This chapter examines the relationship between engagement in high school math and science classes, later academic performance, and choice of college major. Quantitative analyses are complemented by case studies of college students who exhibited high or low engagement in high school.

Continuing Motivation Beyond the High School Classroom

David J. Shernoff, Lisa Hoogstra

About one hundred years ago, Marie Curie moved to Paris to become a student in chemistry and physics, later concentrating on radioactivity for her doctorate. Upon experimenting with different elements, she detected not only that uranium was radioactive, but that uranium ore was much more radioactive than uranium itself. Curie wondered if this could be due to an unknown element invisibly existing in small concentrations. With little money, she and her husband, Pierre, worked on this question for four years in a shed that had been converted from a mortuary. By the time Pierre and Marie Curie announced the discovery of radium in 1898 and won the Nobel Prize in 1903, they had made considerable personal and financial sacrifices.

What lessons may we derive from this bit of history? For one, curiosity can be a powerful force, sometimes overwhelming even basic human desires and physical needs. More importantly from the point of view of this study, human progress often stems from an accumulation of interest in a given field—that is, the purposeful desire to return to the same problem or topic again and again. From an educational perspective, continuing motivation is an important but seldom considered outcome of education (Maehr, 1976). Unlike academic achievement, it has received little attention from educational researchers.

A student's continuing interest in a topic initially encountered in the classroom is one important marker of successful learning (Jackson, 1968).

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Genuine interest in an academic subject may lead to the desire to pursue related activities for their own sake. Such intrinsic motivation has been shown to be associated with short-term increases in cognitive flexibility, conceptual learning, and self-esteem (Deci and Ryan, 1985; Lepper and Greene, 1978). Interest and the desire to learn more in a subject may also affect whether or not a student enrolls in more courses in that discipline (Harackiewicz and others, 2000). Interest can thus become an important long-term as well as short-term motivator.

Continuing motivation may become especially salient in the lives of adolescents as they reach their senior year of high school, apply to and enter college, and declare a college major. Many students choose from a variety of postsecondary institutions, a choice that is often related to their career interests and aspirations. In college many courses are required as part of a general education plan, yet each student typically chooses a field of concentration. Often students have considerable latitude in choosing their college major. For many students that choice represents their first official declaration of their intended career path. As with Marie Curie, a student's choice of concentration can be the precursor to later achievements, particularly when the choice is well matched with the student's interests.

Motivation is a complex process involving an interaction of cognitive and affective factors. We next review some of the recent work identifying and clarifying several specific aspects of student motivation, including interest, achievement goals, flow experiences, and student engagement.

The Nature of Interest

In a meta-analysis of fifty-six studies, Schiefele, Krapp, and Winteler (1992) found a positive relationship between interest and achievement, with interest accounting for an average of 10 percent of the variance in academic achievement. (Previous studies have found that, on average, the correlation between interest and achievement is .32 in math and .35 in science; see Schiefele, Krapp, and Winteler, 1992.) As Schiefele (1991) notes, however, interest is always related to specific topics, and information is acquired in particular domains. In this chapter the terms interest and enjoyment, as well as terms denoting other motivational factors, therefore refer to motivation directly tied to the content area of instruction. We chose math and science as content domains. The primary reason for our choice was the conceptual distinctness of those fields, such that a continuing interest in either math or science could reasonably be linked to the pursuit of a defined body of specializations and occupations. We would expect continuing interest in science to lead to a college major such as biology or chemistry and a continuing interest in math to lead to a major such as accounting or engineering. This expectation is consistent with Maehr's definition (1976) of continuing motivation as a return to a task (or task area) at a subsequent time, in similar or varying circumstances, without visible external pressure to do so, and when other behavior alternatives are available.

Mastery and Performance Achievement Goals

Research on achievement motivation in classrooms has focused a great deal of attention on two contrasting goal constructs: mastery goals and performance goals (for a review see Ames, 1992). Mastery goals are oriented toward learning, developing new skills, and building competence. Performance goals are directed toward ability, self-worth, and outperforming others. Harackiewicz and others (2000) found that mastery goals predicted subsequent interest and enrollment in college psychology courses but not grades. Performance goals predicted grades and long-term academic performance but not interest. Therefore interest appears to be related to mastery goals and continuing motivation in a field but not to long-term performance as measured by grades.

Enjoyment: Flow Experiences and Intrinsic Motivation

Enjoyment appears to be another important component of continuing motivation. States of intense absorption in which tasks are perceived as satisfying and often exhilarating have been documented in studies of flow experiences (Csikszentmihalyi, 1997). A state of flow is most frequently achieved when individuals stretch the limits of their abilities to meet difficult challenges (Csikszentmihalyi and Csikszentmihalyi, 1988). Flow experiences are also characterized by enjoyment of the task itself, or intrinsic motivation. In the long run, individuals who develop commitments to specific fields of interest are those who follow their sense of enjoyment in chosen activities; that is, they feel that they "want to" rather than "have to" engage in such activities (Csikszentmihalyi and Nakamura, 1989; Csikszentmihalyi, Rathunde, and Whalen, 1993).

Student Engagement in High School Classrooms

Previous work (Sernoff, Knauth, and Makris, 2000; Sernoff, Schneider, and Csikszentmihalyi, 2000) has built on Csikszentmihalyi's theory of flow to identify factors contributing to student engagement and optimal learning in academic and nonacademic classes. Although similar to flow experiences, student engagement is a unique case of flow in the following ways: it refers to enjoyment of school-specific learning processes as distinct from other types of skill-related activities, such as games or hobbies; it occurs in classrooms, which are public work settings; and motivation is positive but not necessarily heightened, as it often is in activities such as football or soccer games (Brophy, 1983). In this study we conceptualize student engagement as a combination of interest, enjoyment, and concentration (see Sernoff, Schneider, and Csikszentmihalyi, 2001). Results of previous studies (Sernoff, Knauth, and Makris, 2000; Sernoff, Schneider, and Csikszentmihalyi, 2000)
indicate that students report higher levels of engagement in classroom activities when performing tasks that are perceived as relevant to their future goals, that encourage student autonomy, and that provide challenges appropriate for students' skills. Although this work has focused primarily on student engagement in specific classroom situations, there is reason to suspect that measures of engagement may be predictive of continuing interest and motivation in future academic pursuits. The enjoyment that accompanies active involvement in academic activities, particularly when relevant to students' future goals, may motivate students to seek out similar experiences as they progress through school.

This Study: Overview

In this study we first examined the classroom experience of high school students across the country. For this purpose we used the Experience Sampling Method (ESM) described by Csikszentmihalyi and Larson (1987). To better understand motivation in the classroom, we asked students how interested they were in activities, how much enjoyment they felt, and other similar questions at representative moments during math and science classes over the course of an ordinary week in school. Responses were aggregated by student and analyzed separately for experiences reported in math and science classes. We then tested the relationship of motivation in the classroom to both long-term performance and interest (choice of college major) in math and science. We expected motivational variables in high school classrooms to predict future aspirations and continuing motivation but not long-term performance (Harackiewicz and others, 2000).

Method

The data for this study come from two sources: the Alfred P. Sloan Study of Youth and Social Development (SSYSD), a national longitudinal study that investigates how students think about their lives in relationship to the future; and a three-year follow-up study of these students funded by the U.S. Department of Education's National Institute on Postsecondary Education, Libraries, and Lifelong Learning.

The Original Study. We use data from the original study (the SSYSD) to measure future aspirations and motivation in high school math and science classes.

Data Collection and Participants. A subsample from the original study was selected for the purpose of understanding continuing motivation. Students who were taking math and science classes in their senior year in high school and who participated in the ESM constituted the sample to be analyzed. This sample was 62 percent female and 38 percent male; 16 percent African American, 8 percent Asian, 10 percent Hispanic, and 64 percent white; and 7 percent low income, 14 percent working class, 35 percent middle class, 26 percent upper middle class, and 14 percent upper class (because of missing data, percentages do not total 100). There was a slight response bias due to incomplete data. Males, low-income students, and Hispanics were somewhat underrepresented in comparison with the original sample. (For further details concerning the sampling design and procedures of the SSYSD, see Csikszentmihalyi and Schneider, 2000.)

Our analyses of students' engagement in high school math and science classes were based on data from the ESM. Preprogrammed wristwatches signaled the sampled students randomly eight times each day at different intervals from 7:30 a.m. through 10:30 p.m. over the course of a typical week. Students were asked to complete a one-page self-report form each time they were signaled. The method thus provided a representative sample of each person's moods and activities for that day and week.

Participants in this study provided more than 19,000 ESM responses during the week of experience sampling. Of these, we analyzed 582 responses in math classes reported by 354 students and 625 responses in science classes reported by 324 students. These students constituted our sample for analyses of engagement in classrooms and career aspirations.

Measures. The ESM self-report forms include several semantic differential scales, such as happy-sad or active-passive, as well as several 10-point Likert scales that measure respondents' cognitive and affective states at the moment signaled. Seven ESM variables pertaining to students' motivation were selected for analysis:

- Interest ("Was this activity interesting?")
- Enjoyment ("Did you enjoy what you were doing?")
- Concentration ("How well were you concentrating")
- Future importance ("How important was the activity in relation to your future goals?")
- Skill ("How would you rate your skills in the activity?")
- Active involvement (which combined perceptions of being active and involved)
- Mood (which included feeling happy, strong, sociable, and proud)

The two composite variables (active involvement and mood) were based on factor analyses, indicating that the variables forming the composite were part of the same global factor (for active involvement, \( \alpha = .658 \); for mood, \( \alpha = .855 \)). Previous studies (Shernoff, Schneider, and Csikszentmihalyi, 2000, 2001) have used a composite measure of student engagement that combined interest, enjoyment, and concentration. Because each of these components was of theoretical interest, this study reports them separately.

In addition to measures derived from the ESM, information on background characteristics (gender, ethnicity), socioeconomic status, family type (traditional, single parent, blended), and academic performance were obtained from the Teenage Life Questionnaire, a modified version of the
National Education Longitudinal Study conducted from 1988 to 1994 (Ingels and others, 1994). With regard to academic performance, students were asked to report their grades in math, science, English, and history. To control for performance, we used grades in high school math courses when predicting continuing motivation in math, grades in high school science courses when predicting continuing motivation in science, and average high school grade point average when predicting overall grades in college. If students who reported high interest and enjoyment in math and science classes continued to develop their interest and perform well in college, then controlling for performance in high school would allow us to determine whether this result was due to interest and enjoyment rather than prior performance or ability.

Career aspiration measures were obtained from a career survey in which students were asked what job they expected to have in the future. Career aspirations in math included engineering, accounting, and technical fields related to math (such as computer programming). Career aspirations in science included medical doctor, other medical professional (such as dentist), other science professional (such as biologist or physicist), and science or laboratory technician. Only a small number of students expected to enter careers in technical fields. Because many of these occupations (for example, computer programming or laser technology) were consistent with an interest in either math or science, these categories were combined to form one coding category and were included in our definition of both math and science career aspirations, creating a small overlap in coding.

The Follow-Up Study. A follow-up study was conducted of SSYSN participants after they had graduated from high school. We used data from the follow-up study to measure long-term performance and continuing motivation.

Data Collection and Participants. For purposes of the current analysis, we focused on students who were high school seniors in the base year of the study and who completed interviews two years after graduating from high school, when most were in their second year of college. Additional interviews were conducted with many of these participants two to three years later, when most were college seniors or had graduated from college. Participants were interviewed by telephone and asked if they were in school or working. If in school, they were asked to identify the postsecondary institution they were attending, the degree they were pursuing (B.A., B.S., associate's), their choice of college major, and their approximate grade point average; they were also asked a variety of questions about life as a college student. One hundred eighty-four students were contacted by phone for the follow-up study. Of these, sixty-eight students had reported ESM data while in math class, and sixty-two while in science class, during their senior year of high school. These were the students who constituted the sample for our analyses of continuing motivation and long-term performance. (Fifty-six students had complete data for all variables in our model predicting math major, and fifty-three students had complete data in our model predicting science major.)

Measures. Our measure of continuing motivation was selection of a college major in science in relation to motivational variables in high school science classes and selection of a college major in math in relation to motivational variables in high school math courses. In keeping with Maehr's definition (1976), selecting a college major involves not only a "returning behavior" in an open-choice situation but also a willingness to return to the topic repeatedly and purposefully in the future. Like Harackiewicz and others' study (2000), the present investigation is one of the few studies to use a behavioral measure of continuing motivation in an educational context as opposed to self-reported measures. Students' self-reported college grades were used as the measure of long-term performance because we lacked access to college transcripts.

Case Studies. Cases were selected on the basis of two criteria: extremely high or low scores on engagement during high school math or science classes and choice of major in college (math or science versus other). We selected students who scored in the top or bottom 5 percent on a composite engagement variable (averaging interest, enjoyment, and concentration) when in high school math or science classes. We also selected students who chose college majors in science or math. (For extended profiles of these students, see Hoogstra, 2001.) The cases illustrate the association between early motivation in high school math and science classes and college outcomes in the context of students' lives.

Results

In our first analysis we attempted to predict aspirations for occupations relating to math and science from motivational variables in high school math and science classrooms. For each variable, we conducted a separate logistic regression controlling for the gender, race, socioeconomic status, family type, and performance of the student. The results are presented in Table 6.1. The only variable that predicted preference for a math career in high school was the perception that activities in math classes were important to one's future goals ($B = .274, p < .01$). None of the variables measured during science classes predicted career aspirations for occupations relating to science.

Next we used the same motivational variables in math and science classes measured during the senior year to predict the selection of college major in math or science. In these sets of separate logistic regressions, we were investigating whether motivational variables in high school classes would predict continuing motivation in the same field two years later after controlling for background characteristics and previous performance. We set alpha at .10 due to the small number of cases being analyzed ($N = 56$ for math, $N = 53$ for science). The results are presented in Table 6.2.
Table 6.1. Logistic Regression Coefficients Predicting Math and Science Career Aspirations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Math Career(^a)</th>
<th>Science Career(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>-0.002</td>
<td>0.052</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>0.050</td>
<td>0.098</td>
</tr>
<tr>
<td>Concentration</td>
<td>0.100</td>
<td>0.068</td>
</tr>
<tr>
<td>Future</td>
<td>0.274(^*)</td>
<td>0.104</td>
</tr>
<tr>
<td>Importance</td>
<td>-0.118</td>
<td>0.082</td>
</tr>
<tr>
<td>Skill</td>
<td>0.072</td>
<td>0.009</td>
</tr>
<tr>
<td>Active</td>
<td>0.128</td>
<td>0.109</td>
</tr>
<tr>
<td>Involvement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)The coefficient predicting aspirations for math-related careers from motivational variables in high school math classes after controlling for gender, race, socioeconomic status, family type, and performance. \(N = 244\).

\(^b\)The coefficient predicting aspirations for science-related careers from motivational variables in high school science classes after controlling for gender, race, socioeconomic status, family type, and performance. \(N = 243\).

\(^*p < .01\).

the motivational variables in high school math classes predicted selection of a math major two years later. However, the selection of a science major in college was positively predicted by interest (\(B = .836\), \(p < .01\)), enjoyment (\(B = 1.43\), \(p < .01\)), and concentration (\(B = 1.163\), \(p < .05\)), as well as by skill, active involvement, and mood, during high school science classes two years prior.

Finally, we attempted to predict college grades from motivational variables in math and science courses during the senior year. We had data on students' reports of their grades in college on average, not for each subject separately as we had in high school. We therefore combined motivational data in high school math and science classes to predict overall grades in college in separate OLS (ordinary least squares) regressions controlling for student background characteristics. The results are presented in Table 6.3. Both interest (\(B = 1.50\), \(t = 1.72\), \(p < .10\)) and enjoyment (\(B = 1.33\), \(t = 1.73\), \(p < .10\)) in math and science classes positively predicted grades in college two years later, even when controlling for high school grades. None of the other variables were significant predictors after controlling for background characteristics. In addition, although interest and enjoyment positively predicted grades in college after controlling for the other variables in the models, high school grade point average did not (in the interest model, \(B = .038\), \(t = .136\), n.s.; in the enjoyment model, \(B = .085\), \(t = .297\), n.s.).

What these results suggest is that students' experiences of interest and enjoyment in high school science classes are related to the majors they choose in college. Certainly, some students may be predisposed to major in science, but what seems noteworthy is that the experience of being cognitively and emotionally engaged with a particular topic may direct students' choices of college courses and majors. Moreover, interest and enjoyment in high school math and science classes are significant predictors of academic performance in college, whereas high school grades are not.

### Case Studies

The following case studies illustrate that students reporting high engagement in high school classes sustain their interest in a particular field of study, whereas students reporting low engagement are more likely to change

Table 6.2. Logistic Regression Coefficients Predicting Math and Science Majors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Math Major(^a)</th>
<th>Science Major(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>-0.363</td>
<td>0.836(^***)</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>0.011</td>
<td>1.43(^***)</td>
</tr>
<tr>
<td>Concentration</td>
<td>-0.051</td>
<td>1.163(^**)</td>
</tr>
<tr>
<td>Future</td>
<td>0.150</td>
<td>0.227</td>
</tr>
<tr>
<td>Importance</td>
<td>0.120</td>
<td>0.916(^**)</td>
</tr>
<tr>
<td>Skill</td>
<td>-0.197</td>
<td>1.116(^*)</td>
</tr>
<tr>
<td>Active</td>
<td>-0.647</td>
<td>2.024(^**)</td>
</tr>
<tr>
<td>Involvement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)The coefficient predicting selection of a college major in math from motivational variables in math classes measured two years prior, during the senior year of high school, after controlling for gender, race, socioeconomic status, family type, and previous performance. \(N = 96\).

\(^b\)The coefficient predicting selection of a college major in science from motivational variables in science classes measured two years prior, during the senior year of high school, after controlling for gender, race, socioeconomic status, family type, and previous performance. \(N = 53\).

\(^*p < .10\). **p < .05. ***p < .01.

Table 6.3. OLS Regression Coefficients Predicting Grades in College

<table>
<thead>
<tr>
<th>Variable</th>
<th>College Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>0.150(^*)</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>0.133(^*)</td>
</tr>
<tr>
<td>Concentration</td>
<td>0.110</td>
</tr>
<tr>
<td>Future</td>
<td>0.040</td>
</tr>
<tr>
<td>Importance</td>
<td>0.052</td>
</tr>
<tr>
<td>Skill</td>
<td>-0.203</td>
</tr>
<tr>
<td>Active</td>
<td>-0.124</td>
</tr>
<tr>
<td>Involvement</td>
<td></td>
</tr>
</tbody>
</table>

Note: The coefficients predicting grades in college from motivational variables in math and science classes measured two years prior, during the senior year of high school, after controlling for gender, race, socioeconomic status, family type, and previous performance. \(N = 75\).

\(^*p < .10\).
majors and career interests. We contrast two students who exhibited high engagement in their high school science classes with a third student who reported low engagement. Cases were selected on the basis of students' engagement scores in high school math or science classes, not on the basis of occupational aspirations.

Like the students in our larger sample, those selected for the case studies vary with respect to gender, race and ethnicity, family background, and socioeconomic status. As the results of our quantitative analyses indicate, however, interest and engagement remain significant predictors of continuing motivation even after accounting for background characteristics.

**High Engagement.** As a high school senior, Will Burton was taking honors courses in physics and math analysis and was receiving high grades in those classes. "All through [school] on all my report cards," he said, "my math and science grades [were] always highest and my English and history grades [were] always lower." He believed the reason for this difference in his performance was that his knowledge of math and science was more developed than his knowledge of other subjects and that therefore it was easier for him to grasp new concepts in math and science.

Wills favorite course was physics. Explaining the reason for this, he said, "because I'm interested in science, it's science-related, and I've always liked science." He emphasized that he liked anything related to science and commented, "I think science is going to be a basic part of my life in the future." Even at this time in his life, Will had identified a field of interest, one that mirrored his career aspirations. "Ever since at least probably freshman year," he explained, "I've always known that I wanted to go into medicine. . . . Maybe it was because . . . my second favorite [class] is bio and . . . I've always wanted to do well in that class."

Will said he expected to become a pediatrician, both because of his interest in science and because he had always been good with kids.

Throughout subsequent interviews over the next five years, Will continued to demonstrate a strong interest in science. When we interviewed him during his freshman and sophomore years in college, he was pursuing a bachelor's degree in biology, maintaining a B average, and still planning to become a pediatrician. "I'm interested in science, I'm interested in medicine, and I'm interested in teaching," he explained. "I love kids, I love medicine, and I love science, and I love teaching."

Will sustained his interest in medicine throughout college. He noted that "as college went on [he] just got more and more interested in [medicine] and more and more intrigued by the whole subject." Demonstrating his continuing interest, he enrolled in a one-year medical master's program after graduating from college. The program reinforced his desire to go into medicine: "My goals were always there, but this past year kind of put them into fruition. Just . . . being in class and having actual patients come in and talking, and you know people with Alzheimer's disease, and just . . . knowing it's really real."

When we last interviewed him, Will was studying for the Medical College Admission Test, working for a doctor as a medical researcher, and planning to volunteer at a local hospital. He had made some very strategic job choices that allowed him to gain science-related work experiences outside of his graduate program.

Like Will, Elena Rodriguez received high grades and was enrolled in several advanced courses, including honors chemistry, during her senior year in high school. In describing her courses, Elena explained that she felt most challenged in her math and science classes and worked hardest in those courses. Science was her favorite subject, and she knew she wanted to pursue a degree in science, "any kind of science at all, like chemistry." Her favorite course, however, was biology because she liked "studying about animals." She noted that she was thinking of majoring in biology, or perhaps genetics, when she went to college. Her appreciation for science had been consistent throughout school. 

"[Even when] I had a bad teacher," she said, "I still liked it, so I could manage it." Grades motivated her only because they were the key to continued learning: "I know that if I don't graduate with good grades, then even though they are not important to me, they are important for getting into college."

Elena's engagement and self-direction were also evident five years later, although life events had substantially altered her timetable for completing her education. When interviewed at this time, Elena had married, was attending a two-year college close to home, and was majoring in biology. She had worked part-time throughout college and taken only one or two classes per semester, both for financial reasons and to maintain a high grade point average. Because of her reduced course load, she had not yet completed her associate's degree. However, she hoped that by doing well in her classes, she would be able to qualify for a scholarship to a four-year college. She explained, "I just see this school as basically the vehicle to take me further, . . . so when I transfer out I can just go two more years to a university and get my [bachelors'] degree in biology." Eventually, she said, she hoped to go on to obtain her Ph.D.

Despite financial setbacks, Elena remained committed to pursuing a degree in biology. Although she was behind schedule in completing her degree, she was receiving As and Bs in her courses, had taken several classes in her major, and was in the process of deciding on an area of specialization within biology. Like Will, her interest in science continued to motivate her to pursue her goals. (A similar case study of Elena appears in Cskszentsmihalyi, Schneider, Shernoff, and Hoogstra, 2001.)

**Low Engagement.** During her senior year in high school, Felicia Evens was taking physics, anatomy/physiology, precalculus, English, and advanced placement history, and was getting As and Bs in her courses. She noted that she worked hard in all her classes but felt challenged only in her math and history classes. Although she was taking two advanced courses in the sciences, she indicated that she rarely felt challenged in those classes.

Asked what type of job or career she expected to pursue after she completed her education, she said that she was thinking of going into nursing. "I like talking about the body and stuff like that," she explained. "And I
can remember stuff as far as, you know, the physiology of the body and all that type of stuff. So that's why I think I'd like [nursing]." Unlike Will, however, she offered only a vague explanation for her interest in medicine and expressed none of his enthusiasm when talking about her science classes.

In contrast to Will and Elena, who remained committed to a specific field of study throughout early adulthood, Felicia's interests changed several times after high school. She initially enrolled in a four-year nursing program but disliked the nursing curriculum and felt that nursing "[didn't] pay enough." She left the program after a year to pursue an associate's degree in laboratory technology. She explained that the program appealed to her because she could complete her degree in less than two years and would then be able to work full-time. She noted that she might return to school in the future to earn a bachelor's degree in medical technology, a field related to her earlier interest in nursing, but had no firm plans to do so.

After completing her degree in laboratory technology, Felicia took a full-time job as a laboratory technician in the food industry. Asked why she was working, she said, "Why am I working? Everybody has to work. Um, to pay bills and for benefits in the future so I can get ready to think about retiring and all that good stuff." She also noted that there were a lot of opportunities for career advancement, observing, "[T]he food industry is a good, solid concrete industry. I mean we gotta eat." She expressed little interest in the content of her work and focused instead on the extrinsic rewards of her job.

By age twenty-three, Felicia had abandoned her earlier plans to return to school and study medical technology. She indicated that she was now considering pursuing a degree in microbiology, a field that would enable her to advance in the food industry. In making decisions about school and work, Felicia appeared to be motivated primarily by a desire for economic security. She gave the impression that she was working because she had to work, not because of the interest, challenge, or enjoyment that the work entailed.

**Case Studies: Conclusions.** These case studies suggest that interest not only influences students' choice of major but may also be an important predictor of educational persistence and career commitment. A strong interest in medicine motivated Will to develop strategies for gaining admission to medical school. A continuing interest in biology helped Elena to persist in pursuing her bachelor's degree despite numerous obstacles and setbacks. In contrast, Felicia's lack of engagement appeared to contribute to a pattern of shifting educational and occupational goals.

**Analysis**

Our quantitative analyses suggest that motivational variables in classrooms are generally not significant predictors of high school students' career aspirations. We believe this result is a product of the prevailing uncertainty among adolescents regarding their occupational and career plans. Our data, however, do provide some evidence that motivational variables can be a significant predictor of continuing motivation in the field of science. This applies not only to interest and enjoyment but also to concentration, active involvement, mood, and perceived skill. Interestingly, engagement in classes predicted continuing interest better than students' own career projections.

Interest and enjoyment also predicted college grades two years later. Not only were students who were more engaged in high school science classes more likely to major in science, but students who enjoyed and were interested in math and science classes performed better overall in their college classes. Among all of the variables we tested in our analyses, interest and enjoyment were among the strongest predictors of both continuing motivation in science and subsequent performance in college. This was true even when taking into account other factors, such as student background characteristics and high school grades, suggesting that these results are not due to differences in upbringing, ability, or prior performance. Contrary to the reasonable expectation that future performance is best predicted by past performance, interest and enjoyment in math and science classes appear to be stronger determinants of performance in college than high school grades are. Building on the findings of Csikszentmihalyi, Rathunde, and Whalen (1993), these results point to the importance of intrinsic motivation and optimal experiences in determining long-term motivation and commitment to a field of study.

Why these variables are strong predictors of continuing motivation in science but not math is not immediately clear. It is possible that the importance of educational engagement to continuing motivation is subject specific. It may also be the case that students who are interested in math have more difficulty identifying occupations related to their interests. Careers with an obvious relationship to math—for example, a career in "pure" math or in a strictly applied field such as accounting—are few and may have limited appeal for the majority of students who have an interest in math.

When comparing students reporting high engagement in math and science classrooms with those reporting low engagement, we found that the highly engaged students frequently spoke about liking their favorite subjects and being interested in them. For highly engaged students, in contrast to students reporting low engagement, their interest and enjoyment in specific fields were fundamental considerations when thinking about their future and making important decisions about college, area of specialization, and possible careers. Students who reported low engagement appeared more concerned with their performance, their grades, and other external indicators of success. Interestingly, the students who reported low engagement did not fit the stereotype of underachievement and indifference. On the contrary, many were highly ambitious and concerned with their performance.

The student interviews helped to illustrate how mastery goals and performance goals operate in the real lives of adolescents. It is important to keep in mind that even intrinsically motivated individuals with strong mastery
goals live in a highly competitive society and may seek to participate in competitive fields. Therefore performance goals may often be necessary and important in the pursuit of intrinsically interesting questions and topics. To some extent, students reporting high and low engagement exhibited both mastery and performance goals but gave them different emphasis. For Will and Elena concerns about performance appeared to be secondary to their interest in science. Success was important to the extent that it enabled them to pursue degrees and careers related to their interests. For Felicia the emphasis was reversed. Her concerns about mastery were subordinate to her concerns with performance. She valued competence and skill building as means to an end—a secure job with opportunities for career advancement.

Although intrinsic interest in a subject may enhance long-term performance, as demonstrated by the higher college grades of students who exhibited an interest in math or science in high school, an overemphasis on grades, tests, and other measures of performance may have the effect of reducing student interest and engagement. This study suggests that teachers who desire to nurture lifelong learners would be wise to focus on creating the conditions that allow students' natural interest and enjoyment in a subject to develop. Teachers obviously have a professional duty to be concerned with short-term learning gains and to evaluate those gains. One key to the lasting success of students, however, appears to be authentic engagement, including genuine interest in and enjoyment of a topic.

Note

1. Data for the study, including all quotations, were derived from two sources: (1) the Alfred P. Sloan Study of Youth and Social Development (principal investigators Charles Bidwell, Mihaly Csikszentmihalyi, Larry Hedges, and Barbara Schneider), and (2) a three-year follow-up study funded by the U.S. Department of Education's national Institute on Postsecondary Education, Libraries, and Lifelong Learning (principal investigator Barbara Schneider). Permission to use these studies as data sources was granted by the principle investigators. Written consent to participate was obtained from parents of each young participant in the study, and verbal consent was obtained from each participant. Quotations for case studies were taken from tape-recorded interviews. Under the guidelines of the University of Chicago Institutional Review Board, the confidentiality of all information obtained from participants has been maintained since the project's inception. Pseudonyms have been used for all participants, and sensitive information was excluded.

References


