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Development of Case Stories by Interviewing Students about their Critical Moments in Science, Math, and Engineering Classes

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Development of Case Stories by Interviewing Students about their Critical Moments in Science, Math, and Engineering Classes

Abstract
Dartmouth's Critical Moments project is designed to promote discussions among faculty and graduate students about the retention of students, particularly women and minorities, in science, math, and engineering (SME) disciplines. The first phase of the ongoing project has been the development of four case stories, which are fictionalized composites drawn from surveys and interviews of real Dartmouth students. The surveyed population was 125 students in general chemistry. Of the 77 who agreed to be interviewed, 61 reported having experienced a critical moment – i.e., a positive or negative event or time that had a significant impact on the student's academic life. Leading critical moments were a poor grade on an exam; challenge from group work; excitement from an internship; and falling in love with a non-SME discipline from other coursework. Interviews of 13 students who had negative critical moments led to the development of case stories for: Antoinetta '09, who had a disappointing group experience; Dalila '08, who was poorly prepared; Greg '09, who got in over his head in his first year; and Michelle '08, who was shocked by her result in the first exam. The case stories are being discussed by graduate students, TA and faculty in various workshops at the Dartmouth Center for the Advancement of Learning.

Keywords
retention, stem, critical moments, case stories

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Introduction

Although faculty and students may recognize that retention of women and minorities (and white men, for that matter) in the sciences is an issue nationally, they often are not aware that retention is a pressing issue at their own institution, or what they personally might do to address the problem. For faculty, this means becoming more fully informed about what causes students to abandon (or persist in) their plans to pursue a science-related career, and how they might adjust their teaching or mentoring to retain a more diverse population of students in science, math, and engineering (SME). For students, awareness that other students have critical moments may make them more likely to persist.

Dartmouth's *Critical Moments* project is designed to promote discussions among faculty and graduate students to discover better approaches to retaining a more diverse population of students in SME majors. The first part of the project has been to develop case stories that are being used now, in the second part of the project, to stimulate the discussions. The purpose of this paper is to describe the process of developing the case stories. While the case stories written through this project are based on interviews with Dartmouth College students, we believe the process, as well as the case stories themselves, may be adapted for use at other campuses and for other numeracy issues.

Setting

Overall retention is not a significant problem at Dartmouth College, with the six-year graduation rate for students consistently around 95%. The number of students graduating with degrees in science, math, and engineering, however, is clearly decreasing. As shown in Figure 1, the percentage of undergraduate degrees awarded in SME majors over the past three years at Dartmouth has declined from 32% in 2002-2003 to 24% in 2004-2005 (OIR 2005). Nationally the percentage of SME majors awarded has remained relatively constant, varying from 16.7% to 17.0% of all degrees between 2002 and 2005 (NSF 2007); while the percentage of degrees awarded in SME majors at Dartmouth is relatively high compared to the national average, the decreases are significant.

These decreases in SME majors have a direct impact on both SME faculty and funding for those departments losing students. While retention of all science majors is critical, retention of a more diverse population of students will become increasingly important since "according to the latest population projections, minorities (Asians/Pacific Islanders, Blacks, Hispanics, and American Indians/ Alaskan Natives) are expected to be more than half (52%) of the resident college-

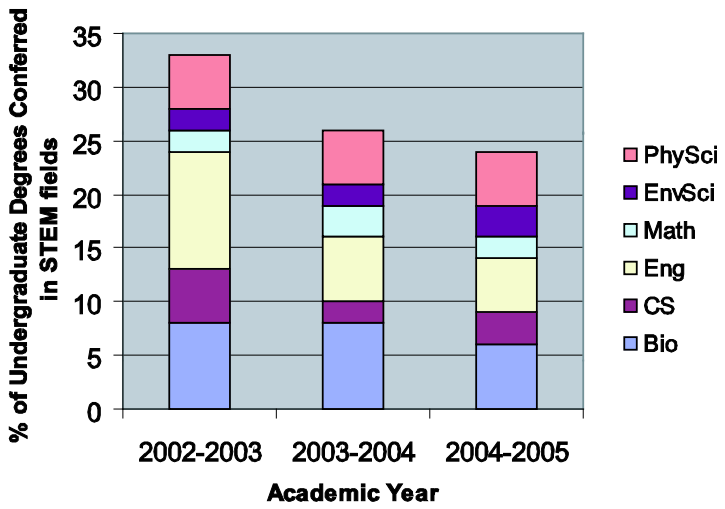

Figure 1. Undergraduate degrees conferred in SME majors at Dartmouth.

age (18-24 years old) population of the United States by 2050, up from 34% in 1999."[1]

Numerous studies have been conducted to determine why students abandon plans to study science, math and engineering. One such study, Seymour and Hewitt's (1997) *Talking about Leaving: Why Undergraduates Leave the Sciences*, involved 335 students at seven four-year institutions using a combination of institutional statistics, interviews, and focus groups. The purpose of that three-year study was to "…discover, and to establish the relative importance of, the factors with the greatest bearing upon the decisions of undergraduates at four-year colleges and universities to switch from science, mathematics, and engineering majors into disciplines which are not science-based" (Seymour and Hewitt 1997, 13). While this study is almost ten years old, it remains one of the most cited references in the area of retention of students in the sciences.

Seymour and Hewitt found that "switchers" and "non-switchers" faced similar issues and had similar abilities, but that "non-switchers" had better coping mechanisms or encountered positive interventions at critical moments. Reasons most often cited for leaving the sciences included: "…loss of interest in science; belief that a non-SME major holds more interest, or offers a better education; poor teaching by SME faculty; and feeling overwhelmed by the pace and load of curriculum demands" (Seymour and Hewitt 1997, 32)

[1] National Science Foundation. "Women, Minorities, and Persons with Disabilities in Science and Engineering," Figure A-1, caption. http://www.nsf.gov/statistics/wmpd/figa-1.htm (Source: U.S. Bureau of Census, http://www.census.gov/population/www/projections/natsum-T3.html)

Seymour and Hewitt also included numerous statistics and prioritized lists of reasons for switching majors based on gender and ethnicity. While many reasons cited by female students were similar to those of male students, female switchers reported more conceptual difficulties, even though institutional data indicated they were equally or more qualified. Female switchers also reported a higher level of dissatisfaction with teaching in the sciences. Minority students cited the same reasons as white students for leaving the sciences, but additionally often cited financial difficulties and being under-prepared.

Other studies (e.g., Johnson et al. 1998) have found that female and minority students learn better through different approaches such as cooperative or collaborative learning. Additional policies and strategies to promote retention of women and minorities (Boylan et al. 2005) include the use of a variety of instructional methods, development of trust in the classroom, use of culturally responsive instruction, availability of mentoring programs, promotion of community involvement, and presence of role models. By culturally responsive instruction, Boylan et al. (2005) mean awareness and acknowledgement of culture differences through the use of culturally diverse examples, discussions, and case studies.

Much of what positively or negatively influences students remaining in the sciences can be tied to teaching practices and students' and teachers' views on learning. Boylan et al. (2005, 63) assert "…institutions need to provide opportunities for faculty and staff [and students] to discuss and better understand the effects of race and culture on teaching and learning."

Definitions

The case stories approach adopted for this project is based on the model developed by The Evergreen State College's Washington Center for Improving the Quality of Undergraduate Education.[2] As described in *Critical Moments: Responding Creatively to Cultural Diversity Through Case Stories* (Gillespie and Woods 2000), a critical moments project is "…a diversity case story project designed to foster critical thinking skills." The Critical Moments Model has been adapted at many universities and community colleges.

Note the use of the phrase *case story* as opposed to *case study*. The case stories used in many critical moments projects, though based on reality, are fictionalized since the case stories themselves are only a small part of a typical critical moments project; how those stories are used to promote critical thinking

[2] Washington Center for Improving the Quality of Education. "Access and Equity: Critical Moments," http://www.evergreen.edu/washcenter/ project.asp?pid=1

about diversity and to provide an impetus for change are the key components of most projects.

A "critical moment" for our study is defined as an event or time that had a significant impact on a student's academic life—either positive or negative. A negative critical moment is an event or time when a student perceives that s/he is different, discouraged, unprepared, or vulnerable; this type of critical moment may deter a student from a certain major. A positive critical moment is a time when a student feels interested, excited, encouraged, or self-confident; this type of critical moment may cause a student to consider pursuing a certain major or become more interested in a science topic.

The case stories are designed specifically to be used as part of regular faculty and graduate student development workshops conducted by the Dartmouth Center for the Advancement of Learning (DCAL).

Methodology

In order to develop authentic case stories, we conducted a preliminary study to better understand students' specific experiences and issues. As part of this preliminary study, we administered a survey to students enrolled in two introductory chemistry classes (CHEM5 and CHEM6), and conducted follow-up, individual interviews with a subset of students from these two courses.

We chose CHEM5 and CHEM6 as our sample population since all SME majors on campus are required to take CHEM5 and CHEM6 (engineering majors are required to take CHEM5 only), and the majority of students take these courses in their first year at Dartmouth. The fact that most students take these courses in their first year at Dartmouth is of special interest since the highest attrition rates for science, math, or engineering majors (through switching to a non-SME major or leaving the college) has been found to occur in the first year; nationally this rate of attrition is around 35% (Seymour and Hewitt 1997).

Survey

A survey, which is included in the appendix, was administered to students in CHEM5 during winter term of 2006 and to students in CHEM6 during the spring term of 2006. The purpose of the survey was to determine reasons cited by students for abandoning plans to pursue math, science, and engineering majors and to identify individual students experiencing critical moments who were willing to be interviewed.

A total of 125 students (102 CHEM5 students and 23 CHEM6 students) completed the survey. A higher percentage of CHEM5 students responded to the

survey than did CHEM6 students; this is likely due to the fact that a paper version of the survey was distributed in CHEM5 during class, whereas an optional online survey was administered in CHEM6. The surveys were administered at the end of the term in both classes. The response rates for CHEM5 and CHEM6 were 92% and 39%, respectively.

The sample population was composed of a fairly comparable number of females (65 females or 52%) and males (60 males or 48%). A higher percentage of students reported being white (83 students or 66% of the students surveyed) than non-white (42 students reported being non-white or 34% of the students surveyed). As shown in Table 1, the 42 non-white students represented a diverse range of ethnic minorities. The majority of non-white students were Asian-American (15 students or 12% of the students surveyed), with the remaining students from four different ethnic minority groups (with 2 or 3 students in each of these groups). Nine students (or about 7%) were international students; they were either Asian (5) or African (4).

Table 1. Survey Breakdown by Gender and Ethnicity

		Female	**Male**	**Total**
White		38	45	83 (66%)
Non-White	African	4	0	42 (34%)
	African-American	1	1	
	Asian	3	2	
	Asian-American	10	5	
	Middle Eastern	2	0	
	Native Alaskan or Hawaiian or American Indian	2	1	
	Southeast Asian or Indian	3	0	
	Other or Not Reported	7	6	
Total		65 (52%)	60 (48%)	**125**

Though the sample size (125 students were surveyed) was relatively small, the population surveyed mirrors that of Dartmouth College relatively well in many areas; 57% of the undergraduate students entering Dartmouth in 2006 reported their race/ethnicity as white (compared with 66% in our sample), 13% reported being Asian-American (12% in our sample), and 6% identified

themselves as international students (7% in our sample) (OIR 2005). Our sample did not well represent the African-American, American Indian, and Hispanic students at Dartmouth but these populations are relatively small at 7%, 4%, and 6% of the total undergraduate population, respectively (OIR 2005).

When asked to report their major, 38% of the students surveyed listed Biology. As shown in Figure 2, 65% of the students listed a science major, while 35% listed a non-science major (including Psychology, Economics, English, Government, Theater, and Religion). Considering only SME majors are required

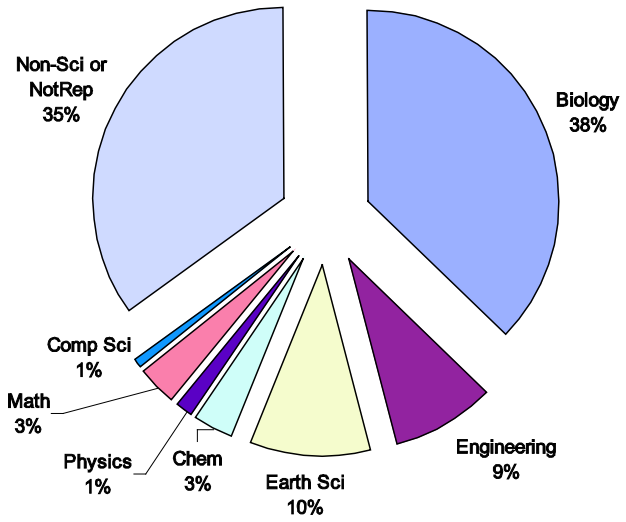

Figure 2. Self-reported majors

to take CHEM5 and CHEM6 it is somewhat alarming that by the end of the term 35% of the students list a non-science major. A closer look at the responses shows that many of the students listed multiple majors, often one science major and one non-science major, and 38% of the students in the "non-science or not reported" category did not report a major.

Interviews

Of the 125 students who completed the survey, 77 students indicated that they would be willing to be interviewed as part of the project. Of those 77 students, 61 reported having a critical moment (33 females and 28 males). Critical moments that were reported on the surveys included:

- Exams – A poor grade on an exam was reported frequently. In at least one case, however, a student reported gaining confidence from a high grade on an exam.
- Group Work Challenges – Challenges working in groups (poor group dynamics and management) and the lack of group work in science classes were listed as critical moments.
- Internships or work – Several students reported becoming excited about science after an internship or summer job (positive critical moment).
- Non-science classes – A few students reported falling in love with non-science majors after taking certain courses (English and Religion in particular were cited). While this might be considered a negative critical moment for science, it was a positive critical moment for the students.

We decided to interview students who reported negative critical moments only since the primary goal of the study was to promote discussion related to the retention of students in the sciences, particularly women and minorities. While the positive critical moments (such as realizing you really enjoy theater) are interesting, we felt they would be less likely to promote rich discussions and were not focused on retention.

From the pool of students who indicated they were willing to be interviewed and reported having a negative critical moment we selected 13 students to interview (Table 2). We purposely selected a mix of male, female, majority, and minority students. We chose to interview proportionately more females and ethnic minority students since we were particularly interested in the issues faced by these students; at the same time, we wished to see how their perspectives might compare to their male and Caucasian classmates.

Table 2. Number of Students Interviewed by Gender and Ethnicity

	Female	**Male**
Majority (Caucasian)	4	2
Minority	5 (2 African, 1 African-American, and 2 Asian-American)	2* (Asian-American)

*Both male minority students interviewed were Asian-American. A limited number of minority males responded to the survey and all of the minority males with both a critical moment and who were willing to be interviewed were Asian-American.

Students were interviewed individually, with interviews ranging in length from 30 minutes to 75 minutes. Each of the interviewers followed an interview protocol, which was developed by an independent evaluation consultant (Cynthia Char, Ed.D.) working with project staff. A team of three project staff conducted the student interviews. Since the purpose of the interview was to collect rich information for the case stories, each interviewer used the interview protocol primarily as a guide, and allowed student interviewees to take the interview in different directions, based on students' life experiences. The interview protocol, which is included in the appendix, consisted of key questions pertaining to six issue areas:

1. Experiences during childhood/youth,
2. Expectations of science studies at Dartmouth prior to coming to college,
3. Nature of their critical moment,
4. Subsequent personal impact of that critical moment,
5. Extent to which students felt their critical moment was influenced by their gender or ethnic identity, and
6. Recommended changes to teaching and learning practices in the sciences at Dartmouth.

In addition to notes taken by the interviewer, the interviews were digitally recorded using an iPod. The digital recordings of each interview were then later transcribed.

Results

Few surprises emerged from the first two issue areas discussed in the interviews. Several students discussed their childhood experiences (issue area 1) at length, citing excellent teachers and role models they had had over the years. Some students even indicated that their desire to study a SME major stemmed from their childhood experiences. None of the interviewees reported negative childhood experiences. When discussing their expectations for science studies at Dartmouth (issue area 2), most students stated that they expected science at Dartmouth to be much more challenging than high school; several interviewees made comments such as the following: "Oh, I'd already heard that the Bio and the Chem classes were weed out classes so I was already, like, afraid of taking them."

Student responses to the question, "do you think your particular race or gender (or other aspects of your personal identity) influenced the nature of your experience?" were surprisingly minimal (issue area 5). The interviewers expected many of the students to attribute their critical moments to their gender and ethnicity but most of the interviewees simply said "no." One female interviewee

made the following comment: "No. Not really. I just thought I'm a girl who's screwing up at science, that's all." One female interviewee did attribute part of her critical moment to her ethnicity: "I'm always the awkward Asian girl."

Several interviewees made thoughtful recommendations when asked what changes might be made to teaching and learning practices at Dartmouth (issue area 6) including:

- Offering additional TA problem sessions;
- Making lecture classes more interactive;
- Doing something to make exams less stressful.

Comments about teaching and faculty were overwhelmingly positive. This was a bit surprising since poor teaching in science classes was cited as a common reason for switching by Seymour and Hewitt (1997).

Most of the data for the case stories was drawn from issue areas 3 and 4 of the interview protocol, which focused on the critical moments. Each of the three interviewers independently reviewed the transcripts and developed a list of major themes that they felt emerged from the interviewees' descriptions of their critical moments. The interviewers, along with independent consultant Cynthia Char, then met to compare and discuss their themes and finally developed a single list of major themes. Five common reasons, or themes, for critical moments were identified. Roughly in order of frequency of comments, the themes were:

- **Exams** – Disappointing results on the first exam were cited as a critical moment by many students. Often students thought they were doing well in the course (based on homework and the textbook) and then were shocked to get a low grade on an exam. Several students reported the level of difficulty of college exams (as opposed to high school exams) as being much higher. Many students were also used to being at the top of their high school classes so even getting a B was new to them. Eleven of the thirteen interviewees commented on exams; some of their comments are as follows:
  - "That was really rough after coming from being at the top of my class in high school. I went into the exam feeling well prepared and then got the test back and I was in shock."
  - "Going into that exam, I thought I had a grip on things. I thought I understood the material better than the last one, and then they just gave a really hard exam, and the median on that exam was like a 50 or something like that."
  - "I thought I had prepared and he just, like, threw a curveball at us and it was, like, I was like, oh my gosh."
  - "The actual critical moment happened during the test. Like I would open the first page and I could do the first question. I looked at the second

question and I blanked. Then I looked at the question after that and it was basically the same story. I couldn't answer the questions."
  - "I got a 52 and I've never gotten a grade that low – especially on math."

- **Group Work Challenges** – Eight of the thirteen students interviewed talked about challenges associated with group work; in particular, several students stated that they were very shy and didn't enjoy working in groups or even attending office hours.
  - "Okay. One-on-one, I'm sort of not [shy], I'm more open. But put me in a group of three and I'll stop talking."
  - "I feel like study groups, I've never tried it, but just getting together with a bunch of other students that you don't know and trying to study with them, I feel like, oh, I don't want them to think I'm an idiot 'cause I don't understand something."
  - "We struggled to find a product to work on… there were limited guidelines and it seemed like everything we thought of had already been done. We finally decided to try to improve the design of a heated jacket. North Face had recently discontinued their heated jacket design so we investigated why and how to improve the design. My primary role in the project was to write the report. The three guys in my group had an easier time getting together so [they] took care of building the prototype."

- **First year** – Several interviewees stated that the first year was much harder than expected and they ended up "way over their heads." Students were accustomed to a lower level of challenge from high school. Five of the thirteen interviewees commented on the difficulty of adjusting the first year. A few representative comments are as follows:
  - "That was the overwhelming feeling of my freshman year—just feeling behind all the time, feeling like I have to work a hundred times more than anyone just to barely make it and feeling alone—and also there's this feeling that everyone else is doing just fine. I mean Dartmouth students seem to give this impression of "I'm doing just great!" So for most of the year I thought I was the only one."
  - "I came to Dartmouth with loads of AP credit and jumped in way over my head. I took Math 9/14 my first year, which is Honors Multivariable Calculus and then Physics 13/14. I was great in math and science in high school but I'm not like the math geeks here at Dartmouth. Me and my friends are more like in the second tier in math. There are guys who are just brilliant at math here, they seem to live and breathe math. I'm just not that into math…"

  - "Oh, I jumped in way over my head at first. Yeah, my start of freshman year was sort of… oh. It was bad."

- **Preparation** – Three of the interviewees cited poor preparation as the reason for their critical moment.
  - "I found at first that my preparation was very different from that of my peers, or so it seemed to me. I felt I was working ten times as much as everyone else just to stay barely afloat in chemistry and physics."
  - "So like my [high school] chemistry class was really sub-par. I don't know what you'd call it really. It was like we never had any lab experiments and it was just all textbook and no hands-on experiments and the textbook itself was out of date – like probably older than me."
  - "I thought they [science classes] would be a whole lot easier. I thought that they would maybe start from a base level. My high school didn't offer AP courses so I already came in with some sort of disadvantage."

- **Support** – The level of support— typically from family and friends—varied widely. Some students felt pressure from family and friends to pursue a certain career (often medicine) whereas others seemed to abandon a certain field because they didn't have any friends pursuing that major.
  - "'Cause it's like the typical Asian parents thing. Like all my friends who are Asians, they're like, oh, my parents want me to be a doctor. They just grumble a lot."
  - "My mom is always very supportive for some reason. She doesn't care what I do as long as I'm happy, which is definitely reassuring when you go through these kinds of changes, to know that there's somebody who's going to be behind you no matter which decision, which path you take."
  - "My dad's a doctor. And all his brother's are doctors and they hang out with doctors."

Case Stories

We wrote four case stories, one for each of the first four major themes or types of critical moments that emerged from the interviews; the fifth theme, support, played a part in all of the case stories. The purpose of the case stories, again, is to promote discussions about the retention of women and minorities in the sciences. The four cases were designed to be compelling illustrations of real students with representative critical moments. Each of the case stories focuses on a single fictitious Dartmouth student, who is typically a composite of 2-3 actual students. Each case story includes several actual quotes from the interviews (generally from several different student interviewees); direct quotes are shown in italics in the case stories.

Three of the case stories feature women, since the primary goal of the project is to promote discussion about the retention of women and minorities. One male character was included to portray one male perspective. Two of the characters are Caucasian (66% of the students who responded to the survey and 57% of Dartmouth undergraduates are Caucasian), one is Asian-American (12% of the students who responded to the survey and 13% of Dartmouth undergraduates are Asian-American), and one is African (7% of the students who responded to the survey and 6% of Dartmouth undergraduates are international students).

The case stories focus on the following four characters (all of the names used are fictitious):

Case Story 1. Antonetta: Disappointing Group Experience. Antonetta describes herself as a "shy, awkward Asian girl." Her critical moment comes when she has a disappointing experience with a group project in an engineering course. Antonetta is Asian-American.

Case Story 2. Dalila: Poor Preparation. Dalila is an international student with poor preparation in math and science who struggles to keep up at Dartmouth. Dalila is African.

Case Story 3. Greg: In Over His Head During the First Year. Greg comes to Dartmouth with "loads of AP credit" and what he thinks is a very strong background in math and science. Honors multivariable calculus and physics prove for a difficult first year experience for Greg. Greg is Caucasian.

Case Story 4. Michelle: First Exam… Michelle works hard and feels well prepared but is shocked when she scores below the mean on her first exam. Michelle is Caucasian.

Each case story, which is included in a separate box of text in this section, begins with some background on the student, followed by a vignette of the student's critical moment. Finally, a list of questions is included to prompt discussion. The facilitator of the discussion gives a brief background of the project before beginning the discussion (future handouts may include a brief written discussion of the project).

The project team views the case stories as evolving—stories that will be modified and expanded based on feedback from faculty and student discussions. After each discussion session, workshop participants are asked to provide feedback on the authenticity of each story and whether additional discussion questions should be included.

Case Story 1: Antonetta '09 – *Disappointing group experience.*

Background
Antonetta is Asian-American; she describes herself as a "shy, awkward Asian girl." She is scared of study groups and intimidated by the idea of seeing a professor during office hours. All of her close friends at Dartmouth are majoring in English or Psychology. Antonetta's parents have always encouraged her to become a doctor but she came to Dartmouth planning to pursue a career in engineering.

> *I volunteered in a radiology department in high school. And one of the technicians in the lab had been an engineer. When I learned more about engineering it seemed like the ideal job for me.*

The Critical Moment
Antonetta's critical moment (a trimester-long moment) came during a group project in ENGS21 – Introduction to Engineering. She enrolled in the course with high expectations.

> *I had heard so much about it. Just the way the class is set up was so exciting. You form your own groups. Then you research a product, develop a design, and then you build it. It sounds fascinating.*

Unfortunately, Antonetta didn't know anyone in the course so she was randomly assigned to a group with three guys. She reports that though they were all very nice, they were close friends so she felt like an outsider.

> *We struggled to find a product to work on… there were limited guidelines and it seemed like everything we thought of had already been done. We finally decided to try to improve the design of a heated jacket. North Face had recently discontinued their heated jacket design so we investigated why and how to improve the design. My primary role in the project was to write the report. The three guys in my group had an easier time getting together so they took care of building the prototype.*
>
> *Anyway, I just found the whole experience to be very disappointing. I'm now planning to major in psychology. Maybe my parents have been right all along and I should just become a doctor.*

Questions to consider:

1. Could the project or group experience have been better structured?
2. How much influence do you think Antonetta's parents had on her decision to major in psychology and possibly become a doctor?
3. How would her experience in ENGS21 have differed if she had had some friends in the course or at least majoring in engineering?
4. Would her experience have been better if she hadn't been the only female in the group?

Case Story 2: Dalila '08 – *Poor preparation.*

Background

Dalila is a sophomore from Kenya. She attended almost two years of secondary school in the United States and always intended to apply to competitive colleges here. She has wanted to be a doctor since the age of 8 but also has a strong interest in physics. She is the oldest of four and until she came to Dartmouth she excelled in all of her science and math classes, both in Kenya and in the US. But physics and chemistry courses in her first year at Dartmouth shook her confidence.

> *I found at first that my preparation was very different from that of my peers, or so it seemed to me. I felt I was working ten times as much as everyone else just to stay barely afloat in chemistry and physics.*

Both chemistry and physics courses were "flying through" loads of material and it seemed that the professor took no account of the various levels and types of preparation students had before coming to Dartmouth. She discovered much later that all of her peers had different levels and types of preparation and many who presented a good front were actually having as tough a time as she was.

> *That was the overwhelming feeling of my freshman year—just feeling behind all the time, feeling like I have to work a hundred times more than anyone just to barely make it and feeling alone—and also there's this feeling that everyone else is doing just fine. I mean Dartmouth students seem to give this impression of "I'm doing just great!" So for most of the year I thought I was the only one.*

Dalila was not aware of most of the support available to her that first year. She did not know about services at the Academic Skills Center such as organized

study groups and tutors. She knew that her physics professor offered office hours but when she finally mustered the courage to attend she felt intimidated by the large group of students there. It never occurred to her that she could ask for an individual appointment with him.

The Critical Moment
Then came that first chemistry midterm in week four of the term:

> *I opened the first page and wasn't sure where to begin. I looked at the second question and I blanked. Then the next and it was basically the same story all the way to the last question. I remember crying during the exam (and I wasn't the only one!)*

I got a 24% on that midterm because I guessed right on one question.

While Dalila knew that she was struggling in the course she had hoped that all of her hard work and studying would pay off and she would do okay on the midterm – 24% is not okay… She wondered if her dreams of becoming a doctor were over. What should she do now?

Questions to consider:
1. What can we learn from her story?
2. What could she have done differently?
3. How can professors take into account different levels of student preparation?
4. Do international students have special needs?
5. How can we at Dartmouth provide more opportunities for more one-on-one experiences?

Case Story 3: Greg '09 – *In over his head during the first year.*

Background
Greg grew up in southern California where all through middle and high school he was on the accelerated track in math and science. Having exhausted the math offerings at his high school, he took calculus at a local community college. As he puts it, he was "one of the ones who gets it" in math and physics and was often called on to help his peers. Almost from the first day at Dartmouth, he feels like he has been struggling and he is not sure why.

> *I have friends who didn't do as well as me in high school but are doing fine in college. I just think math and science at Dartmouth are like way harder than at other colleges.*

Greg came to Dartmouth planning to major in Physics and do pre-med, possibly even trying to become a MD/PhD.

Critical Moment

Greg's critical "moment" was really his entire first year.

> *I came to Dartmouth with loads of AP credit and jumped in way over my head. I took Math 9/14 my first year, which is Honors Multivariable Calculus and then Physics 13/14. I was great in math and science in high school but I'm not like the math geeks here at Dartmouth. Me and my friends are more like in the second tier in math. There are guys who are just brilliant at math here, they seem to live and breathe math. I'm just not that into math…*

Math and Physics did not go well for Greg his first year. His difficulties in math were compounded in Physics 13 and 14, which rely heavily on multivariable calculus from Math 9 and 14.

> *So, I mean, it was a good time but I think it was just too theoretical for me because 9 and 14 are honors courses. They are all about theorems and proving theorems and things like that, which I kind of like but we focused so much on theorems and so little on applications. When I couldn't visualize it theoretically, I had nowhere else to go.*

He is no longer planning to major in Physics. He is currently undecided about a major but "probably not in the sciences."

> *In the Physics Department, in order to take some of the higher level classes, you have to take three intro classes, 13, 14, and 19 and you have to have a certain grade average in order to even continue. So, if you don't have that grade average, which I don't have…*

Questions to consider:

1. What could Greg have done differently in his first year to have a better experience?
2. What could Greg's advisors and professors have done differently?
3. What are the differences between high school and college that made Greg's first year difficult?

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Case Story 4: Michelle '08 – *First exam…*

Background

Michelle came to Dartmouth from a large, well-funded suburban high school where she always did well in math and science courses. Still she was anxious about science courses at Dartmouth because she felt she had been "force-fed" information in high school and she expected college-level courses to be quite different.

> *Everything in high school was distilled – this is what you need to memorize, this will be on the test. I expected I would have to take far more responsibility for my own learning at Dartmouth.*

Michelle has wanted to be a marine biologist since she was a very small girl and spent many summers at the beach. In middle school and high school she really enjoyed her biology courses, especially the labs:

> *I absolutely loved our lab days; they had slides prepared for us to study under the microscope and I found that to be the most fascinating thing. I felt like, Oh, I can see myself doing this for life.*

In her first term at Dartmouth, Michelle took Biology 14 and Math 3, and though she had had some difficulty with high school calculus, she did well in Math 3. The sessions with TAs helped her understand each concept and maintain confidence for the exams. Bio 14 presented more of a challenge. She had to learn new techniques for studying and learning; it wasn't at all like the force-feeding she was used to in high school. Still she was enjoying the deeper learning she was getting in Bio 14 and felt she was getting the support she needed from her professor.

Michelle has great respect for her professors and has taken several of her professors to lunch through the FAST program (FAculty and Students Together). Says Michelle,

> *I really love all my professors. They're very open and friendly. They want you to do well and you can feel it, even when you're not doing well.*

The Critical Moment
Michelle scored below the median on her first midterm in Bio 14 and was shocked.

> *That was really rough after coming from being at the top of my class in high school. I went into the exam feeling well prepared and then I got the test back and I was in shock.*

Michelle's immediate reaction was to call her mom, who advised her to go talk to her professor. She took her mom's advice and has an appointment to see her Bio 14 professor next week. While she really likes her professor, she is worried about talking to him about the exam. What will he say? Will he be disappointed in her performance? What if he tells her that her dreams of becoming a marine biologist are unrealistic?

Questions to consider:
1. What should the professor say to Michelle?
2. If she had not made an appointment to see her professor how might the story have ended?
3. How would this story differ if Michelle had not had the support of her mom?

Conclusions

Discussion and refinement of the case stories and questions has begun. The case stories were discussed as part of the Graduate Student Teacher Training Series conducted by DCAL during both the winter and spring of 2007 and as part of the Math TA training program held during the summer of 2007. Feedback from the graduate students was positive – they felt the stories were authentic and engaging and they promoted an interesting discussion. Faculty will discuss the case stories during workshops held in DCAL during the 2007-2008 academic year. The case stories also are available through the DCAL Web site (http://www.dartmouth.edu/~dcal).

An evaluation of the effectiveness of the case stories is planned for the upcoming academic year.

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[3] A consortium of 34 private, select liberal arts colleges, funded by the Nellie May Education Foundation and hosted by Trinity College, Hartford CT. http://www.trincoll.edu/depts/student-services/chas/

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Appendix

Critical Moments Project Survey

This survey is part of a research project funded by the *Consortium on High Achievement and Success* (CHAS). The goal of this project is to determine why students persist with or abandon plans to pursue math, science, engineering or medical careers.

This is NOT a course evaluation; it is for research purposes only. The identity of participants in this study will NOT be revealed to the instructor of the course.

The purpose of this survey is 1) to determine why students persist with or abandon plans to purse math, science, engineering, or medical careers, and 2) to learn what types of "critical moments" you have had as a student and how they affected you.

A "critical moment" is an event or time that has a significant impact – either positive or negative – on a student's actions or interests. Most students have a critical moment during their academic career that either sparks their interest or leaves them discouraged or upset; a critical moment could result from a certain project or an encounter with a faculty or community member. A negative critical moment is an event or time when a student perceives that s/he is different, discouraged, unprepared, or vulnerable. A positive critical moment is a time when a student feels interested, excited, encouraged, and self-confident.

A. Have you had a "critical moment" (at Dartmouth or in a prior educational setting)?

_____ Yes _____ No

B. If you have had a critical moment, please specify when it occurred (while at Dartmouth, in high school, in a specific course) and whether it was positive or negative: _____

_____

C. If you have had a critical moment, what caused the "critical moment?" _____

_____

_____

_____

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D. If you have had a critical moment, how did you deal with the "critical moment" and what were the outcomes? (e.g., did it sway you away from or into a certain major?)

_____

_____

_____

E. Sex: _____ Male _____ Female

F. With which of the following groups do you self-identify?:

_____ African _____ African American

_____ Asian _____ Asian American

_____ Caucasian/White _____ Middle Eastern

_____ Native Alaskan/American Indian/ Native Hawaiian

_____ Southeast Asian/Indian _____ Other

G. What is your [prospective] major? _____

J. Are you willing to participate in an interview as part of this project?

_____ Yes _____No

K. Name (so we may contact you about an interview – your name will not be revealed to anyone beyond the project team). Students who are interviewed will be paid:

_____

Interview Protocol

Introduction/Purpose of Project

Warm-up Questions: To start off - What year you are at Dartmouth? and Where is your hometown?

1. Childhood/Youth: First of all, I'd like to hear a little about what you were like before you came to Dartmouth. Can you tell me a little about what you were like as a child and in high school, regarding your interest in science, as well as any possible career interests you might have had?

Probes:
1. What were your interests in science?
2. How did you do in elementary and high school in the sciences?
3. What were your thoughts on future careers?
4. Were there any particular people who influenced your interest in science: parents, friends, close family friends, teachers in the sciences?

2. Expectations: Before arriving at Dartmouth, what did you expect studying science at Dartmouth would be like?

Probes:
1. How has what you've actually experienced compare with what you expected? (Similar? Different?)
2. Was there anything that took you by surprise when you got to Dartmouth regarding your experiences in the sciences?

3. Critical Moment Description: As I mentioned earlier, the purpose of this project is to learn more about "critical moments" that you might have had as a student at Dartmouth. We define "critical moment" as an event or time that had a significant impact – either positive or negative – on a student's academic life. A positive critical moment is an event or time when a student feels interested, excited, encouraged, or self-confident (this type of critical moment may cause a student to consider pursuing a certain major or become much more interested in an area of study). A negative critical moment is an event or time when a student perceives that s/he is different, discouraged, unprepared, or vulnerable (this type of critical moment may deter a student from a certain major, or question whether or not to pursue studies or a career in a particular area.)

In your survey, you indicated that you had experienced a critical moment relating to the sciences while at Dartmouth. Can you describe for me what that critical moment was like? It would be great if you could give me as much

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detail as possible – such as where this critical moment took place, who was involved, what happened, and what was said and done.

Probes: 1. Probe as much as possible for details – images, feelings, dialogue, feelings, people directly around them.

4. **Impact:** What happened following your critical moment?
   Probes:
   1. How did you feel or react?
   2. When you were trying to sort out this experience, did you talk about your critical moment with others, such as friends, family, professors, others? (If so, tell me about that.)
   3. Did this critical moment change your views or how you then pursued your work in the sciences?
   4. Did your critical moment sway you away from or towards a certain major?

5. **Personal Identity:** Looking back at your critical moment, do you think your particular race or gender (or other aspects of your personal identity) influenced the nature of your experience?

Optional question (Time permitting) "Do you have any sense of whether other students here have experienced something similar to your critical moment?

6. **Changes:** Are there things that might be done differently at Dartmouth to make it a more positive place for you, and students like you, to pursue science?
   Probes:
   1. How did you find your science professors' teaching style? Did it work OK for you?
   2. How were your interactions with faculty and teaching assistants in the lab? Outside of class?
   3. What was the atmosphere of your science courses and classrooms like - Did you feel comfortable in class?
   4. Did you work much with your classmates and peers – In-class? Outside of class? (Study groups?)

7. **Wrap-up :** Anything else you'd like to share with me?