Enhancing Incoming Male Student Retention: An Analysis of the Experiences of Persistence in Engineering

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***Abstract* – More and more engineering programs have become concerned with retention and persistence in their degrees, because about half of their students either change majors or do not graduate at all. Through qualitative analysis, the purpose of this study was to discover how male undergraduate engineering students persisted in their program.**

The five research questions explored were: (1) What factors of the academic experience are helpful to male student persistence in engineering? (2) How does academic performance impact the student experience and their ability to persist in engineering? (3) What factors related to participation in social activities is helpful to male student persistence in engineering? (4) What features of faculty interactions are supportive to male student persistence in engineering? And, (5) what features of peer interactions are supportive to male student persistence in engineering?

The interpretative phenomenological analysis consisted of 12 total interviews, seven senior and five junior students within the mechanical and electrical and computer engineering departments at a mid-sized private institution located in the southwest. This study suggested practices to benefit the persistence of incoming and first-year male engineering students. The findings were preparation prior to college, developing a strong support network, and being grounded in academic skills and characteristics. Aspects of intrinsic and extrinsic motivation also assisted these students to persist. While the 12 students were upperclassmen, their views offered valuable insights to why peers left engineering and described certain persistence factors in engineering programs that are relevant to enhancing the incoming and first-year student experience.

Index Terms - Persistence, undergraduate engineering, males, retention.

INTRODUCTION

On February 8, 2012, President Obama recognized the commitment of engineering deans to enhancing the retention and graduation of engineering, engineering technology, and computing (EETC) students. The President's Council on Jobs and Competiveness is committed to increasing the number of graduates in EETC disciplines over the next ten years. Although there is no consensus over the specific number of EETC graduates needed to fill current openings, it is reasonable to agree on the value of retaining those talented students who gain admission to EETC programs [1].

The number of EETC students enrolled has grown 23 percent since 2005, but graduates only grew by 1 percent from 2005 to 2009 and by 5.3 percent in 2010 [2]. As graduation rates continue to remain relatively constant, engineering job opportunities will continue to rise over the next decade by 11 percent [3].

Engineering degrees are difficult to obtain. In fact, over half of the students originally enrolled in engineering degrees change to other majors or do not finish college [4]. Seymour and Hewitt identified factors such as loss of interest in the major, poor teaching, too much effort required, too difficult, discouragement, low morale, and lack of peer support as some of the reasons why students decide to leave engineering majors [5]. The impact of these factors is a loss of students, the majority of whom are male, leaving engineering programs throughout the country.

BACKGROUND

Engineering programs should be concerned about retention and student persistence. Seidman argued that retention and persistence in college enhances the development of critical thinking skills, produces graduates who actively contribute to society, and enhances lifelong learning [5]. The sluggish economy has made retention and persistence even more crucial issues within higher education across the country, since the monetary loss can be devastating for both the individual and the institution if a student departs college prematurely [5]. A student that leaves prior to obtaining a degree is subject to an enormous amount of debt that might be hard to repay without a degree [5]. Colleges also suffer in this scenario with the loss of revenue from tuition and fees, as well as future alumni contributions. Seidman cited the following example, "If tuition and fees are $5,000 per term, the loss of only ten students is $50,000 per term," but "the loss for three terms is $150,000, while for seven terms it is $350,000—a significant amount of revenue for most colleges" [6]. Beyond the loss of tuition, colleges might also be concerned with the amount of scholarships given to

students who does not go on to finish their degrees. Retention and persistence are major policy issues in higher education and will continue to be for some time during the twenty-first century [5].

Persistence in higher education and specifically engineering is needed to graduate more students. The number of students enrolled in engineering has grown 23 percent since 2005, but graduates still only grew by 1 percent from 2005 to 2009 and only by 5.3 percent in 2010 [2]. With job opportunities expected to rise over the next decade, more engineers with be needed to fill them [3]. The researcher acknowledges the significant need to increase the population of females and minority students in engineering, but chose to investigate current retention issues and the research led to examining the majority of the population, whom are male. Understanding the factors related to male student persistence in engineering will increase overall retention and produce more qualified engineering graduates to the industry. Kuzmak further recommended the research be extended beyond females and minority students and focused on what she described as students who "have been victims of the leaks in the pipeline", male [26].

METHOD

Approval from the Institutional Review Board (IRB) was sought for this study. The IRB is one of several steps that were taken to protect the rights of the participants and avoid risk during the data collection process. The researcher used the IRB for "assessing the potential for risk, such as physical, psychological, social, economic, or legal harm, to participants in the study" [27]. Participants also remained anonymous to provide an honest and open environment for the interviews. Following the interview, each participant was assigned a pseudonym to track their comments and protect their identity. The research was conducted following an approval letter from the IRB.

The institution was chosen for this research because of its large population of male engineering students and the researcher's accessibility of conducting a variety of meaningful interviews. Following IRB's approval, the dean of the School was approached to approve access to the participants of the study. He approved, and then sent an email recruiting students to volunteer for this research project. The background of the topic and the details of the research were outlined in this meeting and in his email sent to male students. The dean was notified of the benefits of understanding of how male students persist within the school.

Five questions guided this study: What factors of the academic experience are helpful to male student persistence in engineering? How does academic performance impact the student experience and their ability to persist in engineering? What factors related to participation in social activities are helpful to male student persistence in engineering? What features of faculty interactions are supportive to male student persistence in engineering? What features of peer interactions are supportive to male student persistence in engineering?

Participants

The participants of this study attended a university located in the southwest United States. The University is a four-year comprehensive religious institution. The 2012 enrollment was 15,364 (12,918 undergraduate and 2,221 graduate/professional students) from all 50 states and 86 foreign countries. Thirty-four percent of the freshman class was minority students and 72 percent of entering freshmen were in the top 25 percent of their high school graduating class. The student to faculty ratio is 14 to 1, and the average undergraduate class size is 27.

Table I
Demographics

Participant	Ethnicity	Class	Major	GPA	SAT	ACT
#1 "Sam"	Caucasian	Senior	Mechanical	3.51	1400	
#2 "Ben"	Caucasian	Senior	Electrical	2.77	1180	
#3 "Kevin"	Caucasian	Junior	Electrical	3.86	1230	28
#4 "James"	Asian	Senior	Mechanical	3.35	1350	
#5 "John"	Caucasian	Senior	Mechanical	2.89	950	
#6 "Craig"	Caucasian	Junior	Mechanical	3.95	1530	34
#7 "Simon"	Caucasian	Junior	Electrical	2.26	1190	
#8 "Tony"	Caucasian	Senior	Mechanical	3.48	1370	
#9 "Blake"	Asian	Senior	Electrical	3.96	1460	
#10 "Todd"	Caucasian	Senior	Mechanical	3.62	1320	25
#11 "Bryce"	Caucasian	Junior	Electrical	2.78		30
#12 "Joe"	African American	Junior	Mechanical	3.48	1350	30

The ABET-accredited engineering program was founded in 1995 and had 885 undergraduates, 24 percent these students were female and 76 percent male. The student population was 96.5 percent under the age 22; 27.7 percent were minority; four percent were international; and 26.3 percent of the students were from out of state. The mean SAT score for the school was 1289, and the mean ACT was 28.7. Seventy-six percent of the students were in the first quartile of their high school class, 19.6 percent were in the second, 3.6 percent were in the third, and .06 was in the fourth. The student classification breakdown or the engineering departments in 2012 was 38.64 percent freshman, 20.67 percent sophomore, 17.85 percent junior, and 22.7 percent senior.

The average class size in the engineering program is 27 students, and the student-to-faculty ratio is 19 to 1. All undergraduate courses are taught by faculty and approximately 90 percent of labs are taught by faculty. The typical course load within the engineering program for lecturers is 9 hours per semester, or 3-3 for the year (a 3 hour lab counts as one course). Research faculty members have the load of 6 hours per semester, or a 2-2 for the year, but sometimes the load can be modified to a 2-1 or a 1-2, depending on the chair's needs. Additional duties may also provide the faculty members with a course load reduction for either one or both semesters of the academic year. Examples of possible course load reductions are for

responsibilities such as assistant chair, graduate director, or engineering director.

The students chosen for the study were junior and senior students enrolled in the departments of mechanical engineering or electrical and computer engineering. Within these departments, 12 students were interviewed. Smith suggested that at least three students were sufficient for a sample size so that the researcher would not be overwhelmed with the amount quantitative data; therefore, 12 from these departments in engineering exceeded the recommend size [7]. Depth of the interviews is more important than the quantity of subjects when conducting an IPA study.

Data Collection

The data was collected through one-on-one, in person interviews on campus. This provided an opportunity to ask open-ended and non-directive questions [8]-[9]. The data collection for this Interpretative Phenomenological Analysis IPA study is based on purposive sampling, which means that the participants were selected according to their "criteria of relevance to the research question" [9]. The interviews took place during the fall of 2012.

Semi-structured interviews were constructed prior to meeting with the participants. The benefits of the semi-structured interviews were that the participants had the chance to tell their story and go deeper into the details of their experience. This process also allowed the researcher to consistently interpret the participant's experience during the interview and analysis [9].

Data Analysis

According to Smith, "the assumption in IPA is that the analyst is interested in learning something about the respondent's psychological world" [11]. The analysis sought to comprehend the story, the meaning of the conversation, and not necessarily the frequency of topics [7]. Specifically, it is important "to learn about their mental and social world, those meanings are not transparently available – they must be obtained through a sustained engagement with the text and a process of interpretation [11]. The analysis strictly followed the principles of IPA. The four stages of the analysis were: The researcher's initial encounter with the text (reading and re-reading the text), identification of themes (label and characterize each part of the text), clustering of themes (provide structure and a hierarchical relationship), and production of a summary table (quotations that illustrate each theme and capture the participant's experience) [7]-[9].

FINDINGS

The dean of the school of engineering emailed 226 junior and senior male students inviting them to participate in this study. Seventeen engineering students responded and 12 committed to be participants in the study. Seven of the students interviewed were seniors and five were juniors. The students had a combined grade point average of 3.32 out of a 4.0 scale, minority students made up 25 percent of the interviewees, and the average SAT score of the group was a 1302 out of 1600 (math and verbal only). Seven students were persisting in mechanical engineering and five students in electrical and computer engineering. Pseudonyms were chosen for each participant in the study.

Through careful questions and methodic analysis, five themes surfaced that exposed the difficult journey of persistence to complete a degree in engineering: (1) The Importance of Preparation (2) You Cannot Do This Alone (3) Intrinsic and Extrinsic Motivation (4) Mandatory Skills and Characteristics, and (5) Perceptions to Why Males Leave Engineering.

Theme One: The Importance of Preparation

The participants matriculated to the university from diverse high school experiences. Several of the students interviewed attended small private and public '1A' schools, while others graduated from large private or public '5A' schools. High schools are classified based on size from '1A to 5A', from smallest to largest in enrollment. Participant nine, Blake, was the only student who attended a private boarding school. Regardless of whether the participants felt they were well prepared for college or not, each student mentioned the importance of their high school education.

Each of the twelve students interviewed were self-described as strong academic students in high school and ready for college. Yet, three of the students felt that their high school could have done more to prepare them for college. Simon said, "My transition from high school to college was very, very bad." He further described his high school as "little" and was adamant that it did not prepare him for college or to study among students from larger, urban schools. In addition, Simon thought it was "not so much the academics, but the self-discipline that was required" to do well in college.

By enrolling in "AP courses," "attending dual enrollment and community college courses," and "living at a boarding school" the students described their academics in college as less challenging. The more demanding their high school, the more prepared they felt in college and in their engineering program. Sam noticed that he was well prepared during his first year in college as he enrolled in Chemistry, Calculus I, and English. He stated, "Taking those hard classes during high school really paid off…English class here in college was easier than my English class in high school…the same thing with my chemistry in college…it was easier than my chemistry in high school."

The participants stated significant differences existed between high school and attending college and studying engineering. Simon summarized the difference: "In my high school most of your work is done in class and so it

kind of does all the discipline for you. You have a set block; you are in your English class and doing your English work, in your math class doing your math work. In college, they lecture you, then they assign homework and then you have all this free time and in your head, oh you know, I got 32 hours to do this, let me go have fun you know. There's no, you don't know how to mentally block your time out because it has always been done for you. That skill I've completely worked from the ground up in the few years I have been in college."

Theme Two: You Cannot Do This Alone

Many of the interview questions and conversations sought to comprehend levels of academic support, peer interactions, and social activities. The findings described the importance of completing an engineering degree - one cannot complete it alone.

Engineering was described as rigorous and required multiple levels of support. The participants were asked what advice they would give fellow students who struggle or think about leaving the major. The overwhelming response was to "ask for help." Simon said, "I ask for help all the time. I think I'm a slow learner when it comes to math." Seeking help is part of the engineering culture, and the students implied that it was the only way to get through the courses.

Community was also something many stated provided support for those who are persisting through engineering. Community was described as fraternities, clubs, organizations, peers in the classroom, and other social groups on campus. Over half of the students who were interviewed lived, or spent significant amounts of time, in the Engineering and Computer Science Living-Learning Center (LLC) at some point during their time in college. The Living-Learning Center consists of a 300-bed residence hall for like-minded students. The facility boasts of study rooms, faculty and staff offices, and a large room for community events.

Ben specifically remembered a time when he was really struggling during his first year, and when his Community Leader (CL), who is a Resident Assistant at this institution, provided him with emotional support. Ben Stated, "my CL, Tony, he started out as a good friend, a guy that was just a leader and you know, my parents had issues my first -year that I was here…I went to his room and he skipped a rugby game to sit and talk with me for two to three hours." This type of supportive community was reiterated by a number of the participants.

To the participants in the study, faculty members were educators, mentors, and the everyday people at the university who guided them through the rigorous demands of their degrees. Their responses came from a variety of questions surrounding their experience with faculty and persistence within the engineering program. The most intriguing answers came from students who felt that the faculty member treated them as individuals and got to know them on a personal level. Craig stated: "To see professors as more than just somebody who stands up there and talks to you, but you know, understanding that they actually care about you learning the material and about you as more than just numbers, somebody that sits in their class."

Students noted social groups and extracurricular activities as a means to relieve stress and connect with friends. The participants recommended getting involved as a way to persist and continue through the academic hurdles in engineering. Not all of the students said that they used co-curricular activities wisely. Some of these groups took away from their academics. Ben stated, "It's not the smartest decision, but it taught me time management. That includes intramurals, helping out with move-in activities, the first summer I was a Line Camp Leader."

Theme Three: Intrinsic and Extrinsic Motivation

Multiple students described the engineering experience with a variety of feelings and emotions. Ben stated: "Okay, I will be completely honest, there is pressure, fear, there's excitement, because all people that are here, or most of the people, are because they are nerds and they love what they do, and there is that excitement of what I will do when I am done." The findings suggested that they enjoyed their homework and that intrinsic motivators pushed them through the difficult times. Sam said, "There's no point in pursuing such a great degree if you're not going to enjoy it." Regarding the rigor, Kevin said, "You have to be able to work past that, I think that it's really enjoyable." He added, "If you're not enjoying what you're doing when you're doing your homework or when you're studying, then this is not the right degree for you, and you will never make it through." The participants portrayed an inner passion for engineering, which stemmed from their preparation, community, and love for math and science.

The participants gained resilience from believing that an engineering degree was worth it. For many of them, engineering is worth the rigor because of future employment, the ability to have an impact on the world, and the monetary gains. John said: "I know my path is going to be difficult for me now, but it opens up so many more doors for me later. Being an engineer, having that degree, just having that understanding of how things work and all that great stuff." The participants had a big picture mentality and were, as James said, "always looking forward to what's over the horizon." Craig also said it was worth it by being "able to accomplish getting my degree, but then seeing that degree as just a huge resource in whatever I may pursue for the rest of my life."

Theme Four: Mandatory Skills and Characteristics

The participants all asked to define persistence in their own way, through their own perspective. Sam stated, "I would say the drive to keep doing something even if in the current moment you don't necessarily want to. It's getting that rep

out on the bench press or that extra squat and then coming back the next day and doing it again." Tony defined it as "going up a stream regardless of the fact that the stream is going against you because you decide you kind of want to go upstream." John said it is "grinding through it, doing it, even though you are struggling so much right now, you can realize something at the end of it and strive towards that goal, even, even though uh the immediate present is just awful."

These interviews revealed the significance of completing homework in an engineering program. The first step is, according to Ben, "to be very organized and intentional about finishing your work in engineering, I think even more than many other disciplines." The second for Ben is to understand that, "Everything builds on everything within these technical areas, so if I skip a homework because I don't think I have time to do it, uh, there is no way I am passing the next test, figuring out the next homework, passing the final, and possibly passing the class." The third step is to remember, as Sam put it, "You can have a bad day, but you can't have a bad week. Cause once you fall behind you stay behind. To finish homework and stay on top of the work, one must find a proper environment to study. Homework is about staying organized, comprehending the material, not getting behind, and finding a way to learn and study effectively."

The participants often referred to time management as a cornerstone to persisting in an engineering degree. Balancing academic and social life is crucial in college. The students must, as Ben said, "schedule and structure your time" throughout each semester. Students must also sacrifice their time and other experiences. Ben stated, "I had to make a lot of sacrifice, a lot! First semester, I got a 1.7 GPA because I painted my body for every single football game and hung out with friends all the time. I thought I could skate through, and I couldn't." The interviewees focused on the importance of academics, but also encouraged the participation of co-curricular activities.

Theme Five: Perceptions to Why Males Leave Engineering

Within each interview, the individuals were asked to give feedback as to why their acquaintances, classmates, and friends left engineering. The student perspective on this matter offered critical insight into what they heard, saw, and experienced as those around them transferred majors or left the university. Ben stated, "My freshman roommate left because he put so much work in, he had to work so much harder than someone else and he just couldn't handle it anymore." Tony described his roommate's departure, "After sophomore year he switched majors to business and like the only reason he did was because the work was hard which he was doing better than I was at the time. He just didn't want to put in the work to be constantly doing homework all the time. So he went to business where it's easy." The perceptions to why males left engineering had more to do with the amount of work and rigor than their actual academic ability.

DISCUSSION

Helpful Factors in Male Persistence

Students who expressed that they were challenged academically in high school felt better prepared upon enrollment in college. This was consistent with Palmer, Maramba, and Dancy findings; the engineering participants in their study also listed that preparation in high school assisted in their persistence while in college [12].
The academic experience in college led to other factors that appeared to support persistence in this engineering program. The participants further described the ability to seek help when they did not understand a concept or were struggling in a course as a means of persistence. Living in a community among like-minded engineering students also was portrayed as beneficial in supporting the development of study groups with their peers. Interacting with their faculty members assisted in overcoming the challenges of homework and further engaged the students in the program. Lastly, the students believed they worked hard and were willing to go the extra mile to solve a problem or get an "A" on a test.

These findings also support literature that points to preparation, test scores, and high school grades as some of the strongest predictors that undergraduates will finish their program of study [13]-[14]-[15]. During the recruitment process for engineering programs, the academic level of education in high school may also provide foreknowledge of their ability to persistence. As stated by Palmer, Maramba, and Dancy [12], the intense high school preparation supported the student's capability of remaining in the engineering program. The participants in this research agreed and identified that strong preparation in high school made the transition into the rigorous engineering program easier.

Academic Performance and the Ability to Persist

The participants referred to their academic performance (i.e. grades, SAT scores, ACT Scores) very little during the study. Instead, academic preparation prior to enrolling in college was noted as helping them persist in college. The participants explained that not only a strong high school education, but also performing well in those courses prepared them for the adjustment to the program. This finding is congruent with the work of Astin and Oseguera, in which high school grade point averages carried the most weight in predicting whether the student completed a degree or not [14]. Horn and Kajaku also discovered that students who engaged in a difficult high school curriculum were likely to persist in college [16]. All of these points suggest that being challenged in high school courses and having

maintained a strong GPA in high school aid students to persist in engineering.

Intrinsic motivation was explained by the students as a satisfaction to commit to work hard, perform well on tests, and to overcome difficulties in the program. A great deal of pleasure was found by earning an "A" or by solving a complex problem that took many hours or days to complete. Beyond these two areas, academic performance was not directly mentioned by the interviewees. Students did care about their grades and passing their courses, yet achieving this was done by drive, dedication, and hard work. For example, if students put in the time and effort needed to succeed, then their academic performance will reflect it. Intrinsic motivation varied in students but served as a source of inspiration throughout engineering coursework.

Participation in Social Activities

Social activities were emphasized as serving an important role in an engineering program. Activities offered individuals a break from the rigor and daily grind of the work. Examples of such co-curricular activities included, but were not limited to, attending athletic games, Air Force ROTC, community leadership (resident advisor), intramurals, fraternities, hanging out with friends, and internships. The social experiences provided much needed stress reductions, opportunities to develop and engage in collegiate life, and a place to have fun. Lastly, it may be suggested that activities were an integral part of the delicate balance of succeeding in the engineering program.

Social and academic integration also played a valuable role in student persistence as supported by early research [17]-[18]-[19]. Social activities were described as the way participants connected to the university as a whole. This theme was supported by Tinto's work on how beneficial engagement within the institution is for retention [20]. Furthermore, a majority in the study said that participation during times of engagement and activity only happened when homework was completed. Additionally, this emphasized the ability to manage time and reinforced the fact that academics came before social life in this area of study.

Faculty Interactions

Faculty members played a significant role in education and each participant's ability to persist. Faculty members were described as a mentor, leader, friend, or even a motivator in times of need. Faculty members were admired by their students, which developed influential interactions in the classroom, during office hours, and during social programs attended by professors. They also played an integral role in the development and success of the student during his progression towards graduation. Faculty members were reported as influencing the persistence of students, which Seidman also acknowledged in his research as a factor to retain students [21]. His research further noted that faculty and other educators on campus have evolved to be agents of retention for students [21]. Positive relationships with faculty members aided in persistence; therefore, these relationships with students may impact retention in their program of study.

Peer Interactions

Peers played the most significant role in persistence while in college. This was demonstrated through the numerous examples from living with other engineers in the residence halls and seeing how necessary it was to study and socialize together. A potential explanation for this finding was that the institution in this study has a vibrant engineering residence hall on their campus. Zhao and Kuh found that living together in a learning community provided students with a number of advantages and benefits during their time in the engineering program in college [22]. Each student who was interviewed lived for at least one academic year in the engineering and computer science living learning-center. The students enjoyed the community, activities, and the connections they made with like-minded students in their residence hall. Seidman added that these communities offered students an opportunity to "think [and] re-think" about their classes and labs [23]. Tinto also found that students had an enhanced learning experience from these communities [24].

Friends inside and outside of the major provided a variety of activities and fun. The participants explained that when one got stressed or failed a test, peers were their first level of support toward recovery. This finding supports the large investments of institutional effort to connect first-year students during orientation, welcome week, and first-year programs. Allen, Robbins, Casillas, & Oh found that gatherings provided students with a connectedness and a commitment to college, which had direct effects on retention [25]. Group projects, class activities, and homework assigned to students outside of class could benefit these students by helping them make meaningful relationships with peers. Peer relationships appeared crucial to retention and persistence in engineering programs.

FUTURE RESEARCH

Further research is essential to continue to improve retention and graduation rates in engineering programs. Specifically, a continuation of further understanding of the characteristics of students who persist and those who leave engineering are needed. Do male and females remain in engineering for similar reasons? How would those who leave an engineering program of study describe themselves and their factors for leaving? Future research could expand the existing body of research to include more institutions and more diverse students.

A comparative qualitative study between male and female engineering students is recommended. Using the same questions, one might find this study intriguing and

helpful to retain students. Further research may also include the perceptions that students have towards the opposite gender. In the current study, the participants stated that they admired their female classmates and felt the women were more intelligent and more likely to get a job than the male students. Exploring this perception of gender from both the male and female perspective might further help to understand if this is an accurate portrayal by male students. Lastly, expanding this qualitative study to include multiple institutions and longitudinal data could provide information or support for understanding persistence in engineering programs.

CONCLUSION

Male persistence in engineering leads to higher graduation rates. Efforts to educate incoming and first-year students might increase retention and persistence rates in engineering. An incredible opportunity exists for institutions all over the country. Integrating the factors related to persistence in engineering discovered in this study with incoming and first-year educational programs might help the persistence issues within engineering programs.

Retaining and graduating more engineering students supports the goals of the president to increase innovation and technology in the United States [1]. First-year programs may consider the importance of college preparation, developing a support network, focusing on the development of intrinsic and extrinsic motivation for achieving a degree in engineering, determining the academic skills and characteristics necessary to persist in an engineering program, and answering the specifics as to why students leave engineering. These are a glimpse of the issues that need to be tackled to begin increasing persistence. The hope of this study and its findings mirror that of President Barack Obama's goal: to increase the number of graduates in engineering, engineering over the next ten years [1].

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