

**2006-1381: I WISH SOMEONE WOULD'VE TOLD ME: UNDERGRADUATE
ENGINEERING STUDENTS OFFER ADVICE TO INCOMING STUDENTS**

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All the world's a stage,
And all the men and women merely players:
They have their exits and their entrances;
And one man in his time plays many parts,
His acts being seven ages.

~William Shakespeare-All the World's a Stage *from* As You Like It

William Shakespeare's *As You Like It* begins with a soliloquy called "The Seven Ages of Man," that addresses human transitions from infancy to childhood to schoolboy to young lover and beyond.¹ With all due respect to Mr. Shakespeare, we are borrowing the metaphor of a stage and actors to frame an interpretation of the responses of 185 engineering and physics undergraduates to the question: "What advice if any would you offer incoming students to the College of Engineering?" Unlike Shakespeare who characterized his schoolboy as "creeping like a snail, unwillingly to school," we found undergraduate engineering students to be eager for the transition to college, but often under-prepared for and ill-informed of the challenges to be encountered as students progress from the small civic stages of high school to the Great White Way of comprehensive research institutions of higher education.

A student's transition from high school to college entails a monumental shift in perspective and degree of responsibility. This shift of roles for the student, metaphorically speaking, can be thought of as transitioning from being an actor ordered about the stage by other directors to being both the lead actor and the director responsible for all aspects of the production.

Advice offered in our research interviews by predominantly upper-division, undergraduate engineering majors to incoming freshman is interpreted and described through this metaphoric framework. Our students instruct the new collegians to:

- set the college stage early by knowing their desired major and being adequately prepared to pursue that major;
- engage a supporting cast of peers, patrons and programs to become thoroughly involved in their academic careers;
- accept the role of director by assuming academic responsibility including improving time management and study habits, and
- anticipate and overcome critic's reviews in the form of external grades and internal doubts.

The data suggest differences in advice given by male and female students and students from different classifications (*i.e.*, lower division students versus upper division students). This paper reports trends in the attitudes and advice expressed by these students. A consistent finding is that each student must assume personal responsibility for determining, strategizing and achieving desired goals. Advice to students from students can be added to a repertoire of strategies called upon to negotiate incoming students' transitioning from one stage to the next.

Most of the advice given by our students mirrors the advice of faculty, professional counselors and advisors, and literature sources.²⁻⁶ What makes this advice especially important is that it comes from peers, instead of authority figures. Seymour and Hewitt have identified peer advice as more valued by students than advice from formal sources.⁷ Students are, in some sense, more qualified than formal sources to give advice to undergraduate science, technology, engineering, and mathematics (STEM) students. Many counselors and advisors were not STEM students during their undergraduate program. Faculty, while more often STEM students as undergraduates, are likely to have been elite students, who underestimate the challenges facing the average student.

The advice expressed by our 185 interviewees, most of whom are upper division, derives from their actual lived experiences, reflecting on the challenges they have faced in the context of successfully negotiating an engineering curriculum. Most perceptions of strategies needed for success reported in the literature result from surveying or interviewing first-year students.⁸⁻¹⁰ First year students, while temporally associated with the new challenges of college life, have a narrow context in which to place their limited experiences.

The combination of population, sample size and open ended interview protocol distinguishes our methodology from most of the literature addressing students' academic progress. Our respondent population of engineering and physics students at comprehensive research universities is more homogenous than that in studies that incorporate all STEM students,⁷ or the general student population.^{8, 10, 11} Our study answers the call in the literature for more institution-type and discipline specific research.^{12, 13} Focusing on successful students separates us from Seymour and Hewitt.⁷ Other studies using open ended interview protocols use smaller sample sizes.^{3, 9, 10} Student surveys tend to focus on evaluating the efficacy of academic activities and support services,^{3, 8, 11} whereas an open ended protocol allowed our students to generate spontaneous responses and address intrinsic factors.

Research Methodology

As part of investigating an undergraduate engineering program's achievement of gender parity, 185 undergraduate engineering and physics majors were interviewed (215 total interviews). The one- to two- hour semi-structured interviews included students attending four large, comprehensive, research institutions in the United States of America. At our Home University (HU), a public university in the southern plains, we interviewed students in computer science (CS), electrical and computer engineering (ECE), chemical engineering (XE), industrial engineering (IE), and physics (PH). We also interviewed IE students from a public, mid-western university; a private, eastern university; and a public university in the southwest. In Table 1, the institutions are referred to as Midwestern University (MU), Eastern University (EU), and Southwestern University (SU), respectively.

The demographics for participating students by institution, major, and gender are given in Table 1. One participant at HU is a double major in CS and ECE and thus is counted in both majors, but as only one-half interview for each.

Table 1: The number of participants disaggregated by institution, major, and gender.

Institution	Major	Participants	
		Male	Female
HU	Industrial Eng. (IE)	24	27
HU	Computer Science (CS)	13*	9
HU	Electrical and Computer Eng. (ECE)	16*	3
HU	Chemical Eng. (XE)	10	13
HU	Physics (PH)	6	4
MU	Industrial Eng.	12	14
EU	Industrial Eng.	7	10
SU	Industrial Eng.	4	14
Total	All institutions	91*	94

* One male student is counted for both CS and ECE because of double major.

Table 2 provides the distribution of students within each major by their classification. We separate lower division from upper division students at roughly 60 credit hours because of fourth and fifth year students, students who enter school with sophomore standing, students who change majors, and other anomalies. Twenty-five students in our data set were interviewed two or three times at different points in their academic career, therefore we present classification by interview rather than student.

Table 2: The number of interviews disaggregated by major and classification.

Major	lower division interviews	upper division interviews
CS	3	18.5*
XE	9	14
ECE	2	16.5*
IE (incl. all site & former majors)	22	120
PH	4	6
Total	40	175

*Number of interviews shows the double major as ½ per department.

Because our sample population is skewed towards upper division students, large numerical differences in the classifications of respondents might not represent a corresponding difference in the fractions of upper and lower division students offering that advice, e.g. 30 upper division respondents represents 17% of that population, while 10 lower division respondents is 25% of that group. Therefore, when we discuss specific numerical differences in advice from students in the two groups, we will include the note (X% UD, Y% LD; in this example, 17% UD, 25% LD) to indicate the fraction of all respondents within that classification grouping.

The semi-structured interview protocol requires the interviewer to augment standardized questions with additional probes as needed. Students were asked questions which encouraged them to describe their educational background and experiences in college. Near the end of the interview, students were asked, **“What advice would you give a freshman or high school student considering your major, or engineering in general, at your institution?”** The data used in this paper comes from student responses to this question.

Interviews were transcribed, reviewed for accuracy, sanitized to remove identifying information, and coarsely coded using NVivo qualitative data analysis software. The coding was reviewed to ensure accuracy. The coarse coding placed all answers to this question into a single category. Finally the responses to this question were further coded to capture the specific advice offered and whether that advice seems to stem from experience (having successfully implemented the strategy) or from wishful thinking (believing that this strategy would have helped negotiate their degree path). The experiential base could not always be determined; therefore, analysis based on this criterion is only presented in significant cases. These comments were re-grouped to elucidate trends in meaning and intent. Thus we arrive at the four themes discussed here, elaborating the most significant strategies that support each theme. We give considerable thought to gender-based trends in the advice because the overall study to which this analysis contributes focuses on the attainment of gender parity in a particular engineering school. We discuss the distribution of advice between lower division and upper division students because some literature suggests that a student's strategies and advice change during their academic and personal maturation.^{7, 10}

We include here many quotations from the student interviews. Students are identified only by gender, major, and classification to protect privacy. The quotations have been edited for clarity and brevity removing most digressions, restarts, and fillers like "you know"; these edits are represented by ellipses (...) in the quotation. Square brackets [] indicate the addition of a word to help with contextualization. Text within a quote that is enclosed in parentheses () indicates our best guess at text that could not be clearly discerned in the transcription or an indication of a verbal cue (pause, laugh, chuckle).

Results

Emerging from these interviews are students' stories, expressing their understanding of the world around them. A student's academic life occurs in the midst of a complex matrix of external forces and internal predispositions. The use of stories is a powerful vehicle for depicting and explaining these interconnected phenomena, i.e. high school preparation, financial resources, peer-networking, faculty/student relationships, personal responsibilities, course load and study habits. The breadth and richness of narrative stories can easily accommodate multiple and intersecting phenomena not easily handled by simple explanations.¹⁴ Narrative based research has made its way into the canons of engineering literature.^{7, 15} Qualitative research approaches in engineering education have been surveyed.¹⁶

Through the use of metaphor, we bring the matrix of phenomena beyond individual stories into a generalizable meaning. The metaphor also serves as a vehicle by which to transmit these students' lived experiences to individuals not versed in academic or institutional language. For example, academic terms that we take for granted, such as office hours, can be lost on students whose previous teachers taught class from 8 to 4 and then left for the day. We envision these results as a tool to be employed in the recruitment and retention of widely divergent high school students to STEM majors. There are probably other metaphors, such as commonly used sports or military ones that could also describe the advice our students offered, but we chose the stage since it is gender neutral. Even if a student has not participated in theater, actors, directors, and stages are a prominent context in popular culture.

Our seasoned actor/directors, engineering undergraduate students, thus instruct novice directors, the incoming freshmen assuming this new role, to set the college stage early, engage a supporting cast of peers and patrons, direct for success, and anticipate and overcome critic's reviews.

Choose and prepare for your major

Success in college and in the professional world beyond requires many forms of preparation and planning. Our students recommend that students select majors to suit their abilities and interests and to determine experimentally if their choices are correct early in their degree program. Our participants also see appropriate academic preparation as essential. Similarly, background knowledge is essential to a theatrical director, including understanding the historical context of the work, lighting, and staging. Memorizing the lines for the wrong script, studying hip-hop dance then auditioning for "The Nutcracker" ballet, or directing "Hamlet" and expecting uproarious laughter, all would result in frustration and disappointment.

Twenty-three percent of our students (43 of 185; 20 M, 23 F) recommend new students choose a major they are interested in that leads to a career they will enjoy.

You should have a sense of what you want to do and you should look into the future and see if it's going to be worth while and you should be interested in what you like. Because you're not going to be successful if you don't like it because you're going to be bored with it and you're not going to pay any attention.
(female, XE, lower division)

This advice aligns with the findings of Malgwi, Howe and Burnaby: interest in the subject is the primary influence for a successful choice of major, persistence in a major, as well as the primary positive factor influencing a change of major.¹⁷ Similarly, Seymour and Hewitt found that students have the best chance for successful completion of their intended major when they choose based on an intrinsic interest in the discipline and subsequent career.⁷

Ten participants (4 M, 6 F) advise freshmen students to use introductory classes to determine their interests and abilities while choosing a major. These students believe that this experimentation provides a taste of the major and aids in the decision of whether or not it is compatible with their interests and goals.

If you aren't really sure, ... take the Intro to Meteorology class, take the Intro to Architecture class or whatever it is because usually they're only one hour classes, it might cost you a little bit but it really helps to know if you're really interested or just kind of interested and it will save you a lot of money in the long run, if you know. Because I mean, really after I took the Meteorology class I was like, gosh I'm glad I didn't take anymore classes because I would really have hated it had I taken those classes. *(female, IE, upper division)*

This insight from our respondents aligns with Roe Clark's observation that most students do not recognize the opportunities that college classes present for exploring and clarifying career-related goals or discovering talents and preferences.¹⁰ Other strategies for selecting a major recommended by students include being knowledgeable of the details of a major before choosing it, knowing aptitudes beneficial for different majors, and speaking with faculty and students

presently in the major. More complete knowledge of occupational specialties has been associated with greater confidence in career choice.¹⁸

Malgwi et al reported that the top positive factors given for choosing a new major later in their academic careers are the same for both males and females, even though there were differences in factors associated with students' initial choices of majors.¹⁷ In contrast, we find no substantial difference in advice regarding reasons to choose a major/career between male and female students of either upper or lower division classifications.

Four percent of the students (8 of 185 students; 6 F, 2 M) advised students to prepare for college academically and financially. These students report feeling overwhelmed by the academic and financial demands of college, a significant factor in attrition from STEM.⁷ Some students recommend taking college courses during high school to prepare for college.

...take some college classes while you're in high school, so you have that, that transition. You understand what college classes are like before [you start college]. (*female, IE, upper division*)

Network and get involved

Involvement has been positively linked to student cognitive and personal development;⁴ development of leadership skills, job placement potential and success,⁵ and retention.^{5,6} Sixty-two students (40 F, 22 M, some students contributed to multiple categories) advise newcomers to get involved on many levels as an avenue for establishing a necessary supporting network. Thus, many of our actor/directors recognize that surrounding themselves with a great supporting cast is one key to developing and sustaining an academic and professional career.

Networking, described as a strategy for building relationships providing benefit to the individual, is offered by 30 of the 62 respondents as the motivation behind getting involved. Ninety percent of these 30 students are upper division students (15% UD, 8% LD). That twice as many of these more experienced students recognize the value of engaging in relationships and activities that positively impact their academic performance is not surprising. As others have noted,^{10,19} as students mature both in their academic and personal lives, they may feel a greater sense of empowerment to identify potential challenges and develop specific strategies to address them.

In line with the findings of Amenkhienan and Kogan,³ students self reported the following actions as having the most positive impact on their academic performance:

- building relationships with fellow students
- establishing relationships with faculty and,
- engaging in both co-curricular and extra-curricular programs.

Cast of Peers: Building relationships with fellow students in order to study together, share old tests and notes and as a personal support group through challenging times is offered as a strategy for networking by slightly more than 13% (24 of 185) of the students interviewed.

Get to know the people in your class and study with them, you'll be with them for four years. Become friends with them. (*male, ECE, upper division*)

Definitely make friends within your major because engineering seems to be so group oriented and...I just don't see how anyone could get through engineering anytime, without um, working with others. (*female, IE, upper division*)

Engaging with peers who are pursuing the same goals can be reassuring and adds to confidence levels.²⁰ Just as stage actors must learn to trust their fellow actors, it is beneficial for students to develop trust within the competitive environment of engineering.⁹ Additionally, students report that these relationships directly contribute to a richer understanding of subject material, as well as the attainment of satisfactory grades.

...create that network of friends in your cohort, to help each other, because it's so useful and it's so nice to be able to have a student in your class that you can trust. And it's so nice to find people that you know are on the same pages as you, you can trust to work with, and you know are going to be reliable and dependable in doing projects and whatnot. (*female, IE, upper division*)

...it's really a good idea to make friends in your classes so you can bounce ideas off of each other if you don't have an understanding of one section that they might and you might have a better understanding of a different section than they do. So I think that's really going to make or break you in the class. (*female, IE, upper division*)

Drawing on the wisdom of those who have gone before for advice regarding class content and professors is mentioned by 30% (7 of 24) of these students. Much like Seymour and Hewitt found,⁷ these students indicate that the best information about which classes to take or to avoid comes from students who have experienced them.

I think networking among the students is really important. Especially the students that are maybe just a year ahead of you and have just taken the class you're in ... and kind of get advice from them on either the professor or the material or the best way to study or whatever the case may be. (*female, IE, upper division*)

Definitely get to know the TAs. I would say that has helped me a lot. In the class that I have had that I've talked to the TAs, it's so much easier if you can talk to them and if you can get help from them, because they know the information. (*female, CS, upper division*)

The notion that personal and academic success is dependent on building relationships with others does not appear to be gender specific, (13 M, 11 F). However, this advice is given primarily by upper division students who comprise 22 of the 24 individuals (13% UD, 5% LD). Thus, more than twice as many upper division students place importance on building relationships among peers. Eighty percent of these students (19 of 24) base their comments on positive experiences—they have experienced the value in building such relationships.

Supporting Patrons: Twelve percent of the participants (23 of 185; 11 M, 12 F), advise freshmen to establish relationships with faculty. Twenty-six percent (6 of 23) of these students value these relationships as a means to gain access to internships, jobs, research assistantships, or scholarships.²⁰ From the students' perspective, more opportunities are made available when

professors are able to put a name with a face. Taking advantage of office hours is recognized as a vehicle to achieve that end.²¹

... get to know your professors. Go to office hours. They'll nominate you for scholarships and you don't even know it... So, I mean, they'll help you in that way, they'll help you whenever you graduate, letters of recommendation and stuff like that. I mean, it's a big help. (*female, IE, upper division*)

Although there is no difference in the number of men and women who give this advice, the meaning behind the advice from men and women is different. For example, the women focus on building relationships with faculty to gain access to more opportunities (e.g. internships, scholarship nominations). Seven of the 12 women mention future opportunities as the primary reason for getting to know faculty, whereas only three of the 11 men give this reason. One possible motivation for this advice is that, according to Anastasia,⁸ female students seek internship experiences to validate their choice of major and career.

This semester I am an undergrad research assistant and that is something I don't think I would have ever known about which knowing the professors because they are the ones that are going to offer you things like being an undergrad research assistant. Get to know them on a personal level. That really helps. (*female, IE, upper division*)

The male students more frequently mention getting help with coursework as a primary reason for building faculty relationships. Five of the 11 male students talk about spending time with faculty to gain a better understanding of class material. Only three of the 12 female students give this reason.

Twenty-one of the 23 students offering this advice are upper division students (12% UD, 5% LD). Most likely, the upper division students have been afforded and acted upon more opportunities to interact with faculty. This supposition is supported by 70% (16 of 23) of the students basing their advice on positive experiences with faculty. The remaining 30% (7 of 23) express positive experiences with faculty, but wish they had developed these relationships sooner.

... get to know the professors, I wish I had talked to the professors more early on in my career. I could have been doing research much sooner; I could have been getting involved in things going on in the department much sooner. (*female, IE, upper division*)

Join the Guild: Just as actors need to join the Actor's Guild to network with the theater community, getting involved in student organizations is an essential component of academic networking. Seeking new academic and social associations and experiences has been found to enhance students' abilities to think critically and integrate coursework and different ideas.¹⁹ Thirty-one (24 F, 7 M) students strongly encourage freshmen to engage in both co-curricular and extra-curricular programs, whether strictly engineering groups or campus-wide groups. Students did not directly advise freshmen to get involved in engineering-specific groups, but it is interesting to note that only one student gave a non-engineering group as an example.

...join everything even if you're not [ethnic minority] just join everything your freshman year, even if you're not going to be in it very long, even if you don't pay the membership fee. That's the best way to meet people, have great career conferences, with especially the minority groups. (*female, ECE, upper division*)

... I didn't join as many student organizations as maybe I should have. Maybe I should have gotten out there and gotten more involved and I kind of regret that sometimes. (*male, IE, upper division*)

Get involved in AICHE [American Institute of Chemical Engineers]. You see a lot of them not get involved until like maybe their junior or senior year and they're kind of, it really, it really sucks at the senior banquet, who [those who join late] don't know what's going on and don't have the relationships with the professors that all the other students have. (*female, XE, upper division*)

The three most prominent reasons given by students for joining the guild are improving interpersonal skills, learning about other majors and potential career paths, and socializing. Only one student suggests getting involved as a means to pad his or her resume. Faculty often recommend extra-curricular involvement as a means of enhancing a resume. Our students offer the same advice for different reasons. Female students comprise a majority offering this type of advice.

Assume academic responsibility

The students in our study recommend that new students assume academic responsibility, recognize they are in a different environment, manage their time on macro and microscopic levels, and adopt sufficient and efficient study habits. In metaphorical terms, after a student arrives on the collegiate stage, their new role as director of their academic production becomes as important as their role as the leading actor.

The significance of this category is demonstrated by the large number of respondents. Fifty percent of the respondents (93 of 185, 47 F, 43 M) share these sentiments. Since many students had advice in multiple categories, the sum of the numbers of students in the following sub-categories is higher than 93.

"You're not in high school anymore" sums up one advice category offered by 23 students (13 F, 10 M). Students observe that the demands of college are different and generally more rigorous than those experienced in high school. Incoming students need to be mentally and emotionally prepared to meet these new demands.¹⁰ "You can take AP classes all you want in high school and it's nothing compared to coming into a college class." (*female, XE, lower division*) Students also need to realize that they won't be led through the college experience in the same ways that they were in high school.

Don't expect anybody to tell you what to do, you have to figure that out for yourself. You can ask people what to do and they'll tell you, but don't expect them to help you along. (*male, ECE, lower division*)

Sixty-seven students of the 93 in this category (34 F, 33 M) recommend time management and setting priorities for a balanced life and academic success. At the macroscopic time management level, 25 students (11 F, 14 M) address curricular complications arising from interests outside engineering, schedule conflicts, and repeating courses by admonishing students to carefully plan their courses. A male student (*IE, upper division*) commented, “Plan out your entire college career... You need to take it and figure out if it is do-able...” Aspects of this advice include being aware of intermittent course offerings, seeking professor and course recommendations from upper division students in the major, taking courses at a local community college, and paying careful attention to discipline-specific foundational courses.

Get course advising very early and an idea of recurrence very early. One of the reasons it took me five years, one issue is because I was out of the rotation for the course schedule so I had to wait for these courses to come around so I just take other fillers at a time. (*male, ECE, upper division*)

...let me help you pick out which professors are good and which ones are bad. Because you don't want to get stuck having a bad professor when it's avoidable. (*female, IE, lower division*)

Well, probably what classes to take and when. Like some classes I wouldn't advise taking with other classes because, for instance, taking [class 1 and 2] I mean they're both pretty time demanding courses so I would probably advise against that. (*male, IE, upper division*)

Know your statistics. It is very important that you really, that statistics class, it says it is just a general engineering course and you wouldn't think much of it, but it does make a difference because I've noticed that industrial engineering does use a lot of statistics. It is really, it is a foundation of engineering. Know the statistics. (*female, IE, upper division*)

Amenkhienan and Kogan reported that the students who met or exceeded their academic expectations were those who more quickly recognized a need for better time management skills.³ This observation coincides with Seymour and Hewitt who suggest that STEM students discover very quickly that class work must take precedence over all other educational interests.⁷

Microscopic time management (20 students, 11 M, 8 F) follows from what would seem to faculty to be obvious success strategies for students at any level: attend class, don't procrastinate on assignments and keep up. That 11 percent of our interviewees felt the need to state the obvious, out of any and all advice they could offer, speaks to the disconnect between what peers and patrons think the actors need to be told.

...make sure you go to every class. Attend office hours. Keep up with your work, because it's hard once you get behind. If you get behind in an engineering class, you might as well give up. I have friends [not engineering majors] who never go to class and they do just fine. But they just have to read a book and go write a report on what they just read. In engineering, if you are not there to watch them explain it to you, it's very hard to pick it up just from the book. (*female, IE, upper division*)

Woodfield et al found that class attendance is the strongest predictor of degree attainment among several variables examined.²²

Another aspect of time management includes both a time component and a value component as 32 (18 F, 14 M) of our experienced student-actor/directors extolled the virtues of setting priorities, all stating or implying that academics should be the top priority of a student. One student (*female, IE, upper division*) advises, “you’ve got to get your priorities straight and actually like follow a plan that you’re going to do,” while another (*male, ECE, upper division*) comments that “coming to college is not really a time to socialize.” As one male student (*IE, upper division*) remarks, “You have to study constantly. It is not something you can do on a Tuesday or Thursday. It is a discipline.”

Some advice specifically warns students of the hazards of independent living.

...the freedom you get whenever you come to college is something that overwhelms a lot of people. And if you want to be an engineer and make it worth while, you have to put the time into it. (*male, IE, upper division*)

...there are some kids who have never had freedom or they have curfews all the time and they go to the dorms ... and they party hearty all the time and they don’t get any work done ... you need to take things seriously not too seriously, study enough but not too much and not too little. (*female, XE, lower division*)

The second student above also illustrates the sentiment of many that a balance between academic focus and leisure time is necessary.

Also related to that potential pitfall confronting freshmen is the advice from a substantial group of students (8, 4 F, 4 M) recommending that although freshman and sophomore classes may seem easy or repeat high school classes, the incoming students should give them considerable effort to pad their GPA before undertaking more rigorous classes in their major.

More female than male students, as might be predicted, instruct the freshmen to get their work done first, then play, but also more females than males advise students to make time for play – that is, balance the hard work required in engineering with relaxation and recreation.

...You have got to manage your time and then you can go out and have fun like you’re supposed to do in college, ... you have to get your homework done even if you have to sacrifice the time that you’re supposed to be going out, you just have to, because if you don’t you’re not going to accomplish what you need to get to where you want to be. (*female, XE, lower division*)

Finally, 51 (23 M, 28F) students proffer advice regarding study habits. Eighteen female and seven male students tender broad commands to study hard or efficiently or just get good study habits without describing their vision of what that entails; whereas, 37 students (19 F, 18 M) provide specific examples of good study habits. We are unsure why the specific advice is evenly distributed and females predominately offer the more general instructions. The study advice section is the only area where a distinctive gender difference is found in the Direct for Success

category. Besides the difference noted in general advice, more female students mention finding aid in fellow students, especially through forming study groups.

Examples of specific study advice include what to many students and most faculty would be considered obvious:

- get help, including attending office hours, (20 total, 10 F, 10M)
- pay attention in class (5), and
- do homework (8).

the big thing in a lot of classes the professors don't give you a homework grade but they give you suggested homework. Always do that homework. And that's a big thing. That gets a lot of people. Because they think this is not required so I am not going to do it. Then once you do that homework go talk to a professor and talking to that professor helps at times. ... you get a lot of help that people who don't go to office hours aren't getting. (*female, IE, lower division*)

I didn't do that (pause) when was it - probably those semesters I was struggling I didn't go to office hours, you know. And I don't know if there's a direct relationship between when my grades started getting better and whenever I started camping out in the TAs office. (*female, IE, upper division*)

Students suggest finding friends or peers within the major to assist with course work, joining a study group, and finding a tutor as other ways to get help in addition to office hours.

Several students mention the need to be proactive in seeking help in college, "If you need help, get it. Cause it's not just gonna come to you." (*female, IE, lower division*) Echoing the findings of Seymour and Hewitt,⁷ our students also observe a relationship between academic excellence in high school and reluctance to ask for assistance in college. A male student (*IE, upper division*) stated, "When you're in a class and you're frustrated, ask for help. You know you just refuse to get help because you think you know it..." Or in the pained revelation of this female student:

I would say probably just to hang in there. I know that it was very hard for me coming out of high school I had always done really well and I hadn't really needed to try that hard. I guess it is really different when you get into engineering. All of a sudden you're not as smart as you used to be and things are pretty hard. Another thing I would probably say is don't be afraid to ask for help. I had a hard time with that when I had a hard time in classes. I just thought it was me and that I was stupid and didn't know what was going on. I had never had this problem before. Help is there for a reason. Don't be afraid to ask questions and look for help. (*female, IE, upper division*)

Persevere

Grades are often viewed as intrinsic measures of self tied to notions of self esteem.⁷ A student's interpretation of disappointing grades and other difficulties in courses as harsh criticism could lead to self-doubt and attrition. Seventeen percent (32 of 185; 14 M, 18 F) of our respondents advise incoming students to not get discouraged, even in the face of such challenges. In other words, despite disappointing critical reviews, the show must go on.

Ten participants maintain that course work in an engineering curriculum is demanding and has a tendency to promote a sense of discouragement or despair, however, the value of an engineering degree is well worth the commitment.

Stick it out, I think... it's really something you have your heart set on, that you have to really hang in there... It's not fun at all. You think so many times, 'God, I don't know if I want to do this', you know, 'I don't know if this is for me', 'I don't know if I'm gonna be any good at it.' ...But you just have to hang in there, you know, it does get better. And, I think, I've really been happy with it you know, I'm really glad I stuck with it, and didn't switch. (*female, IE, upper division*)

Fourteen students comment upon the tedious nature of general education and general engineering classes (*e.g.* statics, or electrical science), stating that a freshman's chosen major will become more interesting and engaging once he or she progresses into the major course work.

The basic level classes are horrible and boring. Once you get into actually what you want to do and your specialty, it is a lot more enjoyable and you actually know that you are doing what you want to do. (*female, IE, lower division*)

Finally, the interviewees state that freshmen should generally not become discouraged with their choice of major, offering encouraging statements such as (*male, IE, upper division*) "Don't get psyched out. It's really not that hard. You can do it." and (*male, PH, lower division*) "...just don't get discouraged with the work. Look toward what you want out of it in the end."

Conclusion

This work is part of an ongoing research project to understand why a particular program achieved gender parity. Achieving gender parity is a function of both recruiting and retention. We sought to uncover tested strategies for succeeding in engineering by asking students what advice they would offer incoming students. The analysis of this advice along discipline, demographic, and institutional lines continues.

Our data set does not allow us to address differences in student success strategies that are specific to type of institution (*i.e.* small institutions, engineering focused). Further research along these lines would complement our study.

As we interpret the significant trends in the data, the language of stage, actor, and director provides a conceptual framework uniting the broad range of student advice as well as generating a cohesive meaning. The efficacy of this metaphor was demonstrated when, during the writing of this paper, one of the authors successfully used the metaphorical language in discussions with prospective students and parents with limited collegiate experience.

In summary, each student is ultimately responsible for the success of his or her own collegiate, academic production. However, this task will seem less daunting if the tools of the trade passed down from experienced students are used wisely.

In setting the stage for their production, new directors should prepare for a college workload by:

- taking advanced classes in high school,
- using their freshman year to explore possibilities,
- researching intended majors/careers.

Once a production is chosen, the actor/director must develop a supporting cast of peers, patrons, and programs. Our students recommend that this academic and social network be built by:

- finding support from co-curricular students,
- taking advantage of opportunities provided by faculty,
- engaging in co-curricular and extra-curricular activities and programs.

Assuming the role of director is essential to negotiating the challenges of undertaking such a large production. Our seasoned students suggest that ensuring academic and professional success is achieved by:

- recognizing that college is more than glorified high school,
- setting personal and academic priorities and managing time to reflect these priorities,
- learning to study efficiently and effectively,
- seeking help

During the run of this academic production, there may be harsh critical reviews. Setbacks in the form of disappointing grades and self doubt may have to be overcome. Our students recommend pushing through the hard times and not giving up as an effective strategy for recovering momentum lost to external and internal criticism.

While on many issues our students speak with one voice, apparent inconsistencies arise from using different strategies to face the same challenges. Some students recommend that knowing your major before starting college is beneficial, while others encourage exploration early in college to find the best major for you. There is advice to get heavily involved in activities, but there is also advice to focus exclusively on school, a few of the participants even recognize the value of balancing work and play. While some students advise that all general education classes should be taken early as the newcomer experiments with different interests, other students suggest that these presumed easier classes need to be spread out to balance the course load throughout their tenure. Conflicting advice could be confusing for the new collegiate player unless they understand that the underlying principal is that each student is not, as they often see themselves, merely an actor on the stage, they are in fact, the director of their own academic production.

...for the most part, it's not like high school, you definitely need to be in charge of your destiny and fight for it. (*female, IE, upper division*).

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