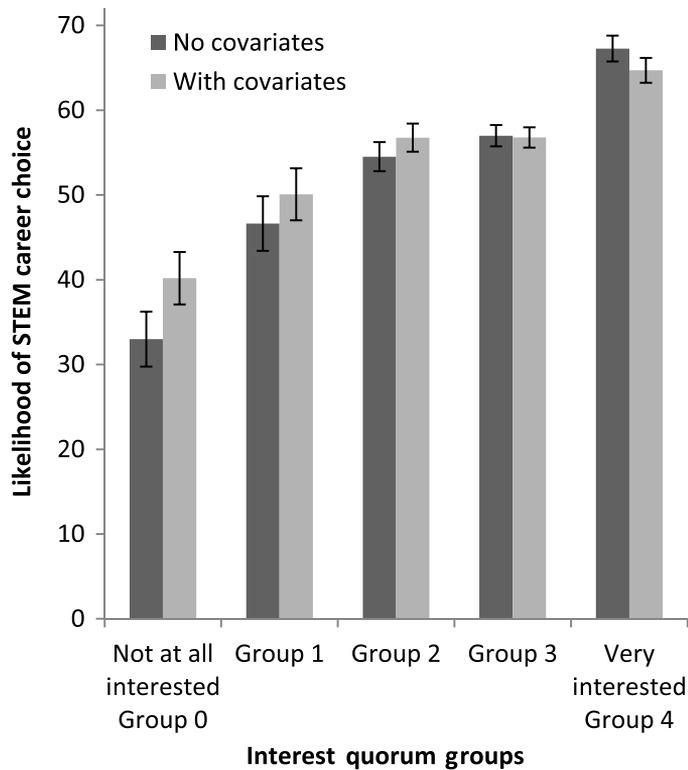


Fig. 1. Comparing interest quorum groups on STEM career choice. Student-reported likelihood of choosing a STEM career as a function of the highest interest quorum experienced in students' last high school biology, chemistry, or physics class [from most students "Not at all interested" (group 0) to "Very interested" (group 4)]. Dark bars represent means without covariates, and light bars represent means after controlling for covariates including gender, academic achievement, family support for science and mathematics, and previous STEM career interests in middle school and high school. Error bars represent ± 1 SE.

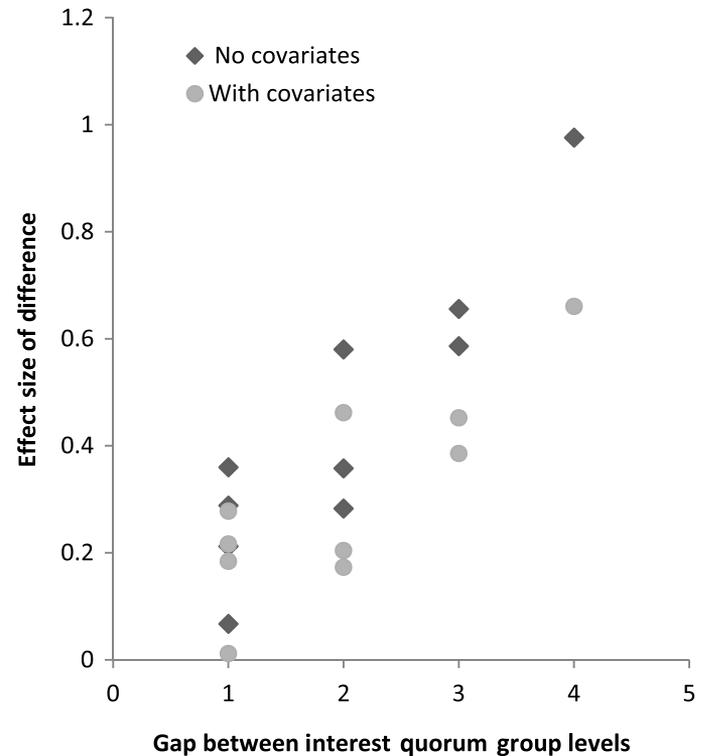


Fig. 2. Effect sizes for group-level difference on STEM career choice. Effect size (Cohen's d) of differences between interest quorum groups as a function of the gap between group levels (that is, groups 1 and 2 have a gap of 1, whereas groups 1 and 3 have a gap of 2), both with no covariates and with covariates of gender, academic achievement, family support for science and mathematics, and previous STEM career interests in middle school and high school.

Table 1. ANCOVA results for STEM career choice. Comparing interest quorum groups on STEM career intentions with multiple covariates included.

	df	F	P
Gender	1	50.2	<0.0001
Academic achievement index	1	52.6	<0.0001
Family's interest in science—a diversion or hobby	1	32.5	<0.0001
Family's interest in science—a way for me to have a better career	1	104.2	<0.0001
Family's interest in math—a diversion or hobby	1	39.7	<0.0001
Family's interest in math—a way for me to have a better career	1	41.0	<0.0001
STEM career interest in middle school	1	34.2	<0.0001
STEM career interest at the beginning of high school	1	44.7	<0.0001
Interest quorum groups	4	14.6	<0.0001

Effect of interest quorums on disciplinary career intentions and course performance

We tested the effect of discipline-specific interest quorums (biology, chemistry, and physics) on students' intentions to pursue a career in that discipline and included all significant covariates. For all subject areas, we see a significant main effect of discipline-specific interest quorums on career intentions in the associated discipline (biology, $F_{4,2176} = 30.2$, $P < 0.0001$; chemistry, $F_{4,2162} = 29.6$, $P < 0.0001$; physics, $F_{4,2141} = 19.9$, $P < 0.0001$) (table S2). In all subject areas, Tukey post hoc tests (table S3) showed significant differences between group 4 and all the other groups as well as groups that were separated by more than one level (groups 3 and 0, groups 2 and 0, and groups 3 and 1) ($P < 0.0001$ to 0.01) (Fig. 3). The largest effect sizes were again observed between the extreme groups (0 and 4) and were 0.73, 0.76, and 0.62 for biology, chemistry, and physics, respectively (table S3).

Finally, we tested the effect of discipline-specific interest quorums on an alternative outcome important in education: course performance [on a grade point average (GPA) scale]. Significant covariates across all three subject areas were included: in this case, academic achievement and previous interest in a STEM career in middle school. For example, STEM career interest in high school was not included because it was not significant in the biology, chemistry, and physics models when STEM career interest in middle school was in the model. For all subject areas, there is a significant main effect of discipline-

specific interest quorums on performance in the associated discipline (biology, $F_{4,1917} = 3.5$, $P < 0.01$; chemistry, $F_{4,1882} = 7.3$, $P < 0.0001$; physics, $F_{4,1856} = 6.7$, $P < 0.0001$) (tables S4 and S5). For biology, groups 4 and 3 have significantly higher grades than group 0 ($P < 0.01$ and $P < 0.05$, respectively) (Fig. 4). For chemistry, groups 2, 3, and 4 all have significantly higher grades than group 0 ($P < 0.0001$ to 0.05). Group 3 also has higher grades than group 1 in chemistry ($P < 0.05$). For physics, group 4 has significantly higher grades than groups 0, 1, and 2 ($P < 0.0001$ to 0.05). Finally, group 3 has higher physics grades than group 1 ($P < 0.05$). The effect sizes for significant differences range from 0.22 to 0.40, with the largest being 0.30, 0.39, and 0.40 for biology, chemistry, and physics, respectively (table S5).

Accounting for difference in teaching quality as alternative hypothesis

In addition to differences between students' previous achievement, family support, and interest, other alternative hypotheses come from differences between the classes themselves. For example, one could argue that interest quorums are indicative of the quality of the teaching and that it is this quality that is beneficial to interest and performance rather than the presence of interest quorums. Thus, teaching quality was included as an additional covariate. For all subject areas, we still see a significant main effect of discipline-specific interest quorums on career intentions in the associated discipline (biology, $F_{4,2097} = 22.5$, $P < 0.0001$;

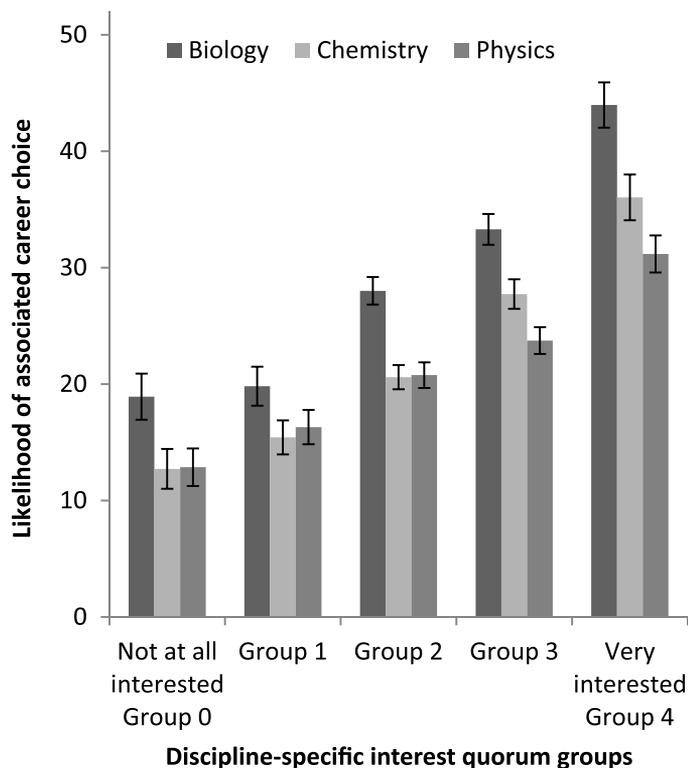


Fig. 3. Comparing discipline interest quorum groups on disciplinary career choice. Student-reported likelihood of choosing a biology, chemistry, or physics career as a function of the interest quorum experienced in biology, chemistry, or physics class, respectively [from most students "Not at all interested" (group 0) to "Very interested" (group 4)]. Covariates included gender, academic achievement, family support for science and mathematics, and previous STEM career interests in middle school and high school. Error bars represent ± 1 SE.

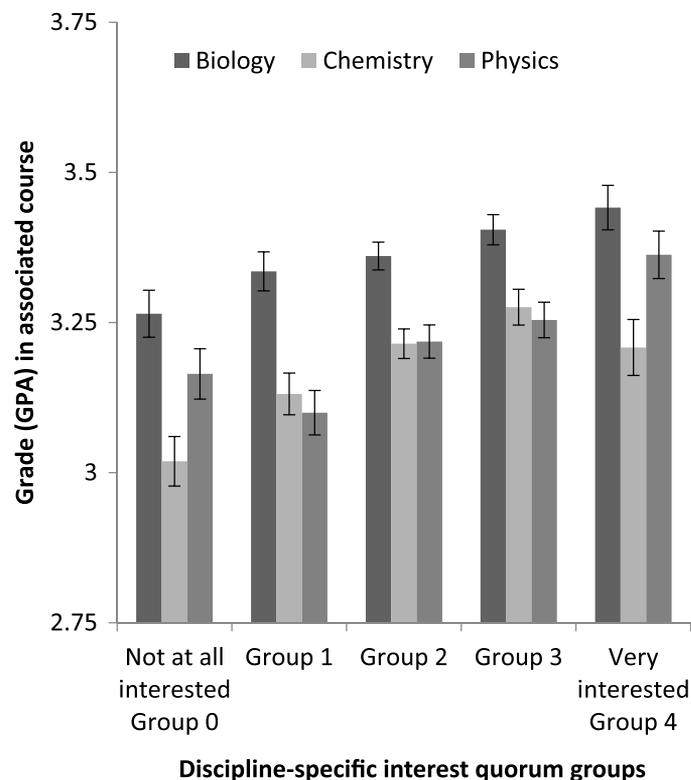


Fig. 4. Comparing discipline interest quorum groups on course performance. Student grades in biology, chemistry, or physics course (on GPA scale) as a function of the interest quorum experienced in biology, chemistry, or physics, respectively [from most students "Not at all interested" (group 0) to "Very interested" (group 4)]. Covariates included academic achievement and previous STEM career interests in middle school. Error bars represent ± 1 SE.

chemistry, $F_{4,2078} = 22.9, P < 0.0001$; physics, $F_{4,2048} = 17.3, P < 0.0001$) (table S6). The effect sizes range from 0.22 to 0.58 (table S7). For course performance, a significant main effect for interest quorums in chemistry and physics remains (chemistry, $F_{4,1810} = 2.4, P < 0.05$; physics, $F_{4,1789} = 3.8, P < 0.01$), but the effect in biology is no longer significant (table S8). Significant effect sizes in chemistry and physics range from 0.20 to 0.40 (table S9).

DISCUSSION

There has been much recent emphasis on increasing the number of STEM graduates and the importance of college classroom environments (for example, active learning) on promoting student achievement in courses to allow students to persist and succeed in STEM. However, most students in college have already decided on their career paths (29). Thus, efforts at this stage are often focused on retention of students. There is another aspect that we consider in this work—that of enhancing students' interests in STEM careers before college, which has been identified as a problem (8, 10, 30). In particular, we focused on the effect of peers within classroom environments at the high school level, a time point when most students make decisions about which college majors they are willing to consider as well as careers associated to these choices (9).

Our findings indicate that experiencing even one science course, in which students perceive a quorum of interest among their peers, can have a large and significant relationship with their STEM career choices. In particular, students who perceive a majority quorum of interested peers in a science course are nearly an SD higher in their intention to pursue a career in STEM than those who perceive little interest among classmates. Our analysis further reveals that the effect of interest quorums is robust even after controlling for competing hypotheses, such as students' previous career interests in STEM in middle school and high school, as well as gender, academic achievement, and family support for mathematics and science. In examining discipline-specific effects, the results generalize to all three science disciplines considered (biology, chemistry, and physics) with similar effect sizes, that is, an interest quorum among classmates in a particular science course has a significant relationship with career intention toward that particular discipline. Whereas the effect is consistent across disciplines, it is not necessarily uniform. Finally, we also examined how perceived interest quorums relate to students' grades in the associated courses and found a significant effect, although the effect sizes were smaller by about a half in comparison to the career intention outcomes.

This work has empirically shown the relationship between interest quorums and educational outcomes in science courses. Furthermore, it highlights that interest quorums are important for both attitudes and achievement. Why are these significant findings? First, they stress the importance of motivation, a construct that is often disregarded in STEM education research as less robust than a focus on achievement and conceptual outcomes. However, creating motivating classroom environments has implications for both cognitive and affective outcomes, including how students engage in learning and what they aspire to in the future. How scientists are motivated during their schooling years has been shown to be predictive of future productivity outcomes, such as publications and grants (31).

Second, motivation and attitudes have been a concern for some active learning environments that have depressed students' attitudes toward learning a subject (6, 7), because the topics can become more cognitively and conceptually challenging. The new challenges posed

to students in these environments require appropriate emotional scaffolding to allow students to maintain or improve their attitudes and confidence to accomplish challenges and persist in learning. Establishing quorums of students who are interested and mobilized toward learning the content may help to achieve this scaffolding, that is, by facilitating the creation of communities of interested learners that attract others into the fold. Building on previous work, these findings further highlight the importance of peer communities for students' engagement in STEM, an area that has been underemphasized in comparison to STEM learning and performance outcomes but is equally important for persistence (32, 33).

Finally, the results advance research on emotional contagion among students by focusing on positive emotions rather than the negative emotions usually studied (for example, those related to problem behaviors) (26). Furthermore, this work considers multiple levels for the peer quorum variable similar to a perceived "density" of interest. The results show that higher perceived levels of interest correspond to increases in STEM career intentions. Given the national push to attract and retain more individuals in STEM careers, it is critical that we understand the features of educational environments that facilitate recruitment and persistence, particularly for students not previously interested in STEM or at risk of dropping out (1, 4). Moving forward, more research on how these environments are created within active learning classrooms is needed. The notion of creating interest quorums is a powerful one to further scientific understanding—from historic examples such as Plato's Academy to the modern conception of vibrant academic research groups who push the bounds of known science through common research interests.

Although the detailed structure of classroom experiences that create interest quorums goes beyond the findings of this paper, the importance of these quorums is highlighted. Although previous work is limited in this area, the findings of one qualitative study point to the likely importance of certain classroom conditions, such as creating mutual focus, using familiar symbols and activity structures, allowing some side talk, and providing opportunities for physical and emotional synchronization (22). Furthermore, it may be important to provide more opportunities for students to express their interests and motivations so as to build pathways for emotional contagion to spread. Future research in this area should investigate the mechanisms by which interest is transmitted among peers and, particularly, what curricular and pedagogical choices made by teachers will allow this transmission. It would also be informative to understand curricular and pedagogical effects that are unique to each discipline because different content requires different strategies to motivate students.

A limitation of this work is the inability to examine in vivo effects within classrooms, to see how emotional contagion is communicated, and to directly observe student responses before and after instruction. This would be an extremely challenging task, given the need for significant variance at the classroom level (so as to distinguish between different practices and clustering by classroom), but would significantly advance this discussion. Thus, future work needs to test the effect of interest quorums at the classroom level to better understand classroom-level effects (for example, pedagogical practices and consistency of detection of interest quorums from the same classes) and use controlled experimental designs. The retrospective self-reported nature of our data limits our ability to draw more nuanced and definitive conclusions. Furthermore, we do not have data to indicate the long-term impacts of interest quorums on persistence in college; it would be valuable to know if these experiences have a lasting impact on students' persistence and retention in STEM.

MATERIALS AND METHODS**Experimental design**

Our study surveyed a nationally representative population of college students in mandatory introductory English courses at 50 colleges and universities across the United States. We briefly describe the participants, procedures, measures, and statistical analysis used in this study. Additional details are provided in the Supplementary Materials. This study followed Institutional Review Board guidelines for research with human subjects.

Participants

The 50 institutions were randomly drawn from a national sample of colleges and universities stratified by type (2- and 4-year) and size (small, medium, and large—three bins with equivalent total student enrollment). Because all 50 institutions that were recruited responded, the institutional response rate was 100%. Surveying mandatory English courses enabled us to capture responses from a general population of college students who had experienced high school science courses and were from a range of majors, including STEM and non-STEM. Responses were collected from 6772 students. Participants were asked about experiences in their last high school biology, chemistry, and physics courses. The 2092 respondents who reported taking these three classes, STEM career interests, and interest quorums were included in the overall STEM analysis.

Survey design

We designed the survey instrument to collect information on the following: students' backgrounds; pedagogical, curricular, and co-curricular experiences in high school science; classroom achievement; and attitudes toward STEM. The survey includes 47 questions with primarily Likert, Likert-type, multiple choice, and categorical responses. A copy of the complete survey is available at <https://stem.fiu.edu/sage/sage.pdf>. Validity and reliability of the survey instrument were established in several ways, including feedback from subject area and education experts, focus groups with students, pilot testing for variability and internal consistency, and a test-retest reliability study.

Measures

For the career intention outcome measures, participants responded to the "likelihood of your choosing a career in the following" (scale "Not at all likely 0" to "Extremely likely 4") given a list of the STEM disciplines. Their maximum response for any of the STEM disciplines scaled out of 100 was used as the outcome variable of STEM career intention. The mean value of the variable is 57 (SD, 37). For responses to the disciplinary career intention items for biology, chemistry, and physics, the means were 28 (SD, 35), 22 (SD, 31), and 20 (SD, 29), respectively. Participants also provided their final grade (scale "A⁺," "A," "A⁻," to "F") in their high school biology, chemistry, and physics courses. These variables were scaled to the standard four-point GPA scale. The means for biology, chemistry, and physics grades were 3.5 (SD, 0.7), 3.3 (SD, 0.8), and 3.3 (SD, 0.8), respectively.

The covariates that accounted for differences between students included gender, academic achievement, family support for science and mathematics, and STEM career interests in middle school and high school. Details and descriptive statistics for the covariates are summarized in the Supplementary Materials. The covariate for teaching quality combined seven items rating teaching for each course (biology, chemistry, and physics) on multiple characteristics (for example, clearly explaining ideas, explaining ideas in several ways, and ability to organize lessons/activities) on a scale from 0 (low) to 6 (high).

For the interest quorums, the survey asked students to report how interested their classmates were in the content/topics in each of their last high school biology, chemistry, and physics courses on anchored five-point scales from "Not at all interested" to "Very interested." Because we were focused on the highest level of peer group interest that students experienced in a science class (interest quorum), students were grouped by the maximum value of their response to these items. To be conservative, we treated this variable as a grouping or ordinal variable. This resulted in five interest quorum groups: groups 0 (No interest), 1, 2, 3, and 4 (High interest). Most of the students experienced their highest level of interest quorum in a single class (51%), whereas the remaining experienced it in multiple classes (18% in two classes and 31% in all three classes). Although we considered weighting based on the number of classes in which they perceived a high level of interest from peers, this weighting had no significant impact on the results. Thus, our initial analysis focused on the highest level of interest perceived in any of their science classes. For disciplinary interest quorums, we used responses to the separate questions for biology, chemistry, and physics.

Statistical analysis

Interest quorum groups were compared on the likelihood of students pursuing a STEM career using ANOVA. An ANCOVA analysis was performed to account for covariates reflecting differences between students. Additional ANCOVA analyses examined the disciplinary effect of interest quorums in biology, chemistry, and physics courses on intentions to pursue biology, chemistry, and physics careers, respectively, as well as grades in the respective courses. These analyses included covariates accounting for differences between students. The final analyses included the covariate for teaching quality. For each analysis, post hoc Tukey tests revealed which interest quorum groups differed significantly, and effect sizes for these differences are reported.

SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at <http://advances.sciencemag.org/cgi/content/full/3/8/e1700046/DC1>

Supplementary Materials and Methods

fig. S1. Home zip codes of student respondents.

fig. S2. Box plot of STEM career choice by interest quorum groups.

table S1. ANCOVA post hoc tests for STEM career choice.

table S2. ANCOVA results for disciplinary career choice (with student covariates).

table S3. ANCOVA post hoc tests for disciplinary career choice (with student covariates).

table S4. ANCOVA results for course performance (with student covariates).

table S5. ANCOVA post hoc tests for course performance (with student covariates).

table S6. ANCOVA results for disciplinary career choice (with student and teaching covariates).

table S7. ANCOVA post hoc tests for disciplinary career choice (with student and teaching covariates).

table S8. ANCOVA results for course performance (with student and teaching covariates).

table S9. ANCOVA post hoc tests for course performance (with student and teaching covariates).

table S10. Description of sample.

table S11. Interest quorum group frequencies.

table S12. Maximum interest quorum frequency.

table S13. Student differences covariates frequencies/descriptive statistics.

table S14. Disciplinary teacher quality covariate descriptive statistics.

References (34–37)

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