AC 2012-3321: ADULT UNDERGRADUATE ENGINEERING STUDENT EXPERIENCE

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Abstract

Efforts to remain competitive internationally in engineering and technology require that engineering departments train a diverse set of talented students. One aspect of student diversity that is often overlooked is student age. Adult learners are an important source of future engineering professionals, and it is critical that these students are supported through degree completion. Because relatively little research has focused on adults as a special population among engineering students, this study aims to elucidate adult engineering student experience. Qualitative interview data was chosen as the means to collect rich information about the lived experience of adult engineering students, providing depth that would not be accessible through quantitative data. Semi-structured interviews were conducted with ten undergraduate students aged 25 or older, focusing on their experience pursuing engineering bachelor's degrees at a small, private northeastern university. Interviews were transcribed and analyzed by applying grounded theory to identify major themes and connections. The four major themes identified in the data are: motivations, challenges, strategies, and outcomes. Adult students have a wide variety of motivations related to supporting themselves and their families, personal challenge and achievement, and intrinsic interest in or identification with engineering. Major barriers to completing their degree work include time stresses; barriers which prevented them from undertaking engineering degree work earlier in their lives include academic readiness. Strategies for overcoming obstacles are tailored to the barriers they experience, but commonly include sleep reduction and seeking academic and financial assistance from multiple sources. These adult students cite positive outcomes including a synergy between work and classroom, and development of professional skills including time management, conflict resolution, and trouble-shooting. In this paper, we will discuss the findings of our analysis, as well as connections between our study and related work in expectancy-value theory and adult student inter-role conflict. Future work aims to expand data collection to multiple sites, and to complement it with quantitative survey data. By understanding the motivations and experiences of adult engineering students, we aim to provide better service to this important part of the student body.

Introduction

The traditional college student as defined by the National Center for Education Statistics (NCES) is taken to be a recent high school graduate, enrolled full time in a 4-year college or university, and to be younger than 23 years of age. Ample studies have sounded the alarm that the U.S. is not preparing enough individuals in STEM disciplines to address future national needs. Adult learners are an important pool of potential engineering professionals, and it is critical that these students are recruited to engineering programs and persist until degree completion. For the purpose of this study, those above the age of 25 years, enrolled in a bachelor's engineering program, are considered adult students. The age of 25 was selected as a threshold for this study to exclude traditional students who entered degree programs right after high school, even those who may take up to six years for degree completion. Adult students can add a valuable dimension to the engineering curriculum, enriching the classroom dynamics by sharing real-world experiences, presenting a different model of faculty-student interactions, and bringing a set of perspectives, accomplishments, priorities, and expectations compared to their younger

classmates.

There is a concern regarding recent national trends in engineering education. According to a recent U.S. Department of Education report,[1] over the last decade undergraduate degrees awarded in the fields of Engineering have dropped from 6.3 to 5.4 percent of the total degrees conferred in the country (p. 297). The numbers are easily misconstrued by the fact that the raw numbers of engineering degrees have actually risen during the same time period. However, this rise in number of degrees is due to the larger number of total degrees conferred. The proportion of students pursuing engineering degrees is declining with students instead populating fields such as business (with 21.4 percent of total degrees conferred) and Communication Technologies (experiencing a ten percent growth over the last decade). Engineering has actually suffered the second-greatest loss of students (percentage wise) over the last decade (after Education which lost 2.3 percent) (p.297). While these percentages are small, over a ten year period (1998-2008), the country has steadily seen a decline in interest in these programs despite an increase in demand.

Drawing from a broad-based talent pool, including adult undergraduate students, may aid in keeping the United States competitive in the areas of technology and engineering. Summer 2011, President Obama called for more engineering graduates: "Today, only 14% of all undergraduate students enroll in … STEM subjects … We must do better than that. If we're going to make sure the good jobs of tomorrow stay in America … we need to make sure all of our companies have a steady stream of skilled workers to draw from."[2] As educators, we can contribute to the development of the economy by advancing the educational level and this can be accomplished by engaging interested students of all ages. Increasing diversity in higher education is not a challenge only for engineering and science. "Unless the US finds ways to improve its performance, it will fall farther behind," stated Dennis Jones of the National Center for Educational Management Systems.[3] In areas rich with manufacturing and industry, many young people may enter the workforce directly out of high school to work in engineering-related functions such as assembly. In the recent past, it was common to have a career path that led to engineering positions within the same company or industry for these individuals. Today, the majority of entry-level engineering positions require a BS degree, and technical experience alone is not enough to be competitive for such jobs.[4]

Additionally, adult student and graduate student enrollment traditionally increases during periods of financial recession, with some programs seeing adult education applications double over the last few years (Master's programs in Education at Texas State University). These students represent a growing segment of the population. They are often unable to attend classes during the day, due to work and family obligations, meaning that there are fewer opportunities for adult students to pursue undergraduate engineering degrees. At the same time, colleges and universities have more opportunities than ever before to engage non-traditional students through use of technology. Important issues include whether institutes of higher education are fully utilizing those resources and, if so, how adult learners are responding to not only the scheduling options but to other potential obstacles.

Adult students make up a significant fraction of all US college students. In 2007, adults aged 25 and older composed 37.6% of all students enrolled in degree-granting institutions, with slightly stronger representation in 2-year institutions (40.3%) compared to 4-year institutions

(36.1%). One would expect that adults, who often are balancing educational pursuits with work and/or family commitments, may be primarily enrolled as part-time students. In fact, 59.3% of part-time students at all degree-granting institutions are adults, but adults also account for 24.2% of full-time students at all degree-granting institutions. Most engineering colleges and programs reside at 4-year institutions, where a full 69.6% of part-time students are age 25 or over. [5]

Literature Review

Improving the levels of retention and recruitment of engineering students has been a major focus area lately in engineering education research. Reasons for students to enter engineering programs include the influence of family, high school teachers, and peers; previous success in math and science courses; and interests in the career track.[6] Related work has demonstrated that a primary reason that students persist in engineering programs is because they identify engineering with their sense of self,[7] an attainment value as described by expectancy-value theory.[8] It is interesting to consider the differences between traditional-age students and adult students in these motivations and persistence trends. Adult students, especially those already engaged in technology and manufacturing fields, may have a more realistic view of what an engineering career means, or may have a stronger sense of identity with the engineering profession compared to younger classmates.

Adult students can experience high levels of stress and inter-role conflict stemming from their responsibilities in work, personal, and academic domains. Kohler Giancola, Grawitch, & Borchert explored the interactions between stressors, inter-role conflict, coping behaviors, appraisal styles, life satisfaction, and general well-being by surveying a sample of 159 adult students at Saint Louis University's School for Professional Studies.[9] Students reported the highest levels of stressors related to work (as opposed to academic or personal stressors), which is believed to be related to the limited control the students have over work demands. Students reported the greatest levels of inter-role conflict from school to family (example, "Because my school work is demanding, at times I am irritable at home"), with significantly lower levels of stressors from family to school, work to school, and school to work. The authors present some implications for researchers and institutions, noting a need for a qualitative study to gather student stories and experiences to create depth and direct hypothesis testing, as well as an integration of social and academic spheres, such as peer and faculty relationships. They recommend the creation of a model which examines sources of stress including classroom instruction, academic advising, admissions and financial aid, safety and security, etc., and examines learning outcomes, GPA, course drops, persistence, and graduation rates. Programs to help with stress and time management including support services geared toward adult students such as their own orientations, academic and financial aid advisors, peer advisors, and support staff and faculty who understand their needs without loss of academic rigor,[10] campus day care, families invited to campus events, etc.

Additional research supports the hypothesis that the balance adult students face between work, school, family, and other commitments is an additional cause of stress for adult students, but the difficulty of the coursework was also a factor. A research project in 2009 that surveyed 72 adult graduate students at Texas State asked students an open-ended question: "_____ are the most common sources of stress in my life." 51 of 72 respondents listed school or school work as their primary answer.[11] It is important to note here that half of these students were doctoral students

and the other half masters students. All were adult commuters. Compared to the literature on undergraduate students, we see that with more challenging academic areas (i.e. graduate school), academics becomes the leading stressor (with the work, school, life balance being second). Presumably, in a difficult course of undergraduate study, such as engineering, similar results might be found that would change the way that we look at the services we provide these students. At the very least, this justifies why we should ask the questions in a guided, open-ended format.

This project builds upon two predominant concepts in adult learning literature; self-directed learning and experiential learning. One of the fundamental concepts of andragogy is the concept that adult learners are more inclined towards self-directed learning than their younger counterparts.[12] Dating back to the 1930's, education pioneers such as John Dewey recognized that 'all genuine education comes about through experience' and this is echoed by modern literature that emphasizes the need for adult education programs to capitalize on this life experience that adult students bring to the classroom (p.162). It is important for us however to ask how best to use this experience to enhance an adult engineering students' experience in degree programs.

Extensive work in the field of Adult Education has focused on areas where adults are well represented, including workplace training, and community colleges, but less literature has taken adult engineering students as the focus. Furthermore, within engineering education, various special groups have been studied at some length, including women and ethnic minorities, but less has centered on adult students.

Two recent areas of research that may have connections to adult engineering students include work on United States military veterans in engineering and the integration of peer tutors and peer quality managers in the learning process. Universities such as the University of Kentucky are working to develop comprehensive programs to support the transition of military veterans from active service to success in engineering programs.[13] The Engineering Veteran Pathways project aims to provide resources for veterans from the application to graduation stages. Researchers at Northeastern University have implemented peer "quality managers" in engineering courses.[14] These quality managers are selected among responsible, mature students currently enrolled in the course, and they provide additional support to peer students by assuming a temporary responsibility for specific classroom activities, somewhat similar to teaching assistants. Jaeger et al. found that these student quality managers had positive outcomes in their relationships with the professor, and that they were willing to be quality managers again in the future. Furthermore, the majority of other students in the courses with quality managers reported increased learning and smoother class function. This approach could potentially be a model for engaging adult students in a different way in the classroom.

Research Questions

Through this exploratory research project, we aimed to determine:

> What are common issues for engineering students over the age of 25?
>
> How do they describe their motivations, challenges, success strategies, and work/life applications?

What are the theoretical and practical implications to improve recruitment and retention of adult engineering students?

Methods

Participants

Participants were recruited from the University of New Haven, a small, private, northeastern university that had 481 undergraduate students in fall 2011, 24% of whom are 25 years or older. An e-mail invitation was sent to all adult (age twenty-five and over) engineering students. Within the e-mail, they were told what would be requested of them if they agreed to participate in the study, why the study was taking place, and that there would be monetary compensation (ten dollars) for the participant's time. The content given in the e-mail was also displayed in flyers which were hung throughout the buildings on campus. In a further aid to recruit participants, a researcher (graduate psychology student) was invited to speak to a few evening engineering classes which were known to have adult students present. For this, the content of the e-mail was simply reiterated.

This paper reports on the finding from the first ten participants. Eight participants are male, and the majority of participants are Caucasian. The participants range in age from 25 to 59 years of age. About half of the participants are married and half have children. Three participants work full-time, six participants work part-time; six participants are currently full-time students. Although the demographic questionnaire did not address military veteran status, three participants did describe themselves as veterans during the course of the interviews. A summary of demographic responses can be found in Appendix D.

Measure

A demographics survey was used as a measure of behavioral method in an effort to gain further *general* information about the participant(s). It included questions pertaining to the participants' employment and marital status, age, gender, and class load information. (Please see appendix A for demographics questionnaire.)

Procedure

Participants e-mailed the researcher (graduate psychology student), either responding to the mass e-mail, flyer, or in-vivo invitation, stating their willingness to participate. Once a date and time was agreed upon, they were welcomed into a quiet, private room and consented to the study. The hour-long, semi-structured interview was conducted by the researcher (graduate psychology student) and was audio recorded via a digital recorder. The interview consisted of questions pertaining to the participant's reason(s) for pursuing a bachelor's degree, challenges and strategies they have encountered, and degree to which they feel connected to others in their program. (Please see Appendix B for the full list of interview questions.) Once the interview concluded, participants were then given the demographics form, debriefed, and given monetary compensation for their time.

In an effort to preserve the participant's anonymity, the analysis of the transcriptions did not

occur until the first ten interviews had been completely transcribed and the next set of transcriptions had begun. There were four individuals (all four of the researchers) who coded each transcription independently. The grounded theory method of qualitative analysis was used as the focus of the thematic analysis. Once individual coding was completed, the coders regrouped and decided on a few basic themes (motivators, demotivates, class barriers, prior entry barriers, university-specific feedback, strategies for success, and applications of work/life to study) and categories within those themes that they found to be reoccurring. For this, Google Docs was used so that all would see what was occurring real time and conversed via Skype conference calls on a regular basis so that all would be frequently updated. They then independently coded the transcriptions using the aforementioned themes. All four coders completed their analyses independently, regrouped, and shared their results and came to a group consensus onto which themes will and should be used. For the next step, universals per demographic were created based on the demographics categories as well as five outcome questions which each researcher responded to independently.

Findings

The most common themes that emerged during the interview coding are elaborated below. The researchers acknowledge that there is always potential for response bias in interviews with voluntary participation; volunteers who respond to an invitation for participation may have a particular issue that motivates them to become involved.

Motivators

Motivators for adult engineering students are the reasons that inspire students to enroll in engineering programs, and cause them to persist in pursuit of their engineering degree. The motivators for this population are numerous and varied, with these reasons coming from inside the students themselves (intrinsic) or from other external influences or rewards (extrinsic). The most commonly cited motivators are described in detail below, and representative quotes are provided.

Long-standing interest in science, technology, engineering, or mathematics

One common intrinsic motivator among informants is the idea of always wanting to be an engineer, or always having a love or interest for science, mechanics, etc. These motivations are expressed by eight of the ten interview participants, and are sometimes informed by familiarity with engineers.

> *"I always thought I wanted to be an engineer as a young person..."*

> *"Math and science always interested me through traditional K-12 education. I was in the military. I was part of an engineering squadron, so I had actually spoken with many of the engineering officers... it had always been one of the career fields I was interested in. So learning from them, what they were doing, it seemed like the type of work I would be interested in."*

Desire to learn and be challenged

Another type of intrinsic motivation among the informants is an innate love of learning (held by seven participants), the personal challenge of learning to be an engineer (four participants), and the desire to learn engineering material as distinguished from pursuit of a degree (two particpants).

> *"It's a personal achievement. I love being in school. I like learning... It's kind of a release for me. As much as it is work, it's enjoyable."*

Experience working in the engineering field

All ten informants in this study describe previous or current work experience in engineering or technology fields. Their experiences include technician and assembly line work, licensed surveying, military work on engineering projects, and working as non-degreed engineers.

> *"I've worked in a utility company...under the direction of electrical engineers..."*

> *"I wound up taking a job at an assembly line and at the time the modules I was building had very heavy engineering involvement so I got to work with the engineering department a lot..."*
> *"I've always work in the engineering field. In the Navy working with electricians..."*

Career opportunities

Among the most common external motivators is improved career opportunities. This is expressed as dissatisfaction with a current career, a desire for career options and increased opportunities, work/life balance, and related aspects. These ideas are cited by nine informants.

> *"The real reason is that I was really bored, honestly. I have a previous degree in liberal arts and it wasn't doing anything for me. I was bored. I wasn't able to do anything interesting."*

> *"...maybe more responsibility, more responsibility brings on more challenges... I don't think an engineer should have that role of somebody telling you to do ABC, I think you should be able to pick it up and say hey this is an idea that I have. And by having those opportunities, that actually opens up and expands those opportunities for me to have available when needed."*

Financial reward

Increased income and improved financial stability is a common external motivator for the adult engineering student participants in this study, with six of the participants citing this motivator. This increased income can be in comparison to students' current work as a non-degreed engineer, or to students' work in non-engineering job roles.

> *"There's a great incentive because once I'm done... my job will be evaluated again, and that's where it becomes more rewarding. So rewarding more compensation-wise."*

> *"...I might end up having to work possibly two jobs full time to be able to afford to live there, while working as an engineer I could probably get by just working the one job and spending that time to have more time for myself."*

Four of the participants cited a specific variation on financial reward as a motivator: supporting a family. This motivation relates to other aspects of many adult students' experience, including challenges and conflicts also related to family.

> *"...a lifestyle that would generate more income, be able to hopefully afford a house and a lot of other things that people typically associate with being successful... or being able to support a family hopefully one day in the future."*

> *".. I don't see myself retiring son since I have a daughter that's 15 years old. She needs to get through college, and my son is in college right now, so I need to take care of them."*

Additional motivators cited by only one or a few students included: giving back to society, doing tangible work, and avoiding manual labor.

Challenges

Adult engineering students face a number of challenges related to the pursuit of a challenging degree and the balance of multiple responsibilities in their lives. The nature of being a minority population at the university may create additional challenges for them. In this study, we find a number of common demotivators and barriers. Demotivators are factors which may negatively impact the attitude, desire, and resolve of engineering students for completion of their degree. Barriers are defined as factors which impede the completion of their degree.

Time challenges

All but one participant cite time as a major barrier to the completion of their degree work. Other time-related barriers to degree completion include difficulty scheduling courses around other commitments (four participants), and commute (two participants). A related demotivator is a lack of personal time, which was reported by six of the participants.

> *"As far as time, I'm an adult. I pay my rent. I pay my taxes. I pay my gas so I do maintain part-time job. I work about 20 hours a week with over-time if there is over-time so scheduling my classes around my job and vice versa has been difficult. This is a particular problem when I'm assigned group work that requires out of class time, but so far it has been something I can handle."*

> *"One of the biggest challenges is finding courses in the time slot that is good for me."*

> *"I'm living at a pretty far distance as far as being a commuter student, so I mean that has probably been the biggest challenge so far is that I have an extensive commute to get here. ...it just consumes so much time."*

> *"As far as personal life goes, I have absolutely no time so there aren't a heck of a lot of personal roles that get impacted. I've been out on a couple of dates since I have started going back to school but I cut them off. It wasn't going to be doable with going to school and with going to work."*

Inter-role conflict

Kohler Giancola et al. found inter-role conflict, the impact of multiple roles on one another (such as the role of employee taking away from family time), to be a major factor for adult students. Adult engineering students in this study were asked directly in interviews if they experience this type of conflict. A majority of participants (seven) did agree that inter-role conflict is an issue in their lives. This was especially true for students in particular demographic groups, including those who are married (all four married participants), those who have children (four of five participants with children), or work full-time (two of three participants who work full-time).

> *"They all interact! Oh boy, yeah, when one goes down, they all go down. Yeah you know, when anybody has a bad day at work knows that it affects the rest of their lives. And I know on days when I have exams, my mind is in a totally different spot than being at work... It's all one big circle, one little thing causes the circle to wobble instead of going along in a nice circular path."*

> *"I have to study a lot, and my wife will feel neglected and say I'm never home because I'm always studying. I'll have to hire the nanny to come and it will cause financial hardship which will cause emotional hardship. Or... I can benefit those and not hire the nanny and not come to school and study and have more money so I resolve that issue, but then my studies fall."*

Readiness

While not explicitly prompted to describe reasons that engineering bachelors degree study was delayed, many participants did discuss this issue. Some cited specific reasons for delaying their degree program. The most common barrier to degree program entry was a lack of maturity and/or academic readiness, expressed by five individuals.

> *"...probably when I was an 18 year old. I was less driven... There was a reason I didn't go to college when I was 18. I was busy partying."*

> *"...I say hey, I couldn't do this at 21. Hey, I didn't. I would have totally flunked out if I tried it at 21. It just wouldn't have happened. I was just one of those who cared more about living..."*

Other challenges cited by one or a few students include: tedious classwork, notable age differences, workload and course difficulty, time since leaving school and related changes in technology, and differences of priorities between younger peers and themselves.

Strategies for Success

The adult engineering students interviewed for this study had a varied set of strategies for overcoming obstacles, tailored to each students' own challenges and situations. Several common themes did emerge, especially in response challenges of difficult coursework and limited time

resources.

Seeking help from multiple sources

The adult students in this study are deeply committed to achieving their academic goals, and demonstrate a responsibility for their own learning by seeking academic assistance from a wide variety of resources, including professors, teaching assistants, tutoring centers, classmates, study groups, recorded lecture sessions, and extra classes or projects. This theme was expressed by seven participants. Three of the participants also said that they reach out to friends and family for support for emotional, financial, and time management needs.

> *"It certainly helps that I have made good enough friends with classmates and constructive study groups and so relying on the help of other classmates, and teachers and places like the Center for Learning Resources* (tutoring center) *certainly for the first couple of years... trying to regain a lot of what I had previously learned and then forgotten--that was a big help."*

> *"...when we went into this, [my wife] committed to me. Just like I committed to this decision, she committed to my decision as well, and that's the key thing here... You can't do it if they're not going to understand that you have to take all of this time... secondly, I need her for moral support because sometimes I get really buried with work and stressed out..."*

Persistence and hard work

Eight of the participants cited a variation on hard work, determination, persistence, and pushing themselves as a strategy for overcoming obstacles and succeeding in their degree programs.

> *"I've been very good at buckling down and getting the work done..."*

> *"Study hard! Try to stay on top of it all. Yeah, just study harder."*

> *"[I] just bear it on my shoulders. It's only six years--you have to hold your breath as long as you need to. Keep saying, 'In May, I'll breathe.'"*

Reducing or adjusting sleep hours

Responding to the challenge of limited time resources evoked several time management strategies, some healthier than others. Five participants report having changed their sleep schedules, some adjusting sleeping or waking times, and some reducing sleep hours altogether.

> *"Well, lack of sleep. Because those are always hours you can eat away at, unfortunately. The first hours to go are the hours we would sleep."*

> *"It may result in me staying up a little later; I'm exhausted to go to work in the morning."*

> *"I stay up until like two in the morning every night, and I get up at seven, because that's when my 21-month old gets up."*

Financial planning and resource utilization

The adult students in our interview pool are economically diverse, with reported annual incomes ranging from $10,000 to $100,000. Four participants specifically mention strategies for funding their education through scholarships, the G.I. Bill, and personal savings before entering college.

> *"And now I have the G. I. Bill that's providing tuition costs for me, so it's not really a concern, and it also provides a living stipend as well which allows me to not have to work as much so I have more time to concentrate on school."*

> *"I have been luck enough to receive a couple of scholarships that have helped enormously. I don't know if I could do it without the scholarships."*

> *"I made the decision that I was going to go to school full time almost a year before that actually happened, so I was able to save up just enough to get me by the first few semesters, and after that I had to rely on working again..."*

Applications of Work and Life to Study

The students interviewed in this study cite examples of the skills and knowledge they have gained in work and other pursuits, which help them in their engineering study.

Application of engineering theory

Six of the participants described an ability to appreciate and understand the applications of engineering concepts and theory. This connection to the tangible aspects of engineering study may help students to stay motivated. One participant also acknowledged that the 'application first, theory second' way of learning engineering is the reverse of the dominant style of engineering education in which theory is described first and then applied to examples. One student even felt that exposure to real applications hampered the ability to take idealized class examples at face value.

> *"So the things I've excelled in have been things that I've pulled from my past work history, really, and things that I have already seen, done, put my hands on. And now it's the opposite of what most people do. They learn the concepts and theories about things and then go out in the field and learn about them... So I think I have a better understanding of what's out there, why we're doing this, and the reasons that we do the different exercises that we do, and I'm more willing to do them."*

> *"Sometimes your work life experiences get in the way of your engineering studies, because they'll be telling you this theoretical thing and you know it's completely wrong. They'll say it's an approximation, and the traditional students, because they have no life experience, they just take it at value and they can do the calculations and they don't think too much about it. ...my life experience comes in handy and sometimes the professor will talk about an abstract topic and I'll see all the kids glaze over because they don't understand what he's talking about, but I'll have a life experience that actually does."*

Leadership skills

Half of the informants reflected that they have been able to apply management and leadership skills to working with groups of other engineering students, by helping team members to communicate with one another, manage conflict, stay focused, and distribute tasks.

> *"I would say the teamwork aspect that they try and instill. That's obviously working in teams is important in engineering. It's something that I have a lot of experience from the military, so my experience with that has allowed me to perform very well in a teamwork situation, so I guess resolve any sort of conflicts that arise within teams and just ensure that teams stay on task and accomplish what they need to."*
> *"...bringing in the teamwork that I learned in the Navy...mostly teamwork and communications I would say... "*

Professional skills

Four informants also cited other transferable interpersonal and professional skills, especially including time management.

> *"I do think that projects benefit a non-traditional student... So, I think that because we are so used to applying time management skills to our everyday life, then projects that apply time management are easier for us. It's just another day."*

University-Specific Feedback

Study participants were asked to identify ways in which the university could better serve and support them in their endeavors. While these suggestions have the potential to be limited to universities similar to the small, private, northeastern university in this study, the most common suggestions related to transfer-credit practice and policies (three participants) and improved offering of evening classes (four participants), which may be more universal issues.

Improved transfer credit practice

Students expressed frustration with the transfer-credit practice, an issue which may be common for adult or traditional-age students who begin their engineering degree coursework at community colleges or other institutions. Accepting credit for summer classes offered at neighbor institutions, having a clear, timely, and consistent system for notifying students of transfer credit decisions, and dedicated academic advisors were related wishes for these students.

> *"Transfer credits have been a thorn in my side for the past year. They accepted originally almost all of the credits...but the registrar's office has gone back and forth on a couple of them..."*

> *"The only issue I have had is regarding transfer credits incoming, where they weren't all applied until it was too late...registering for spring. Having the transfer credits applied as the should have been, I would have been able to register early and have more class availability..."*

Improved offering of evening courses

As adult students seek to manage school, work, and family responsibilities, evening courses are an important option for them. Students suggested a later starting time for evening classes (classes beginning at 4:30 pm are categorized as "evening" courses at the small, private, northeastern university in this study), and increasing the number of evening class offerings. A related request was to offer more online courses, specifically requested by one participant.

> *"The university can stop recognizing 4:30 as evening to start a class...some students get out of work at 5:00. To me, 5:30 is evening."*

> *"...if more courses could be offered later into the day would be the biggest help."*

Additional suggestions included improved parking, review or revision of the core curriculum to reduce tedious coursework and/or non-engineering courses, increased upper division tutor availability, all-hours access to study space, family-friendly social events for adult students and their families, better professor availability for office hours in the evening, improved information technology support, lower tuition, and integrated math and engineering instruction.

Informants also consistently reflected positive attitudes and feelings about the college and their experience as students in the engineering program, including satisfaction with the quality of the curriculum, an ability to get along with younger peers, an appreciation for the work of committed faculty, and a sense that the college offers what they need to reach their academic goals.

A table is included as Appendix C, summarizing the findings by participant and response type.

Discussion

This paper was primarily an exploratory research project. The primary goal was to determine if current engineering education practice is adequately accommodating the growing proportion of adult students in engineering. The engineering field has focused on the traditional student who had the drive and means to complete a difficult and heavy course load in a short period of time. One question that we began to ask ourselves was, what about the older student? Is there another demographic of student that we should be paying attention to? Is there a value to having older students in the engineering classroom? What are the needs and issues facing adult engineering students? Our preliminary analysis indicates that this is an area that needs further research.

For example, one thing we found is that adult students in engineering programs are highly motivated. What we heard from these students was that most of them were already in established careers and had settled down with families but there was still something missing. There was something they had always wanted, but were never able to accomplish. They always wanted to be engineers, but earlier in life they did not have the financial means, they were convinced by themselves or others that they could not do it, or something else stopped them. They seem to have a powerful drive that is rare among most higher education students. They also have the added benefit of maturity and stability. While these students do struggle to balance family and school obligations, they're not likely to miss a deadline because they were out late at a party. They know what they want and they are motivated to accomplish their goals as quickly as possible. In the age of declining graduation rates and slow progression, this could be a sizable benefit to a university that is able to retain this population.

As engineering educators, the authors find some resonance between classroom observation and the reports of student interview participants. One of the authors, who taught evening engineering courses at the university where the study was conducted, sees a great deal of consistency between her experience and the adult students' report of time as a major challenge. Even bright and motivated adult students demonstrated evidence of this time pressure, by submitting incomplete homework assignments, or asking questions about homework problems very close to the submission deadline. Some requested other time-related accommodations, such as adjustment of the course starting time or permission to regularly come to class a few minutes late, due to work schedules.

Another author who has worked with entirely traditional-age students at a military academy, notes that students were also motivated, but had no work experience, and so instructors had the full burden of relating personal experiences and tying engineering theory to application. All ten of the student participants in this exploratory research project have engineering or technical work experience, and could potentially provide that valuable perspective for the benefit of an entire engineering class.

What we still need to ask though is what can we do to support these students and encourage them to apply and stay in our programs? This question was partially answered in this study with the obvious limitations being the size of the population and the university-specific information.

Theoretical implications

Experiential learning was a common concept that came up with our adult learners in this study. Many of them mentioned both prior military experience and prior work experience in similar technical fields that allowed them to contribute to the field. Many even mentioned that this outside work experience was beneficial to some of the younger faculty who may have more theoretical than practical experience. The rush of military students returning to higher education is likely to mean a substantial increase in experiential learning in the classroom.

We theorize that this might significantly change the demographics of the engineering classroom in forthcoming years. The number of traditional students on college campuses is declining for a number of financial and political reasons. Another trend is a rapid increase in military veterans returning to school, due to the withdrawal of U. S. troops from the Middle East combined with a dramatically improved post-9/11 GI Bill. The new GI Bill introduced in the last few years makes college a viable option for a number of these military students. This influx changes the college classroom demographic in more than one way, however. These students are not all as academically prepared as the traditional student they are replacing (St. Omer). They do bring experience and maturity to the classroom but it remains to be seen if our pedagogy will have to change to meet their needs.

The findings of our study support the concept of self-directed learning among adult students, as demonstrated by their seeking academic assistance from multiple sources. Instead of waiting to get what they need to learn from a lecture only, these students take responsibility for their own learning by seeking answers and support from other resources. Some of the students even describe completely extra learning tasks, including taking additional classes and taking on extra projects (building robots, doing faculty-mentored research). We can also draw connections

between our findings and expectancy value theory. We theorize that adult engineering students are persistent and successful in their degree work partly because they have experience that causes them to believe that they will enjoy and be good at engineering work. Their experience in engineering and technical jobs, combined with their life-long interest in science, math, and technology, gives them a strong base of a high value and a high expectation of success.

Practical implications

In their study of adult student stress and behaviors, Kohler Giancola et al. call for examination of sources of academic stress for adult students. Our findings indicate that academic advising, especially related to the evaluation of transfer credit, is a significant source of stress for adult students. We recommend a dedicated academic advisor for adult students, who will act in concert with other university support staff to meet adult student needs including: assessment of the need for any additional foundational coursework (computer skills, mathematics refresher courses, etc), timely evaluation of transfer credit, recommendations for summer course offerings that will be accepted as transfer credit.

Unsurprisingly, course scheduling is a common barrier for adult students. We recommend that opportunities for evening classes (beginning 5:30 pm or later), online and hybrid classes, and summer classes be expanded to better support and retain adults as part of a diverse student body.

Our findings also show that adult students perceive themselves as leaders among their peers. They recognize and apply the professional skills they have developed in years of work. In our subset of ten adult engineering students, 100% of these students have technical work experience, which educators should seek to draw upon in the classroom. This finding is in agreement with the work of Raymond J. Wlodkowski, who recommends the use of group work as a motivational strategy for engaging adult learners.[15] Engineering faculty can make an effort to engage adult students as leaders in their classroom for the benefit of all students in the classroom, as peer tutors or quality managers, or by inviting students to lead discussions on applications of engineering concepts. We recommend that these roles do not require significant amounts of extra preparation time outside the classroom for adult students.

Another observation that we gained from this study is that adult students are less connected to their campuses than traditional students. Most of them have jobs during the day and families to go home to at night. They are therefore not spending as much time on and deeply invested in their campuses. They are not here for the 'college experience' they are simply here to graduate and get a better job. Campuses that want to actively recruit adult students will have to decide what implications this has for their campuses and whether or not it is worth making changes to how activities are structured and timed.

Future Work

Future work in this project aims to continue and expand the project, as well as to use multiple data sources to probe specific hypotheses. We plan to revise the interview question protocol to address any issues of potentially leading questions or questions that are unclear (for example, most students were not familiar with the idea of inter-role conflict, and this question will be revised). We intend to expand to include interview participants from other colleges and

universities, to collect data from a diverse cross-section of institutions. We have begun survey work to compare particular items for traditional-age to adult students, to determine to what degree the themes we discovered are unique to older students. We expect that some themes such as the strong intrinsic motivation to learn, family- and work-related time pressures, and opportunities to translate work experience into classroom success will demonstrate differences between adult and traditional aged students, while other factors such as potential for financial reward and an experience of time pressure may be common to engineering students of all ages. There is also potential to examine adults engaged in graduate engineering programs. We will use this information to build upon our recommendations for institutions wishing to better serve this population of adult engineering students.

References Cited

1 Aud, S., Hussar, W., Planty, M., Snyder, T., Bianco, K., Fox, M., Frohlich, L., Kemp, J., & Drake, L. (2010). *The condition of education 2010* (NCES 2010-028). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

2 Bacon, Perry. "Obama calls for more engineering grads as a way to spur the economy." *The Washington Post* (Online Blog: Politics and policy in Obama's Washington), 13 June 2011.

3 Jones, D., Mortimer, K., & Sathre, C. O. (2007, November). Increasing productivity: Is higher education [as we know it] up to the task? Paper presented to the Association for the Study of Higher Education, Louisville, KY. http://www.nationalcommissiononadultliteracy.org/content/nchemspresentation.pdf

4 Carnevale, A.P., Smith, N., Strohl, J. (2010). *Help Wanted: Projections of Jobs and Education Requirements through 2018*, Georgetown University Center on Education and the Workforce.

5 US Department of Education, National Center for Education Statistics, 2007 Integrated Postsecondary Education System (IPEDS). (2008). http://nces.ed.gov/programs/digest/d09/tables/dt09_193.asp

6 Seymour, E. & Hewitt, N. H. (1997). *Talking about leaving: Why undergraduates leave the sciences.* Boulder, CO: Westview Press

7 Matusovich, H. M., Streveler, R. A., & Miller, R. L. (2010). Why do students choose engineering? A qualitative, longitudinal investigation of students' motivational values. *Journal of Engineering Education, 99 (4).*

8 Eccles, J.S. (2005). Subjective task value and the Eccles et al. model of achievement-related choices. In A.J. Elliot & C.S. Dweck (Eds.) *Handbook of Competence and Motivation*, (pp.105-121). New York: Guilford Press.

9 Kohler Giancola, J., Grawitch, M. J., & Borchert, D. (2009). Dealing with the stress of college: A model for adult students. *Adult Education Quarterly, 59, 246-263.* http://aeq.sagepub.com/content/59/3/246

10 Johnson, L.G., Schwartz, R. A., & Bower, B. L. (2000). Managing stress among adult women students in community colleges. *Community College Journal of Research and Practice, 24, 289-300*.

11 Hollis, M.J. (2009). Unpublished data from Graduate Student Stress Survey, Texas State University, San Marcos, TX.

12 Merriam, S.B., Caffarella, R.S., & Baumgartner, L.M. (2007). *Learning in adulthood: A comprehensive guide; 3rd Ed.* San Francisco: John Wiley & Sons, Inc.

13 St. Omer, I. (2011). Engineering Veteran Pathways. Paper presented to the American Society for Engineering Education, Vancouver, BC, Canada.

14 Jaeger, B., Balint, C., Wishon, C., & Fritze, C. (2010). ATLAS- Academic Teaching and Learning Assistants Study: The Use of Peers as 'Quality Managers' in Engineering Class Instruction. Paper presented to the American Society for Engineering Education, Vancouver, BC, Canada.

15 Wlodkowski, Raymond J. (2008). *Enhancing Adult Motivation to Learn: A Comprehensive Guide for Teaching All Adults; 3rd Ed.* San Francisco: John Wiley & Sons, Inc.

Appendix A: Demographics Questionnaire

Instructions: For each question, please circle the response that is most applicable to you.

1. Gender
a. Male
b. Female
c. Transgender or other

2. Ethnicity/Race (circle one or more)
a. Black or of African Descent
b. American Indian, First Nations Member, or Alaskan Native
c. Asian
d. Hawaiian or Pacific Islander
e. Caucasian/White
f. Hispanic or Latino
g. Multi-racial
h. Other race not listed here
i. Prefer not to respond

3. Current Class Load
a. Full-time
b. Part-time

4. Class Level
a. Freshman
b. Sophomore
c. Junior
d. Senior
e. Graduate
f. Non-degree student

5. Employment
a. Full-time
b. Part-time
c. Unemployed
d. Other

6. Marital Status
a. Single
b. Co-habitation or domestic partnership
c. Married
d. Separated
e. Divorced
f. Widowed

7. How long have you been employed in your current job?
a. Less than one year
b. 1 to 5 years
c. 6 to 10 years
d. 11 to 15 years
e. more than 15 years

8. What is your level in the organization?
a. Employee
b. Supervisor
c. Manager
d. Executive
e. Other

9. Many adult students enrolled in a degree program are the first member of their families to pursue a college degree. Please choose the option below that best describes you.
a. My mother and father have never attended college.
b. At least one of my parents attended college, but never graduated.
c. One of my parents is a college graduate.
d. Both of my parents are college graduates.
e. None of the above describes me.

10. If you have children, how many do you have? _____

11. What is your current yearly income?_____

12. What is your current GPA (estimate if uncertain)? _____

13. What is your age? _____

Again, thank you for your participation!

Appendix B: Interview Questions

- What are the major reasons for your decision to pursue a Bachelors degree in engineering? Why? How important are these factors relative to one another?
- What have been the major challenges to completing your degree work?
- Have there been moments of doubt along the way in which you considered discontinuing your degree? If so, what made you feel that way? What influenced your decision to persist?
- What are the most effective strategies you have experienced for taking advantage of your work and life experience in the engineering classroom? What are the tasks where you have shined? Design? Projects? Problem sets?
- Are there any occasions in which you feel especially connected or disconnected to your engineering student peers, professors, or the University?
- Do you experience "inter-role conflict" in which you experience pressure related to one of your roles (i.e. student, worker, parent, etc) negatively impacts your performance in another role?
- In what ways can the University improve its services to help you achieve your goals?

Appendix C: Common Responses by Participant

	Motivators								Challenges						Strategies for Success					Application of Work and Life to Study			University-Specific Feedback	
	Long-standing interest in science, technology, engineering, or mathematics	Desire to learn and be challenged			Experience working in the engineering field	Career Opportunities	Financial Reward	Fiancial Reward - Supporting a Family	Time Challenges				Inter-role Conflict	Readiness	Seeking help from multiple sources	Reach out to friends and family for support	Persistence and hard work	Reducing or adjusting sleep hours	Financial planning and resource utilization	Application of engineering theory	Leadership Skills	Professional Skills	Improved transfer credit practice	Improved offering of evening courses
		Innate love of Learning	Personal Challenge of Learning to be an Egineer	desire to learn engineering material as distinguished from pursuit of a degree					Time as a major barrier to the completion of thei degree work	Difficulty scheduling courses around other commitments	Commute	Lack of personal time												
P1	x				x	x	x		x		x	x	x	x					x		x		x	
P2	x	x	x	x	x	x		x	x				x	x	x	x	x	x		x		x		
P3	x	x		x	x	x			x			x	x	x		x			x		x	x	x	
P4	x	x			x	x	x	x	x	x		x	x	x			x	x		x		x		
P5	x	x	x		x										x		x				x			x
P6	x		x		x	x	x		x	x	x	x	x		x		x	x	x	x			x	
P7	x	x			x	x			x					x	x		x			x	x			
P8	x				x	x	x	x	x	x		x			x		x		x			x		x
P9		x	x		x	x	x	x	x	x			x		x	x	x	x		x				x
P10		x			x	x	x		x			x	x		x		x	x		x	x			x

Appendix D: Demographic Summary

Age:			
	Average	Median	Range
	34.9	31	25-59
Year in Program:			
	Average	Median	Range
	2.7	2.5	1-4
Class Load:			
	6 Full-time; 4 Part-time		
Employment:			
	3 Full-time; 6 Part-time		
Marital Status:			
	5 Single; 4 Married; 1 Divorced		
Family Education:			
	5 Have one parent with a college degree		
	3 Have parents who never attended college		
Children:			
	5 Have no children		
	5 Have average of 1.6 children		