"Gunning" for the Win! How Competitive Classroom Environments and Student Experiences Predict Pre-Meds' Commitment to Health Research and Practice

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Increasing the number of physicians, especially from underrepresented racial minority (URM) groups, is critical for decreasing health care disparities and improving our nation's health (Association of American Medical Colleges [AAMC], 2005; Bergen, Jr., 2000; Council on Graduate Medical Education [COGME], 2005; Smedley, Butler, & Bristow, 2004). Despite representing over 25% of the U.S. population, URMs (e.g., African Americans, Latinos, and American Indians) account for less than 10% of the physician workforce (COGME, 2005). In order to address the racial disparities in medical school matriculation and degree attainment rates, the COGME (2010) has called upon institutions to implement educational environments that promote the success of premedical and medical students. Achieving greater diversity among medical professionals requires an understanding of the premedical experience and context, especially in introductory STEM classrooms, as these courses present significant barriers for URM persistence in premedical studies (Barr, Gonzalez, & Wanat, 2008).

The fierce competition for premedical students begins early in college as grading structures in introductory STEM courses assume that not all students are capable of succeeding (Baldwin, 2009). Supporters of this sifting mechanism argue that competition can create healthy learning environments, as students are forced to take courses seriously and perform at a higher level (Woo, 2010), and that gatekeeper courses are necessary in order to "weed out" students who are weak in or are not committed to the sciences (Barr, 2010). Critics, however, argue that the ultra-competitive premedical environment may produce high rates of depression found among premedical students (Fang, Young, Golshan, Fellows, Moutier, & Zisook, 2010), may drive many students to perform unethical behaviors (Fred, 2008), and is inconsistent with the patient-centered philosophy of medical care (Woo, 2010). Many scholars question whether premedical education is truly distinguishing the "wheat from the chaff" (De Vries & Gross, 2009), as success in these gatekeeping courses does not predict success as a physician, yet these courses push out many promising students who would otherwise make outstanding medical care professionals (Barr, 2010).

Introductory STEM courses' diversion of premedical talent presents a troubling dilemma given that premedical students typically have the strongest pre-college academic credentials, especially in STEM subjects (Antony,1998a; Larson, Bonitz, Werbel, Wu, & Mills, 2011). Larson et al., 2011 found that premedical students demonstrated higher levels of self-efficacy, interest, and goals in STEM fields than non-premedical students, which may be reflective of having greater exposure to premedical experiences due to higher parental income (O'Connell & Gupta, 2006). According to Antony (1996), three reasons why students initially aspire to become physicians include (1) strong academic abilities, coupled with an interest in science, (2) altruistic motivations, manifested through a desire to help and serve others, and (3) attraction to the money and status associated with being a doctor.

Often missing in the discussion of the nature of premedical education is empirical evidence documenting how ultra-competitive learning environments in introductory STEM classrooms may influence diverse premedical students' interest in the medical field. Given the importance of students' early premedical experiences on their pursuit of medical careers (Gonzalez, Barr, & Wanat, 2010; Lent, Brown, & Hackett, 1994; 2000), this study examines how competitive and collaborative learning environments in introductory STEM classrooms influence premedical students' interest in the health profession. Specifically, this study addresses the following research question: Controlling for students' prior academic preparation and co-curricular experiences, how do premedical students' experiences in introductory STEM courses, the learning environments in these courses, and the pedagogies students encounter predict the development of their commitment to health research and practice?

The Plight of Premedical Students

The undergraduate premedical experience is not just a means to enter medical school but is also a process that shapes students' character (De Vries & Gross, 2009). The current selection process upheld by medical school admissions committees has largely identified those "most highly qualified" to study medicine as those who demonstrate scholastic aptitude in the sciences and academic success in STEM courses, with substantially less emphasis placed on their personality and character strengths (Barr, 2010). Nearly all entering medical students are required to complete some sort of premedical curriculum consisting of gateway calculus, physics, biology, and chemistry courses, and students' grades in these courses are heavily weighed in the medical school application process (Barr, 2010). Thus, in hopes of maximizing their chances of medical school acceptance, premedical students must intensely compete for higher college GPAs (Coombs & Paulson, 1990; Gross, Mommaers, Earl, & De Vries, 2008), often "concentrate on science with a fury" (Thomas, 1978, p. 1181), and, in turn, have often been categorized as "gunners" (Woo, 2010), or excessively hard-working, competitive, grade-conscious, and less sociable than others (Hackman, Low-Beer, Wugmeiter, Wilhelm & Rosenbaum, 1979). Not surprisingly, premedical students describe their premedical years as more of a competition than a journey of self-discovery (De Vries & Gross, 2009).

Many premedical students have to navigate a hypercompetitive educational environment that is incongruent with a profession grounded on serving others in need of care. The AAMC Medical School Objectives Writing Group (MSOWG) identified attributes that all medical students should develop before becoming a physician, including: altruism, where practitioners are trustworthy; compassion; empathy in caring for patients; and a sense of duty, where physicians feel obliged to collaborate with other health professionals for providing the best possible care for individuals and populations (MSOWG, 1999). Yet medical schools require premedical students to complete a series of STEM courses, namely calculus, organic chemistry, and physics that are designed to “weed out” students (Emanuel, 2006), even though success in STEM premedical coursework is not predictive of success in the latter years of medical school and as a practicing physician (Barr, 2010). Grade normalization policies, or grading on a “curve” (which are instrumental in the weeding out process of STEM fields) are known to create and exacerbate a competitive atmosphere in classrooms (Fines, 1997).

Thus, to demonstrate their dedication to saving lives and providing patients with humanistic medical service, premedical students must first objectify their classmates in competitive “weeder” courses as opponents and exercise behaviors that may skew the competition in their favor (e.g., not sharing notes, cheating on exams, etc.) (see Fines, 1997). For example, premedical students often describe being unwilling to help fellow premedical peers with questions and ceasing to provide information about important opportunities such as internships (Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012). The underlying values of this undergraduate premedical structure may not only undermine the goals of the medical profession but may also influence many students, regardless of whether they are high-achieving, to leave premedical studies. Previous research in this area has focused on curricular reform (e.g., Barr, 2010; Emanuel, 2006) and the holistic review selection process of medical schools (e.g., Cantwell, Gonzalez Canche, Milem, & Sutton, 2010).

Similar to the competitive environment, teaching strategies in college STEM courses also have a critical influence in developing students' interest in STEM fields. Generally, STEM faculty rarely utilize learning theory or research on cognitive science to guide their teaching and are often reluctant to utilize active learning strategies (National Research Council, 2003; Wood, 2003). Most introductory STEM courses are large, lecture-based classes that encourage passive learning and have been linked to the high attrition rates in STEM fields (Seymour & Hewitt, 1997). Specifically, scholars have criticized STEM instructors' limited use of illustrations to clarify scientific concepts and processes (Seymour & Hewitt, 1997), scant discussion of the applications of abstract scientific concepts to real life and the implications of the material covered in class (Bok, 2006; Seymour & Hewitt, 1997), use of "cookbook problem solving" exercises in undergraduate STEM courses (Bok, 2006, p. 261), and the ineffectual use of instructional technology.

The use of new innovative instructional techniques and models has expanded recently, and these strategies demonstrate mixed signs of success in engaging students. These active learning strategies include personal student response systems ("clickers), hands-on and collaborative group projects and presentations, interactive peer-led team learning, and case studies or problem-based learning (Allen & Tanner, 2005; Baldwin, 2009; Brainard, 2007; Gasiewski, et al. 2012). Interestingly, Gasiewski et al. (2012) found that, in general, premedical students tended to prefer STEM courses that were lecture-based given the amount of content to be learned. However, lecture-based courses disregard individual learning styles. Understanding how teaching practices in STEM courses impact premedical students' interest in the health profession is critical to adequately address the objectives of a diverse physician workforce.

This study seeks to build on prior examinations of premedical students' experiences in introductory STEM courses by examining how both classroom climates and faculty pedagogical strategies in introductory STEM courses can predict premedical students' commitment to health research and practice. To better understand how learning experiences and classroom contexts influence premedical students' commitment to their intended profession, we utilize Lent et al.'s (1994, 2000) Social Cognitive Career Theory (SCCT).

Occupational Choice: Social Cognitive Career Theory

The career choice and development process involves numerous factors that influence individuals' occupational pursuits. Social Cognitive Career Theory (Lent et al., 1994, 2000) emphasizes the importance of the interrelation between other person, contextual, and experiential/learning factors with self-efficacy, outcome expectations, and personal goals in an individual's career choice. Although the purpose of this study is not to empirically test the SCCT, this framework provides a useful model to help understand how individual characteristics and classroom contexts may influence premedical students' interests in a medical career.

The SCCT proposes that background characteristics, such as predispositions, race/ethnicity, and gender influence an individual's learning experiences, which ultimately impact students' career-related choice behavior by affecting both their self-efficacy and outcome expectations. Students who have medical career aspirations upon entry into college tend to possess investigative, social/altruistic, and artistic personality types (Antony, 1998a), yet must endure an undergraduate curriculum of introductory math and science courses that tend to reward competition (Baldwin, 2009). The majority of attrition in the sciences occurs during the first two years of college during which students must complete numerous introductory STEM courses (Chang, Cerna, Han, & Saenz, 2008; Seymour & Hewitt, 1997). The competitive atmosphere in these courses is unwelcoming and may influence many potential STEM students to perceive themselves as not belonging in STEM fields (Baldwin, 2009; Seymour & Hewitt, 1997).

Proponents of the “gatekeeping” model of undergraduate STEM education argue that it is an important and necessary practice to discourage students who are “unfit,” or unsuccessful in the sciences, to change their academic major and to select only students who demonstrate a strong commitment to the discipline and profession. However, competitive classroom environments may disadvantage some students, may reproduce stratified and unequal social relations, and de-emphasize an equality of learning environments (Fines, 1997). Proponents of the gatekeeping modeling assume that premedical students’ educational experience in introductory STEM courses does not have a negative effect on their interest in the health profession. As Fines (1997) notes, “A student’s ability to learn is likely to be hampered if an educational environment is at odds with that student’s basic values” (p. 904).

In SCCT, the concept of values is incorporated through an individual’s outcome expectations (Lent, et al., 1994). The relative importance of those positive anticipated outcomes of a medical career (e.g., status, money, helping and serving others) may decline for those students who do not thrive in or value a hyper-competitive learning environment. These students may associate the competitive learning environment to the medical profession and may not only reduce their interest in medical careers but in STEM professions overall. Findings by Antony (1998a) lend support to this considerable loss of STEM talent as roughly 65% of premedical students abandoned their medical career aspirations by their senior year of college. Moreover, while those with investigative, social, and altruistic personality types maintained their medical career aspirations into their senior year, premedical students with artistic personality types did not significantly maintain their initial medical career aspirations, (Antony, 1998a), suggesting a differential impact of the premedical experience on particular students.

Competitive learning environments may also have differential effects by gender and race (Seymour, 1995; Seymour & Hewitt, 1997). According to SCCT, one's occupational interests are reflective of one's self-efficacy beliefs, which results from the relationship between students' social identities (i.e., race/ethnicity, gender) and learning experiences (Lent, et al., 1994). Thus, lower self-efficacy among premedical students likely diminishes their occupational interests in medicine. Past research has found men to be less troubled than women by the fiercely competitive atmosphere of science and math classes and that the competitive climates of STEM disciplines represent a fundamental reason for the high attrition rates among female STEM students (Manis, Thomas, Sloat, & Davis, 1989; Strenta, Elliot, Adair, Matier, & Scott, 1993).

Conversely, Seymour (1995) found that concerns about competition has a greater impact on male rather than female students who leave STEM majors, which is partially attributed to males' lower likelihood to establish peer groups for collective study and mutual support. Seymour (1995) states that, "the tendency to work collaboratively, offer[s] women a buffer against the negative impact of the weed-out experience" (p. 447). Being forced to become more competitive and individualistic through competitive educational environments may present a significant barrier for many students, as they are pressured to act in ways contrary to their esteemed cultural values.

The characteristics needed for success in a predominantly white, male-dominated competitive science setting tend to match Whiteness and maleness; thus, women and students of color are disadvantaged even if they don't experience explicit prejudice or discrimination (Johnson, 2007). By not acknowledging the cultural differences of their students, instructors who value individualism or competition may perceive their students' actions as lacking industry or self-motivation and thus may undermine these students' achievement (Snipes, 1997), as recognition from meaningful others is significant to developing strong science identities (Carlone & Johnson, 2007; Martin, 2007). Therefore, a competitive classroom functions under a set of values, orientations, and expectations that largely reflects the cultural norms of Anglo-Americans and may be at odds with students from ethnic groups who tend to have more cooperative cultural norms (Snipes, 1997).

Method

Data and Sample

The data for this study come from a longitudinal study of students in introductory STEM courses. In the spring of 2010, we administered pre- and post-surveys to undergraduate students enrolled in more than 70 introductory STEM courses. We administered the pre-survey at the beginning of the academic term, and students completed the post-survey at the end of the academic term. These surveys collected information on students' background characteristics, pre-college experiences and academic preparation, educational and career aspirations, experiences in their introductory STEM courses, and perceptions of the professors teaching these courses. Additionally, we administered a survey to faculty who teach these courses, which asked faculty to report on their perceptions of and goals for undergraduate students, the instructional strategies they used in their introductory STEM courses, and their opinions about institutional priorities. We administered these surveys to students and faculty on 15 campuses, and these campuses differed by institutional control, Carnegie classification, minority-serving status, and selectivity. For a more complete description of the surveys, see Gasiewski et al. (2012).

A total of 3,205 students across 76 classrooms completed both surveys and had faculty data, and these responses translated to a 42.6% response rate. Given the focus of the present study, we limited the sample to only those students who indicated on the pre-survey that they intended to pursue a medical degree, which included M.D., D.D.O., D.O.O., and D.V.M. Restricting the sample to only include premedical students reduced our final analytic sample to 1,218 students across 65 classrooms.

Variables

We used principal axis factoring with promax rotation to derive our outcome of interest: premedical students' commitment to health research and practice. Table 1 presents the factor loadings for the three items comprising this construct: the personal importance students placed on making a theoretical contribution to science, improving the health of all communities, improving the health of minority communities, and working to find a cure for a health problem. The Cronbach's alpha for both the outcome (0.75) and direct pretest (0.72) for students' commitment to health research and practice exceeds the recommended minimum threshold of 0.70 (Pedhazur & Schmelkin, 1991).

The model included a number of predictor variables. We accounted for students' background characteristics by controlling for gender, race (URM compared to White or Asian American), and parental income, as SCCT (Lent et al., 1994) suggests including these "person inputs" in models predicting individuals' choice goals. Likewise, we included composite SAT scores as a measure of pre-college academic performance. We also included indicators of students' participation in pre-college STEM programs and research programs as measures of pre-college preparation. We added the factor of acting like a scientist as a measure of students' propensity to engage in scientific activities, and we created this factor through principal axis factoring with promax rotation. The factor loadings and Cronbach's alpha appear in Table 1. The appendix provides a complete list of all variables and their coding schemes.

A primary focus of SCCT is individuals' self-efficacy as it relates to career interests and goals, and the model included six separate measures of self-efficacy (Lent et al., 19944). We considered students' self-rated communication skills, initiative-taking, ability to overcome hardship, and competitiveness. Given the negative association between competitive STEM classroom environments and students' interest and persistence in STEM (Seymour & Hewitt, 1997), these measures of self-efficacy represent characteristics of students' agency that may assist them in overcoming many of the challenges in their introductory STEM courses and in maintaining their commitment to health research and practice.

The next set of variables tested in the model focused on students' experiences in their introductory STEM courses. These measures included students' reports of professors' reliance on lecture, perceptions of their professors, behaviors in class, and overall sense of collaboration and competition among their peers. Specifically, we controlled for students' perceptions that the professor made the class difficult enough to be stimulating and encouraged collaboration among students. The model also examined the relationship between asking questions in class and students' commitment to health research and practice. Additionally, we examined students' perceptions of being respected by their peers, the extent to which the course emphasized applying concepts to practical problems and new situations, and the extent to which students received feedback that helped them to learn and improve. We also accounted for several co-curricular experiences: time spent preparing for exams; time spent participating in supplemental instruction; attending review or help sessions; discussing grades with the instructor; changing study habits due to poor performance; and time spent working with other students to prepare assignments or projects. These items collectively represent students' early learning experiences, which SCCT suggests influences their outcome expectations, career interests, and choice goals (Lent et al., 1994).

The last set of variables represented the classroom context and instructional strategies students encountered in their introductory STEM courses, as Lent et al. (1994) recommend examining contextual measures that may influence individuals' choice goals. Specifically, we considered the extent to which professors had students solve real-world, complex problems. Additionally, we included measures of the extent to which professors graded on a curve and the average sense of collaboration and competition among students in each introductory STEM course. These three measures represent the competitive and collaborative climates students experienced in their introductory STEM courses. Additionally, the model included a variable representing faculty's perception that there is no such thing as a question that is too elementary in this classroom, as prior research has found that faculty who perpetuate such an environment increase students' engagement in introductory STEM classrooms (Gasiewski et al., 2012).

Analyses

Before beginning our multivariate analyses, we examined our variables for missing data. All variables had fewer than 5% of cases with missing values, and SAT composite scores had the highest percentage of cases with missing data at 4.5%. We used the expectation maximization (EM) algorithm to impute values for cases with missing data on continuous variables, excluding the dependent variable and its pretest (McLachlan & Krishnan, 1997). Using maximum likelihood techniques, the EM algorithm provides a more robust method than mean replacement or listwise deletion for handling missing data when the proportions of cases with missing data are small (McLachlan & Krishnan, 1997). One limitation of the EM algorithm is that it provides just one imputation for missing data, and more recent work suggests that missing values may represent a source of variance, which means that multiple imputation offers even more precise estimates (Sinharay, Stern, & Russell, 2001).

After addressing cases with missing data and examining descriptive statistics, we proceeded with our multivariate analyses. Given the clustered nature of the data, with students nested within classrooms, we analyzed our data using hierarchical linear modeling (HLM). HLM accounts for the homogeneity of errors within groups and helps researchers to avoid making a Type I statistical error by falsely concluding the significance of a parameter (Raudenbush & Bryk, 2002). Furthermore, HLM avoids violating the assumption of independence of observations by partitioning the variance at each level of the data (i.e., student and classroom).

When using HLM, researchers should have both a conceptual and statistical justification. The intra-class correlation coefficient (ICC) can provide a statistical justification, as the ICC represents the proportion of variance in the outcome attributable to between-group differences. The ICC for students' commitment to health research and practice at the end of the academic term was 0.03, which indicated that 3% of the variance in the outcome was due to differences across classrooms. Although that ICC was lower than Raudenbush and Bryk's (2002) recommended threshold of 10%, we decided to proceed with the use of HLM analyses given the significant, albeit limited, variation in the outcome across classrooms. Furthermore, given the assumptions of SCCT and the role that context has on influencing individuals' goal choices (Lent et al., 1994), we had a strong conceptual justification for relying on HLM techniques.

Limitations

Several limitations should be considered before presenting the results of the analyses. Although our data represent students across 60 classrooms and 15 institutions, the generalizability of the findings beyond these classrooms and campuses may be limited. Additionally, the short timeframe of the study – one academic term – may have limited the extent to which students changed in their commitment to health research and practice. Had we tracked students over a longer period of time, changes in this commitment may have been more substantial. We did not provide a full, explicit test of SCCT; instead, we relied on the assumptions of SCCT to examine how classroom contexts and experiences in introductory STEM courses shape students' commitment to health research and practice at the end of the academic term. Finally, although our survey included a number of questions about students' experiences inside the classroom as well as their co-curricular experiences, we did not capture the full picture of students' activities during the academic term; thus, our model likely excluded a number of other activities in which students engaged outside the classroom and in other courses that may have influenced changes in their commitment to health research and practice.

Findings

Table 2 presents the results of the descriptive analyses for variables included in the study. The results show that 61% of our sample was female and just 22% of students identified as an underrepresented racial minority (i.e., Black, Latino, or Native American). Premedical students in this study had high SAT composite scores (mean = 1270.75). Additionally, respondents came from relatively affluent families with mean incomes between $60,000 and $100,000. Faculty in the sample reported rarely grading on a curve, as the average introductory STEM course instructor in our sample reported grading on a curve, on average, just slightly more than once. On average, students in the introductory STEM courses experienced competition (mean = 2.82) and collaboration (mean = 2.90) "sometimes" among their peers.

We present the results of the HLM analyses in Table 3. The model accounted for 42% of the variance in the outcome occurring at the student level and 82% of the variance in the outcome attributed to differences across classrooms. Overall, the model explained 44% of the variance in students' commitment to health research and practice.

Several classroom variables had a significant association with the outcome. Students in classrooms where faculty had students spend more time solving real-world, complex problems finished the academic term with significantly weaker commitments to health research and practice. By contrast, faculty members' perception that no question is too elementary had a significant association, positive with the outcome. Students enrolled in courses where faculty felt more strongly that all types of questions were welcomed ended the course with significantly stronger commitments to health research and practice. The findings indicate that the extent to which professors graded on a curve had no significant association with students' commitment to health research and practice. Likewise, the average sense of competition and collaboration among students in the classroom did not significantly relate to the outcome.

Among the student-level variables, we found that none of the background characteristics significantly predicted premedical students' end-of-course commitment to health research and practice. Only one pre-college variable had a significant association with the outcome. Students who participated in a pre-college research program reported significantly stronger commitments to health research and practice by the end of the spring 2010 academic term. SAT composite scores had no relationship with the outcome, which may be related to the restricted variance of this variable, as the premedical students in the sample were tightly clustered near the high end of the range of SAT scores.

Results in Table 3 show that students who conceived of themselves as resilient by reporting a higher self-rated ability to overcome hardship had a stronger commitment to health research and practice at the end of the academic term. In testing for cross-level interactions, we found that the effect of this variable varied significantly across classrooms. Premedical students in a more collaborative classroom environment benefited even more from their resiliency, as indicated by the significant, positive relationship between the moderating variable of average sense of collaboration among students and the outcome. We found no other significant associations between the self-efficacy variables and the outcome.

Turning to students' experiences in their introductory STEM courses, we found that students who reported that their professors made the course difficult enough to be stimulating developed a greater commitment to health research and practice by the end of the term. This effect varied significantly across classrooms, and the results show the relationship between being intellectually stimulated and one's commitment to health research and practice was strengthened when students were enrolled in classrooms where faculty more frequently graded on a curve. Additionally, students who felt more respected by their peers reported being significantly more committed to health research and practice. Applying concepts to new situations in class also had a significant, positive association with the outcome. Similar to the aggregated variables of competition and collaboration, the individual measures of students' sense of collaboration and competition had no significant association with their end-of-course commitment to health research and practice; however, students who perceived that their professors more frequently encouraged collaboration among students reported a significantly stronger commitment to health research and practice.

The results in Table 3 show that just two co-curricular experiences had a significant association with the outcome. Students who spent more time preparing for exams ended their introductory STEM courses with a stronger commitment to health research and practice. By contrast, students who more frequently discussed grades with their introductory STEM course professors had significantly lower scores on their commitment to health research and practice. The model detected no significant association between participating in supplemental instruction or review sessions and the outcome.

Discussion

The results from the analyses suggest that the introductory STEM classroom environment has a very limited influence on students' commitment to health research and practice at the end of the academic term. The collective sense of competition among students did not significantly relate to their interests in health research and practice. Gasiewski et al. (2012) found that premedical students significantly influenced the culture of the class by increasing the level of competition that students experienced; thus, it may be the case that premedical students, on average, are not affected by such an environment given their role in perpetuating this climate. By contrast, as Gasiewski et al. (2012) and Seymour and Hewitt (1997) suggest, this competitive atmosphere may have more serious consequences for STEM students who do not conceive of themselves as premed. Similarly, the collective sense of collaboration in the classroom had no bearing on students' end-of-course commitment to health research and practice. Gasiewski et al. (2012) suggest that the individualistic mentality of premedical students make them more engaged in class and less interested in working with other students; likewise, non-premedical students in the study by Gasiewski et al. (2012) reported being unwilling to work with premedical students on assignments. Given these findings, it is not surprising that premedical students appear somewhat immune to the collective sense of collaboration among students in introductory STEM classrooms.

Regarding the classroom environment, we found that premedical students in classrooms where faculty encouraged solving real-world, complex problems tended to end the course with significantly lower scores on their commitment to health research and practice. This finding also connects to work by Gasiewski et al. (2012), as the authors reported that premedical students preferred their introductory STEM course professors to use lecture rather than more engaging pedagogies given the amount of material these introductory courses covered. We did not, however, find a significant association between the extent to which faculty lectured and students' commitment to health research and practice.

Classrooms where faculty encouraged questions by exhibiting an attitude that no question would be considered too elementary fostered stronger commitments to health research and practice among premedical students. Such an environment encourages interaction between students and faculty and helps to address potential misconceptions that students may form regarding course content. Such an environment also signals that the instructor cares about students' learning, and students tend to respond favorably to such cues (Hurtado, Eagan, Tran, Newman, Chang, Velasco, 2011; Gasiewski et al., 2012).

In addition to the classroom context, several student experiences significantly related to premedical students' commitment to health research and practice. Exposure to research prior to college significantly strengthened students' commitment to health research and practice, and this finding connects to SCCT in that early learning experiences and predispositions significantly influence individuals' career goals and interests later in life (Lent et al., 1994). Previous research has linked early exposure to research and stronger STEM identities (Eagan, Hurtado, Garibay, & Herrera, 2012).

Students' self-rated ability to overcome hardships appears to provide them with agency to overcome some of the challenges associated with introductory STEM courses. Respondents who conceived of themselves as having more strength by rating themselves higher on their ability to overcome hardship ended the academic term with a significantly stronger commitment to health research and practice, and being in a more collaborative classroom environment strengthened this relationship.

Premedical students increased their commitment to health research and practice when their professors provided intellectual stimulation, and this effect was even stronger in courses where faculty more frequently graded on a curve. Given premedical students' higher levels of academic engagement (Gasiewski et al., 2012) and desire to master content in preparation for future coursework in STEM and medical school matriculation (Gross et al., 2008; Woo, 2010), they seem to welcome academic challenge. Encountering more frequent grading on a curve may present an additional contest for them to compete against their peers. However, such a highly competitive atmosphere may be detrimental to premed students' health (see Fang et al., 2010) and may not serve all students. Although we did not detect significant differences in commitment to health research and practice across race or gender, faculty must remain cognizant of the types of learners who benefit from and are discouraged by such grading practices (Snipes, 1997).

Students who felt respected by their peers and had professors who more frequently encouraged collaboration among students ended the academic term with a stronger commitment to health research and practice. These findings speak to the positive benefits of having healthy relationships with classmates, as working with rather than competing against peers predicted higher scores on students' career interests. These relationships may have particular benefits to premedical students, especially women and underrepresented racial minorities, who do not subscribe to the culture of competition and who instead value working with classmates to master course content (Johnson, 2007; Seymour, 1995).

Conclusion

Although our findings did not show a direct link between competitive introductory STEM classroom environments and students' commitment to health research and practice, the results indicate that providing students with more opportunities for collaboration may enhance their interest in and commitment to the medical profession. When students felt respected by peers or received encouragement from faculty to work with their classmates, they strengthened their commitment to health research and practice. These experiences not only may increase students' commitment to health research and practice but also are consistent with the goals of the medical profession. Being capable of working with and developing respectful relationships with colleagues represents a set of important qualities for aspiring medical students, as these characteristics correspond more closely with providing holistic patient care than do ones of competition and objectifying colleagues as opponents (MSOWG, 1999). Indeed, one of the items in the outcome corresponded to an individual's goal to work to find a cure for a health problem. Such endeavors are typically undertaken through teamwork and collaboration, and emphasizing these attributes early in premedical students' undergraduate education can only serve them well as they matriculate into and through medical school.

Additionally, the combination of developing students' perceived strength in their ability to overcome adversity and collaborative classroom climates is critical to enhancing students' interest in the health profession. The higher a student's perceived strength in their ability to overcome hardships the greater (more positive) the effect of a more collaborative classroom environment on the student's commitment to health research and practice. One way to increase students' self-perceived strength and resilience may be to encourage them to develop collaborative relationships with peers, as these connections may form a network of support to help students overcome challenges they encounter in STEM courses, later in their undergraduate experience, and in medical school. In collaborative spaces, students learn to transition from an individualistic mentality to one that relies on and values the support of a collective community. Although individualistic students may be just as resilient as their peers, our findings suggest that encountering more collaborative rather than competitive environments strengthens the relationship between students' strength self-efficacy and premedical students' career goals and interests.

In conclusion, given that the undergraduate premedical experience is a process that shapes premedical students' character (De Vries & Gross, 2009), it is important to implement environments and practices that not only strengthen students' interests in the medical profession, but also are in line with the goals of the medical field. While a professor's use of grading on a curve has a greater (more positive) effect on students' commitment to health research and practice for those students who felt the professor made the course difficult enough to be stimulating, competitive learning environments can impede the development of interpersonal communication skills and decrease the development of empathy and altruism (Fines, 1997). By implementing learning environments that encourage more collaboration among students in introductory STEM courses faculty may increase premed students' interests in pursuing a medical degree while maintaining an environment that is consistent with the patient-centered philosophy of medical care and the collaborative context of scientific research. Fostering cooperative work early in the premedical experience can go a long way in decreasing health disparities and improving our nation's health by developing premedical students' skills (i.e., interpersonal communication) and attributes that are conducive to being a more effective physician and/or medical researcher.

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Appendix
Table of Measures

Variable Name	Coding
Dependent Variable	
Commitment to health research and practice posttest	Continuous
Classroom and Faculty Characteristics	
Structure: Frequency that professor had students solve real-world, complex problems	1=not at all to 3=to a great extent
Frequency: Professor graded on a curve	1=none to 7=6 or more times
Professor perception: There is no such thing as a question that is too elementary in my classroom	1=disagree strongly to 4=agree strongly
Professor perception: There is not enough time to give individual attention to each student	1=disagree strongly to 4=agree strongly
Average sense of competition in class	Continuous, aggregated from student-level data
Average sense of collaboration in class	Continuous, aggregated from student-level data
Pretest	
Commitment to health research and practice pretest	Continuous
Background Characteristics and Pre-College Preparation	
Underrepresented racial minority student	0=no, 1=yes
Sex: Female	0=male, 1=female
Parental income	1=less than $20,000 to 8=more than $200,000
Participated in a math, science, or engineering pre-college program	0=no, 1=yes
Participated in a pre-college research program	0=no, 1=yes
Acting like a scientist (pre-survey)	Continuous
SAT Composite (100)	Continuous

Measures of Self-Efficacy (Pre-Survey)	
Self-rated communication skills	1=lowest 10% to 5=highest 10%
Self-rated initiative taking	1=lowest 10% to 5=highest 10%
Self-rated ability to overcome hardship	1=lowest 10% to 5=highest 10%
Self-rated competitiveness	1=lowest 10% to 5=highest 10%
Classroom Experiences	
Professor evaluation: Made the course difficult enough to be stimulating	1=strongly disagree to 4=strongly agree
Professor evaluation: Encouraged collaboration among students	1=strongly disagree to 4=strongly agree
Class activity: Asked questions in class	1=never to 5=very often
Sense of competition in class	1=never to 5=very often
Sense of collaboration in class	1=never to 5=very often
Perception: I was accepted and respected by my peers	1=strongly disagree to 4=strongly agree
Perception: The course emphasized applying concepts to practical problems	1=strongly disagree to 4=strongly agree
Perception: The course emphasized applying concepts to new situations	1=strongly disagree to 4=strongly agree
Perception: I received feedback that helped me to learn and improve	1=strongly disagree to 4=strongly agree
Co-Curricular Experiences	
Time spent preparing for exams	1=0 hours to 13=more than 10 hours
Time spent participating in supplemental instruction	1=0 hours to 13=more than 10 hours
Had to change study habits in the middle of the term due to poor performance	1=never to 5=very often
Attended review or help sessions to enhance understanding of course content	1=never to 5=very often
Discussed grades with the professor	1=never to 5=very often
Time spent working with other students to prepare assignments or projects	1=never to 5=very often

Table 1

Factor Loadings

	Pre	Post
Commitment to Health Research and Practice		
Improving the health of all communities	0.72	0.78
Working to find a cure to a health problem	0.67	0.70
Improving the health of minority communities	0.66	0.76
Making a theoretical contribution to science	0.50	0.43
Cronbach's alpha	*0.72*	*0.75*
Acting Like a Scientist		
Relate scientific concepts to real-world problems	0.71	
Synthesize several sources of information	0.70	
Conduct an experiment	0.54	
Look up scientific research articles and resources	0.59	
Memorize large quantities of information	0.41	
Cronbach's alpha	*0.75*	

Table 2
Descriptive Statistics

	Mean	S.D.	Min.	Max
Dependent Variable				
Commitment to health research and practice posttest	0.00	0.89	-2.95	1.30
Classroom and Faculty Characteristics				
Structure: Frequency that professor had students solve real-world, complex problems	2.20	0.56	1.00	3.00
Frequency: Professor graded on a curve	2.18	1.58	1.00	7.00
Professor perception: There is no such thing as a question that is too elementary in my classroom	3.49	0.81	1.00	4.00
Professor perception: There is not enough time to give individual attention to each student	3.10	1.01	1.00	4.00
Average sense of competition in class	2.82	0.69	1.00	4.11
Average sense of collaboration in class	2.90	0.76	1.00	5.00
Pretest				
Commitment to health research and practice pretest	-0.02	0.86	-3.03	1.28
Background Characteristics and Pre-College Preparation				
Underrepresented racial minority student	0.22	0.41	0.00	1.00
Sex: Female	0.61	0.49	0.00	1.00
Parental income	5.38	2.18	1.00	8.00
Participated in a math, science, or engineering pre-college program	0.15	0.35	0.00	1.00
Participated in a pre-college research program	0.06	0.23	0.00	1.00
Acting like a scientist (pre-survey)	-0.03	0.85	-3.22	1.92
SAT Composite (100)	12.71	1.52	5.00	16.00
Measures of Self-Efficacy (Pre-Survey)				
Self-rated communication skills	3.78	0.89	1.00	5.00
Self-rated initiative taking	3.79	0.86	1.00	5.00
Self-rated ability to overcome hardship	4.01	0.78	1.00	5.00

Self-rated competitiveness	3.81	0.95	1.00	5.00
Classroom Experiences				
Professor evaluation: Made the course difficult enough to be stimulating	3.26	0.76	1.00	4.00
Professor evaluation: Encouraged collaboration among students	3.31	0.76	1.00	4.00
Class activity: Asked questions in class	2.52	1.23	1.00	5.00
Sense of competition in class	3.20	1.24	1.00	5.00
Sense of collaboration in class	2.99	1.11	1.00	5.00
Perception: I was accepted and respected by my peers	3.11	0.58	1.00	4.00
Perception: The course emphasized applying concepts to practical problems	2.85	0.72	1.00	4.00
Perception: The course emphasized applying concepts to new situations	2.87	0.71	1.00	4.00
Perception: I received feedback that helped me to learn and improve	2.63	0.79	1.00	4.00
Co-Curricular Experiences				
Time spent preparing for exams	7.51	3.41	1.00	13.00
Time spent participating in supplemental instruction	2.73	2.14	1.00	13.00
Had to change study habits in the middle of the term due to poor performance	2.65	1.24	1.00	5.00
Attended review or help sessions to enhance understanding of course content	3.10	1.35	1.00	5.00
Discussed grades with the professor	2.44	1.24	1.00	5.00
Time spent working with other students to prepare assignments or projects	3.00	1.33	1.00	5.00

Table 3

Results of HLM Analyses of Premedical Students' Commitment to Health Research and Practice

	Coef.	S.E.	Sig.
Classroom and Faculty Characteristics			
Intercept	-0.12	0.07	
Structure: Frequency that professor had students solve real-world, complex problems	-0.08	0.04	*
Frequency: Professor graded on a curve	0.01	0.01	
Professor perception: There is no such thing as a question that is too elementary in my classroom	0.07	0.03	*
Professor perception: There is not enough time to give individual attention to each student	-0.03	0.03	
Average sense of competition in class	-0.03	0.03	
Average sense of collaboration in class	-0.07	0.05	
Pretest			
Commitment to health research and practice pretest	0.47	0.03	***
Background Characteristics and Pre-College Preparation			
Underrepresented racial minority student	0.06	0.06	
Sex: Female	0.07	0.04	
Parental income	-0.02	0.01	
Participated in a math, science, or engineering pre-college program	0.05	0.06	
Participated in a pre-college research program	0.27	0.09	**
Acting like a scientist (pre-survey)	0.05	0.04	
SAT Composite	-0.04	0.02	
Measures of Self-Efficacy (Pre-Survey)			
Self-rated communication skills	-0.04	0.03	
Self-rated initiative taking	-0.02	0.03	
Self-rated ability to overcome hardship	0.13	0.04	***
Frequency: Professor's use of grading on a curve	0.02	0.02	
Average sense of collaboration in class	0.18	0.08	*
Self-rated competitiveness	0.03	0.02	

Table 3 (continued)

	Coef.	S.E.	Sig.
Classroom Experiences			
Extent to which the professor relied upon lecture	0.02	0.02	
Professor evaluation: Made the course difficult enough to be stimulating	0.10	0.03	**
Frequency: Professor's use of grading on a curve	0.06	0.02	*
Average sense of collaboration in class	0.04	0.05	
Professor evaluation: Encouraged collaboration among students	0.07	0.03	*
Class activity: Asked questions in class	-0.03	0.02	
Sense of competition in class	0.02	0.02	
Sense of collaboration in class	0.01	0.03	
Perception: I was accepted and respected by my peers	0.15	0.05	***
Perception: The course emphasized applying concepts to practical problems	-0.06	0.04	
Perception: The course emphasized applying concepts to new situations	0.13	0.04	***
Perception: I received feedback that helped me to learn and improve	0.01	0.03	
Co-Curricular Experiences			
Time spent preparing for exams	0.01	0.00	*
Time spent participating in supplemental instruction	-0.02	0.01	
Had to change study habits in the middle of the term due to poor performance	0.03	0.02	
Attended review or help sessions to enhance understanding of course content	0.01	0.02	
Discussed grades with the professor	-0.04	0.02	*
Time spent working with other students to prepare assignments or projects	0.02	0.02	
Explained Variance			
Level-1 explained variance	0.42		
Level-2 explained variance	0.82		
Overall explained variance	0.44		