Predictors of Matriculation in Intended Major in a First-Year Engineering Program

Katherine M. Ehlert, Maya Rucks,
Baker A. Martin, & Marisa K. Orr
Clemson University
marisak@clemson.edu

Abstract

This complete research paper documents how confidence in choice of intended major and self-regulated decision-making competency influence whether a student changes their intended major while participating in a compulsory first-year engineering (FYE) program. Initial major, confidence in that major choice, and self-regulated decision-making competency were documented in the Fall of 2017 for students matriculating into a FYE program. Student enrollment in a major in the Fall of 2018 was connected to this data. Retention in any engineering major and in the student's intended major were analyzed using logistic regression.

Introduction

Students make decisions that affect their lives every day, whether they are small decisions (what to eat, where to study, etc.) or critical decisions (what major to declare, what internship to select, etc.). To help students make self-regulated decisions, it is important to understand how their abilities to self-regulate are influencing how they make important decisions. Previous work evaluated whether students changed their self-declared intended major during their first semester in a year-long FYE program [1]. That work determined students became more confident in their intended major as the year progressed. However, students with low confidence in their original intended major were more likely to change their intended major by the end of the first semester. In this paper, we seek to extend this work to evaluate students a full year after their initial survey participation. This work will test the relationship between major change and decision-making competency taking into account a single-item measure of confidence in intended major choice. The research questions we seek to answer: **(1) Is confidence in intended major a predictor of major change (defined by different intended major from declared major one year later)? (2) Is decision-making competency a predictor of major change?**

Background

Studies have shown that decision-making competency can lead to greater confidence and satisfaction in career choice. Germeijs & Verschueren [2] found that high school seniors who were less confident in their career choices at the end of the school year were more likely to change their intended major by the beginning of their first year in college. This same study revealed that students who had higher orientations of broad and in-depth career exploration, self-exploration, and high commitment to their initial career decision at the end of grade 12 were more equipped for the academic demands of higher education [2].

Undergraduate student decision-making competence and motivation orientation has also been evaluated to determine if they predicted career exploration of self and career exploration of the environment [3]. The Decision-Making Competency Inventory (DMCI) was used to measure decision-making competence, the General Causality Orientation Scale (GCOS) was used to measure causality orientation, and the Career Exploration Survey (CES) was used to measure career exploration behaviors. Individuals with autonomy orientation, as measured by the GCOS, exhibit behaviors that are driven by personal goals and interests. Those with control orientation exhibit behaviors that are driven by social norms and external rewards. Lastly, individuals with impersonal orientation feel that they cannot or are unable to regulate behaviors to any desired outcome whether they be personal or social. Results showed that decision making was the only significant predictor of environmental exploration and autonomy orientation was the only significant predictor of self-exploration [3].

Researchers studied the effects of person-job fit and major-job fit among undergraduate students and professionals in the finance industry. The results indicated a full mediation effect of fit with college major in the relationship between self-regulated decision making and major satisfaction. Additionally, they found a full mediation effect of major satisfaction in the relationship between self-regulated decision making and major-related future careers [4].

Instrument

Major and Major Confidence

Students were asked "Which of these majors are you pursuing?" and provided a list of all the majors offered in the college of engineering including an option to write in another major. This was used to calculate whether a student remained in engineering (Fall 2017 intended major & Fall 2018 enrolled major are in engineering) and if they remained in their major (Fall 2017 intended major = Fall 2018 enrolled major). After selecting a major, students were asked to rate their confidence in that major ("Rate your current level of confidence in your choice of major") on a scale of 1 (Not confident) to 10 (Very confident). We refer to this variable as "Major Confidence" and note that it represents a student's certainty in their choice of major, not confidence in themselves or in their abilities.

Decision-Making Measures

The Self-Regulated Model of Decision-Making (SRMDM) was developed by Byrnes [5] and states that self-regulated decision-makers will spend time in three phases when making decisions: generation of options, evaluation of options, and learning after the decision is made. Additionally, self-regulated decision-makers are aware of moderating factors that prevent good decisions being made like biases or memory limitations and develop strategies to overcome those factors. Byrnes also co-developed the Decision-Making Competency Inventory (DMCI) to measure self-regulated decision-making [6].

The DMCI developed by Miller and Byrnes and additional decision-making items as described by Orr, Ehlert, Rucks, and Desselles [7] were used to measure decision-making competency in this study. Although the DMCI was developed with intended subscales, those subscales were not supported by subsequent exploratory factor analysis. The DMCI is used as a single scale and has shown good internal consistency [6]. Orr et al. [7] revised the DMCI to better map to the SRMDM and revealed a three-factor model addressing the elements of the decision-making process for engineering students. Factor one contains questions relating to the generation and evaluation of options phases of the SRMDM and many of the original DMCI questions. Factor two contains questions that reflect the lack of a decision-making process or impulsive decision making. Factor three contains questions that relate to reflection in the decision-making process. These factors more accurately map to the original SRMDM phases and are a valuable addition to this study because they allow specific aspects of decision-making to be isolated for predicting a change in major. Students were asked to rate statements relating to decision-making on a 5-point Likert-Type scale. Many of these items began with the stem “When I have a big decision to make…”. Items that were negatively-worded were reverse-coded prior to data analysis. For a complete list of items, please see Orr et al. [7].

Methods

Context

Data was collected at a single public institution in the southeast United States that has a compulsory year-long first-year engineering (FYE) program. Students are required to complete specific FYE courses to be eligible to then apply to an undergraduate engineering program. Some engineering departments have minimum GPA requirements; however, it is not consistent across all engineering departments. Students remain listed in a non-degree granting FYE major in institutional data until they declare any major, engineering or not, regardless of when this occurs. According to institutional research, the FYE population is 25% female, 75% male and 79% White, 8% Black, 4% Hispanic, 4% two or more races, and 3% Asian.

Survey Distribution

In the Fall of 2017, students in the FYE courses were offered extra credit for completing a survey through Google Forms. The survey was available for the first ten days of school. Out of approximately 1200 students in FYE courses, 737 students completed the survey. Students had the option to opt out of the study but still received the extra credit for completing the survey.

Pre-Analysis

Statistical analysis was conducted in R Statistical Software [8]. All students who did not complete the survey, were under the age of 18, did not agree to connect their survey responses to their academic data, or were not enrolled as a FYE major at the time of the survey were removed from this data set leaving 460 valid responses. Students who reported their major as “Undecided” were also removed from the data set as that response was not easily interpretable leaving 446 responses. Student major enrollment was collected from institutional records and connected to the survey data.

Continuous variables were calculated as an average of student responses and included student decision-making competency (DMCI) [6] and revised decision-making factors (RDMF) [7]. Skew for the continuous variables ranged from -0.98 to -0.28 and kurtosis ranged from 0.02 to 2.05, well within normality assumptions [9]. Binary variables were also calculated to determine if the students enrolled in their intended major (Fall 2017 intended major = Fall 2018 enrolled major) and if they remained in engineering in general (Fall 2017 intended major & Fall 2018 enrolled major are both in engineering). Continuous variables were calculated as an average of student responses and included student decision-making competency (DMCI) [6], revised decision-making factors (RDMF) [7], and student intent to persist in engineering [10]. Skew for the continuous variables ranged from -0.98 to -0.28 and kurtosis ranged from 0.02 to 2.05, well within normality assumptions [9]. Binary variables were also calculated to determine if the students enrolled in their intended major (Fall 2017 intended major = Fall 2018 enrolled major) and if they remained in engineering in general (Fall 2017 intended major & Fall 2018 enrolled major are both in engineering).

FYE courses are open to all students at the university regardless of major so some students taking FYE courses may be from non-engineering majors. FYE is the only department that offers some engineering-focused courses like computer aided design which may be of interest to students beyond those in the FYE program. Only students intending to enroll (Fall 2017 data) or enrolled (Fall 2018 data) in a degree program that requires the FYE course sequence were considered "In Engineering". Students who remained enrolled as an undeclared engineering major were also included in the "In Engineering" category as this indicated that they were still pursuing an engineering degree but had not officially declared an engineering major in the Fall of 2018.

As a note, intercepts for logistic regressions will be reported but will not be discussed. For each logistic regression, the intercept does not provide conceptually relevant material. In traditional regressions, the intercept would be the average y-value when x is equal to zero which may have conceptual value. This is not true for our case; however, it is best practice to report all regression values.

Results

Major Confidence and Retention in Major

We began by first visually examining the distribution of confidence in major choice for students who enrolled in their initial intended major and those that did not (Figure 1). Students in the "same major" group were students who were enrolled in the same major in the Fall of 2018 as they intended in the Fall of 2017. Students in the "switched majors" group were students who were enrolled in a different major in the Fall of 2018 than their intended major in the Fall of 2017 which included non-engineering majors.

Visual inspection of these two distributions indicates there may be a difference in student major confidence between students who remained in the same major and students who switched. There is a relatively normal distribution of major confidence for the students who switched because the distribution is centered around six with a balanced number of students on either side. However, there is a visual skew in the confidence distribution for the students who remained in the same major. This distribution has many more students with major confidences of seven or larger, especially compared to the number of students with major confidences at five and below. Additionally, there are a similar number of students with very high confidence (9 or 10) who switched majors as those who stayed. For example, of those students with a self-reported confidence of 10, 13 students switched majors and 15 enrolled in the same major as they initially intended.

This visual difference between confidence distributions is also supported by the logistic regression results (Table 1). Confidence in major is a statistically significant positive predictor of students enrolling in the major they intended to a year later ($p = 2.10E-05$).

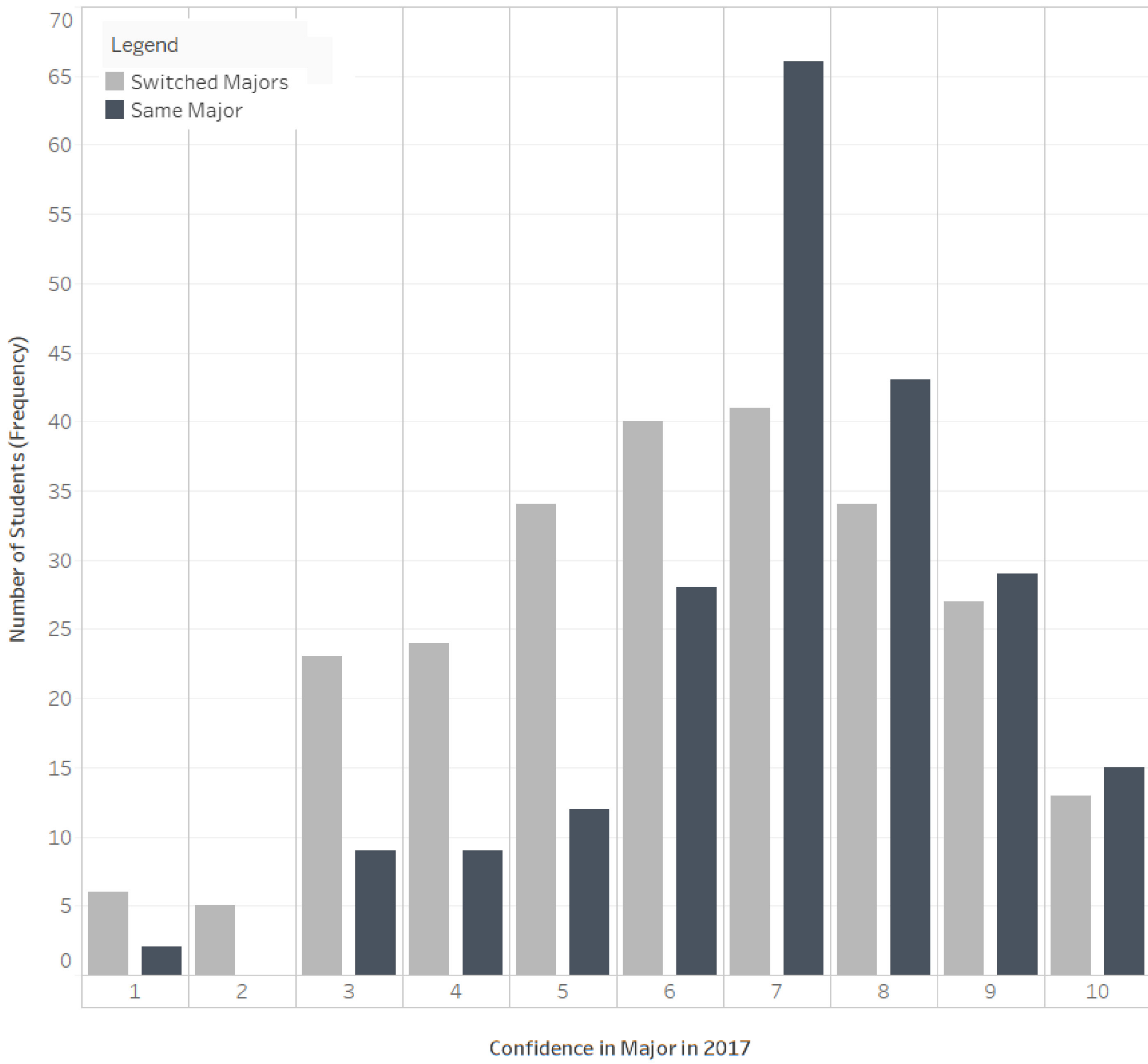

Figure 1: Adjacent histograms of the number of students who switched majors (light) and enrolled in their intended major (dark) by the Fall of 2018 based on their reported confidence in that major choice in the Fall of 2017.

Table 1: Logistic regression results of Major Confidence for students who remained in their intended major one year later. Values marked with and asterisk (*) indicate significance at $p < 0.05$.

Retention in Major		
Variable	Value	p-value
Intercept	-1.51	1.58E-05*
Major Confidence	0.21	2.10E-05*

Major Confidence and Retention in Engineering

When visually inspecting the two confidence distributions for students who left engineering or remained enrolled in an engineering major, the results are different (Figure 2). In this set of distributions, although the frequency difference is high for students who chose to remain in an engineering major, the shapes of the distributions are very similar. Each distribution is relatively normal in shape with each side relatively balanced. The middle of the distributions is around six or seven with few students in the lowest confidence bins. The most noticeable visual difference is that there are substantially more students who chose to remain in engineering than those who chose to leave engineering all together. The lack of difference between distributions of student confidence for those who left engineering relative to those who remained is supported by the results of the logistic regression (Table 2). Major confidence is not a significant predictor of students remaining in any engineering major ($p = 0.13$).

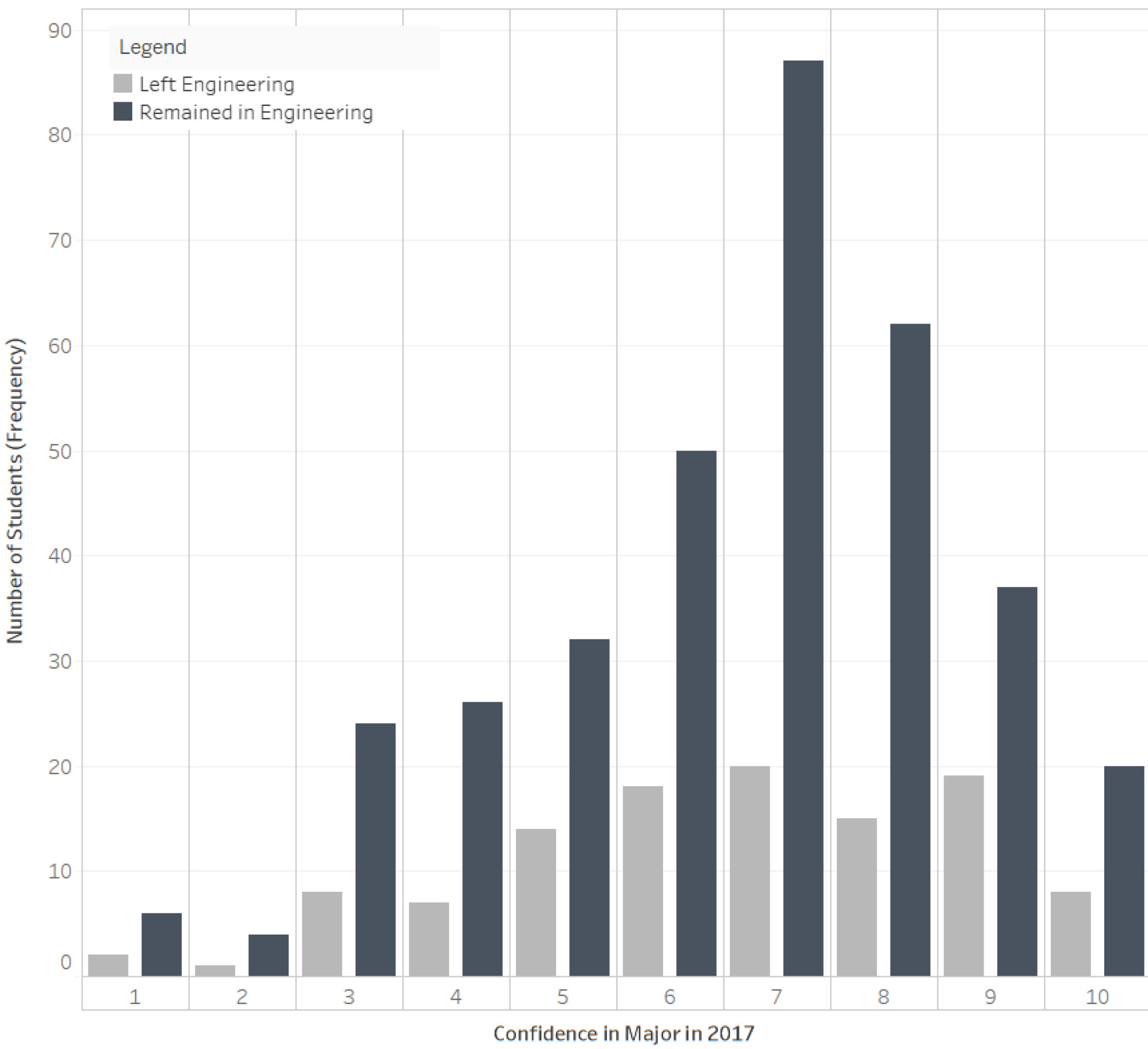

Figure 2: Adjacent histograms of the number of students who left engineering (light) and remained in engineering (dark) by the Fall of 2018 based on their reported confidence in that major choice in the Fall of 2017.

Table 2: Logistic regression results of Major Confidence for students who remained in engineering in general one year later. Values marked with and asterisk (*) indicate significance at p < 0.05.

Retention in Engineering		
Variable	Value	p-value
Intercept	1.86	7.18E-06*
Major Confidence	-0.09	0.13

Measures of Decision-Making

Measures of decision-making (DMCI and RDMF) were then evaluated to determine if they were significant predictors of student choice of major. DMCI and RDMF were analyzed separately because many of the items were included in both scales

Decision-Making Competency Inventory (DMCI) and Retention in Major

DMCI was first visually explored to see if there were visible differences in the distributions between DMCI for students who switched majors and those students who remained in the same major (Figure 3). There were some small differences between the two distributions with the mode (the greatest number of students) being slightly higher for students who remained in the same major than students who switched. Additionally, all students with DMCI scores below 2.75 switched majors. Logistic regression results indicate that DMCI, on its own, is a predictor of students remaining in their intended major a year later (Table 3). The visual differences in the distributions supports the logistic regression results.

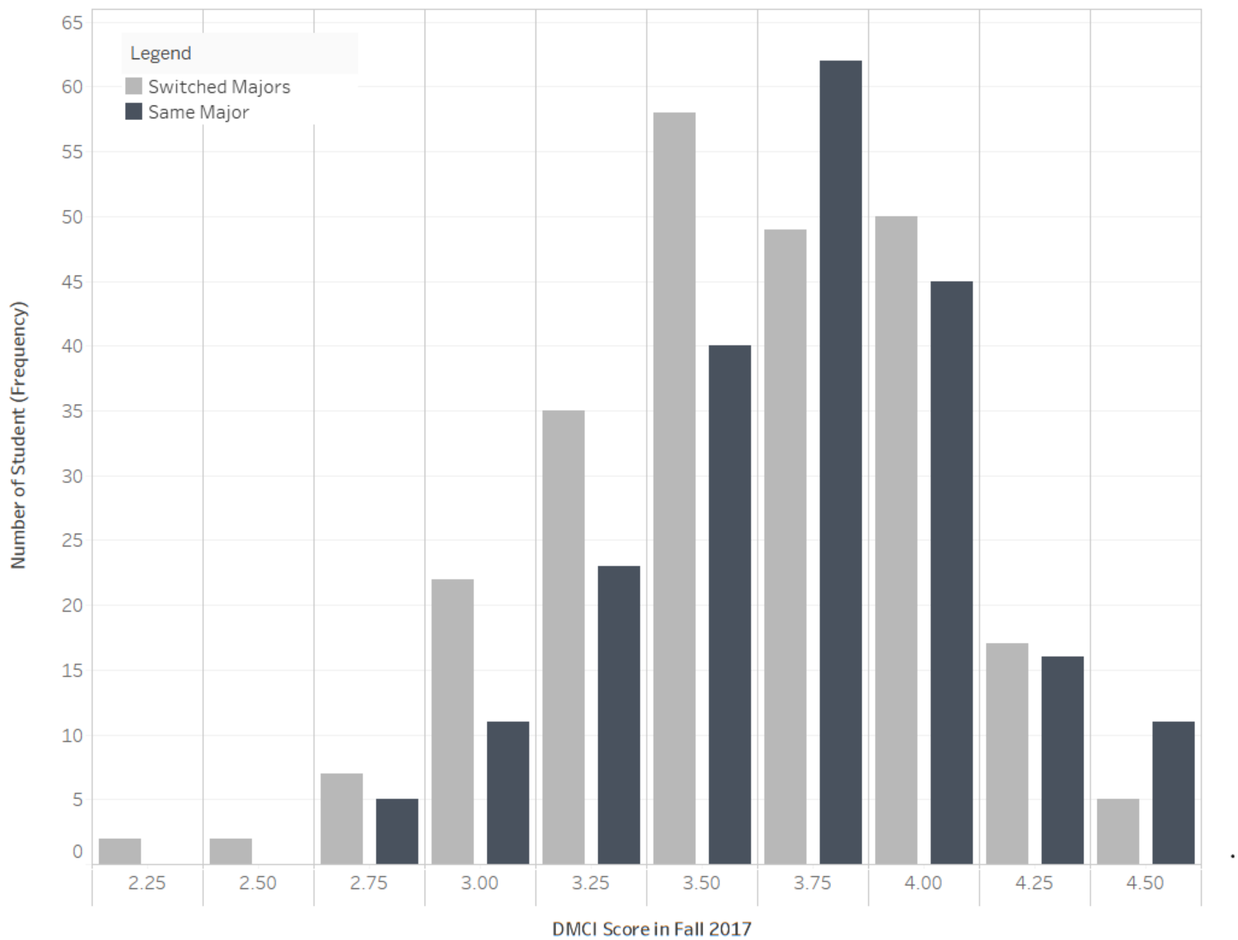

Figure 3: Adjacent histograms of the number of students who switched majors (light) and enrolled in their intended major (dark) by the Fall of 2018 based on their calculated DMCI score from the Fall of 2017.

Table 3: Logistic regression results of DMCI for students who remained in their intended major one year later Values marked with and asterisk (*) indicate significance at $p < 0.05$.

Retention in Major		
Variable	Value	p-value
Intercept	-2.46	7.08E-3*
DMCI	0.63	9.00E-3*

DMCI and Retention in Engineering

DMCI was also plotted to visualize the distributions of DMCI with those students who remained in engineering (Figure 4). Very few differences are observable with the exception that most students remained in engineering. The overall shape of the two histograms seems relatively similar with a similar number of students with low DMCI scores left or remained in engineering.

This is also supported by the logistic regression results as DMCI is not a statistically significant predictor of retention in engineering in general (Table 4).

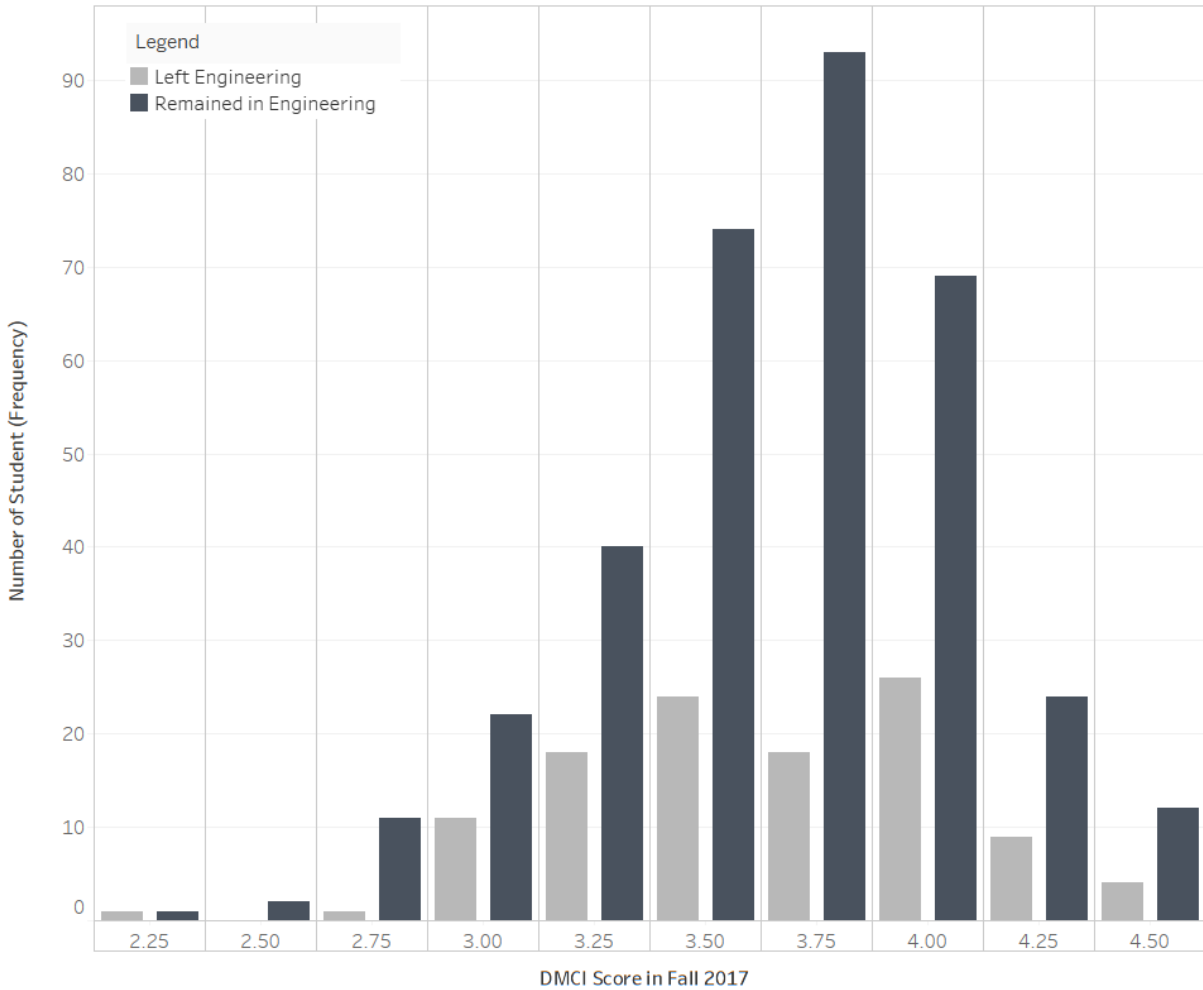

Figure 4: Adjacent histograms of the number of students who left engineering (light) and remained in engineering (dark) by the Fall of 2018 based on their reported confidence in that major in the Fall of 2017.

Table 4: Logistic regression results of Major Confidence for students who remained in engineering in general one year later. Values marked with and asterisk (*) indicate significance at $p < 0.05$.

Retention in Engineering		
Variable	Value	p-value
Intercept	1.46	0.18
DMCI	-0.05	0.86

DMCI and Major Confidence

Major confidence was then incorporated into the model to determine the effect that DMCI had while controlling for major confidence. Results indicated that DMCI was no longer a statistically significant predictor of students remaining in their original intended major when accounting for major confidence nor for retention in engineering in general. However, major confidence remained a significant predictor of student retention in their intended major (Table 5). These results indicate that major confidence is a stronger predictor of student retention in their major than DMCI scores.

Table 5: Logistic regression results including DMCI and Major Confidence for students who remained in their major and who remained in engineering one year later. Values marked with and asterisk (*) indicate significance at $p < 0.05$.

Retention in Major		
Variable	Value	p-value
Intercept	-3.23	8.00E-04*
Major Confidence	0.2	1.20E-04*
DMCI	0.49	0.05
Retention in Engineering		
Variable	Value	p-value
Intercept	1.71	0.12
Major Confidence	0.06	0.83
DMCI	-0.1	0.11

Interaction terms were also included in the analysis to determine if the interaction between confidence and decision-making skills was a predictor. A statistically significant interaction term would indicate that DMCI scores would have different effects depending on the confidence level of the student. When the interaction terms were included in the models, none of the terms were statistically significant indicating a strong covariance between DMCI and major confidence (Table 6).

Table 6: Logistic regression results including DMCI, Major Confidence, and an interaction between DMCI and Major Confidence for students who remained in engineering in general and who remained in their intended major one year later. Values marked with and asterisk (*) indicate significance at $p < 0.05$.

Retention in Major		
Variable	Value	p-value
Intercept	-4.64	0.15
Major Confidence	0.87	0.31
DMCI	0.41	0.38
DMCI * Confidence	0.06	0.64
Retention in Engineering		
Variable	Value	p-value
Intercept	-0.07	0.98
Major Confidence	0.54	0.57
DMCI	0.17	0.74
DMCI * Confidence	-0.07	0.60

Revised Decision-Making Factors (RDMF) and Major Confidence

Previous work established revisions to the DMCI and determined three factors in decision-making: generation and evaluation of choices (RDMF 1), impulsiveness or lack of decision-making process (RDMF 2), and reflection on decisions (RDMF 3) [7]. As there are three factors in this measure, there was no simple way to visualize the data. The three factors and major confidence were included in the model. Results indicate that confidence in intended major is the only statistically significant term (Table 7).

Table 7: Logistic regression results including the three revised decision-making factors (RDMF) and Major Confidence for students who remained in engineering in general and who remained in their intended major one year later. Values marked with and asterisk (*) indicate significance at $p < 0.05$.

Retention in Major		
Variable	Value	p-value
Intercept	-2.60	8.40E-03*
Major Confidence	0.19	2.40E-04*
RDMF 1	0.38	0.08
RDMF 2	0.06	0.81
RDMF 3	-0.14	0.43
Retention in Engineering		
Variable	Value	p-value
Intercept	2.29	0.047*
Major Confidence	-0.09	0.131
RDMF 1	0.38	0.113
RDMF 2	-0.48	0.098
RDMF 3	-0.08	0.716

Conclusion

Confidence in choice of intended major was a consistently strong predictor of retention in major. This aligns well with the observations made by Veurink & Foley [11] that students with higher amounts of confidence in their original major were most likely to graduate in that same major. This reinforces that a general measure of student confidence in their major choice can be a successful predictor of retention in their intended major. However, confidence in intended major choice was often not a statistically significant predictor of students remaining in engineering, indicating that students highly confident in their major choice are just as likely to leave engineering within their first year than students with lower levels of confidence in their choice.

Decision-making measures were not statistically significant predictors of retention in engineering or intended major. We hypothesize that the effects of decision-making competency may become more salient as students move through their chosen curriculum. Although students at the institution studied are informed about each engineering discipline throughout their first year, they are not exposed to the most challenging aspects of each engineering discipline. We expect that the more self-regulated decision-makers will reflect on the learning experiences they have in their second year and be quick to notice and address any misalignment between their goals and the major they have chosen. Decision-making skills may be more predictive of students remaining in engineering after their first year and graduating with an engineering degree.

Future work will continue to follow these students as they navigate their college degree programs, monitoring how these factors and others may predict major retention further into the curriculum.

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Author Biographies

Ms. Katherine M Ehlert, Clemson University

Katherine M. Ehlert is a doctoral student in the Engineering and Science Education department in the College of Engineering, Computing, and Applied Sciences at Clemson University. She earned her BS in Mechanical Engineering from Case Western Reserve University and her MS in Mechanical Engineering focusing on Biomechanics from Cornell University. Prior to her enrollment at Clemson, Katherine worked as a Biomedical Engineering consultant in Philadelphia, PA. Her research interests include identity development through research experiences for engineering students, student pathways to engineering degree completion, and documenting the influence of co-op experiences on academic performance

Maya Rucks, Clemson University
Maya Rucks is an engineering education doctoral student at Clemson University. She received her bachelor's degree in mathematics from the University of Louisiana at Monroe and her master's degree in industrial engineering from Louisiana Tech University. Her areas of interest include, minorities in engineering, K-12 engineering, and engineering curriculum development.

Baker A. Martin, Clemson University
Baker Martin is a graduate student in the Department of Engineering and Science Education at Clemson University. He earned his BS from Virginia Tech and his MS from The University of Tennessee, Knoxville, both in chemical engineering. His research interests include choice and decision making, especially relating to major selection, persistence, and career choice.

Dr. Marisa K. Orr, Clemson University
Marisa K. Orr is an Assistant Professor in Engineering and Science Education with a joint appointment in the Department of Mechanical Engineering at Clemson University. Her research interests include student persistence and pathways in engineering, gender equity, diversity, and academic policy. Dr. Orr is a recipient of the NSF CAREER Award for her research entitled, "Empowering Students to be Adaptive Decision-Makers."