The CSU Engineering Admissions Process: A Preliminary Analysis

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CONTEXT
The Charles Sturt University (CSU) Engineering Program is the first of its kind in Australia. Abstaining from traditional course structure, high stakes testing, and a strict ATAR cut-off for admission, CSU staff have developed and implemented an admissions process to try to identify potential student engineering candidates for their program. Since CSU has set a maximum cohort size of 50 students per year, the need for the most effective means of identifying potentially successful student engineers is a top priority. The primary motivation for this work is to understand the impacts of the CSU admissions process, and identify the variables most indicative of future performance in the program.

PURPOSE
The purpose of this research is to evaluate the validity of the CSU Engineering admissions process, and to identify any correlations between entry credentials and subsequent academic performance. Since the application process includes traditional UAC procedures, a secondary application form, a direct application option, and a final interview, the analysis of this data and its relationship to topic completion and design challenge marks will help inform recruiting efforts in the future.

APPROACH
Data was collected from student applications including course preparation, ATAR scores, secondary application responses, and interview evaluations. Quantitative analysis was done using the Shapiro-Wilks test and the Spearman model to compare selection parameters (Total Topic Completion, ENG161 Marks, Math Topic Completion, and CSU Engineering Topic Completion) and statistically significant correlations were identified. A p-value less than 0.05 was considered statistically

RESULTS
The results of this study show correlations between topic completion and performance on engineering design challenges. In particular, entering student engineers with ATARs above 70 seem to be both completing topics at a faster rate, and performing better on their design challenges. Further, overall topic completion is correlated most strongly with Khan Academy math topic completion, implying that high school preparation in mathematics may be a strong predictor of performance in the CSU Engineering course.

CONCLUSIONS
Based on the results of this study, it is clear that applicants with ATARs above 70 are performing better than those with lower ATARs, but outliers remain. While the ATAR does seem to be predictive of student performance in higher education, the outlier cases need to investigated qualitatively to help identify potentially successful student engineers whose abilities are not being captured by the traditional ATAR metric.

KEYWORDS
Admissions.

Context

Charles Sturt University's Engineering Program is a new course with a unique structure unlike any offered in Australia (Lindsay & Morgan, 2015). The course enrols student engineers in a combined 5 ½ year program that grants a combined Bachelor/Masters degree in Civil Systems upon completion and a head start on chartered status. The course requires students to be on campus for three semesters in which they participate in four design challenges while completing topics on the CSU "Topic Tree." The Topic Tree is CSU's replacement for traditional lectures, homework problems, and exams that partitions civil engineering content into three-hour blocks that can be completed either online (i.e. Moments in Statics) or on-site (i.e. Surveying) depending on the content. Table 1 illustrates (insert). At the conclusion of third semester, student engineers begin a series of four year-long placements in industry consistent with their engineering interests.

Table 1: Topic Breakdown by Category

Category	Major Branches	Example Topics
Khan Academy Maths	- Probability and Statistics - Differential Calculus - Integral Calculus - Linear Algebra - Differential Equations	- Normal Probability Distribution - Limits at Infinity
Open Learning Initiative Statics	- 2D Statics - 3D Statics	- Free Body Diagrams - Moments of Inertia - Equilibrium of Bodies with Engineering Connections
CSU Engineering	- Structural Engineering - Water Engineering - Geotechnical Engineering - Project Management - Materials Science - CAD Modelling	- Stress vs. Strain - Soil Compaction - Failure of Materials - Surveying

As this system is structured in a fundamentally different way than than high school, it is imperative that CSU be able to identify and select candidates for their program that can be successful within this new paradigm. To apply for the CSU program, candidates must complete a three-phase application process that includes the submission of their Australian Tertiary Academic Rank (ATAR), a Secondary Application Form, and an interview.

With this holistic approach, the goal of this paper is to analyse the effectiveness of this process and identify which factors correlate to performance in the program. For this study, performance will be defined as the total number of topics completed and the marks received on the first design challenge (ENG 161).

Table 2: Course Outline for First 18 Months

<table>
<tr><td rowspan="6">Face to Face</td><td>Semester 3</td><td>Client Lead Engineering Challenge
(ENG 261) - 14pt</td><td rowspan="3">Performance Planning & Review - 4pt</td><td rowspan="5">Topic Tree - 48pt</td></tr>
<tr><td>Break</td><td>Christmas Break</td></tr>
<tr><td>Semester 2</td><td>Process-Focused Engineering Challenge
(ENG 162) - 14pt</td></tr>
<tr><td>Break</td><td>Semester Break</td><td></td></tr>
<tr><td>Semester 1
Weeks
3-16</td><td>Humanitarian Engineering Challenge
(ENG 161) - 14pt</td><td></td></tr>
<tr><td>Semester 1
Weeks
1-2</td><td colspan="3">Rube Goldberg Engineering Challenge - 2pt</td></tr>
</table>

The structure of the course requires students to manage their time well and self-direct their own learning. In particular, student engineers are responsible for identifying the technical content needed to best support the advancement of their projects within their design challenge subjects. From the design challenges outlined in Table 2, only the Engineers Without Borders Challenge is relevant to this study. The Engineers Without Borders Challenge requires student engineers to devote approximately 20 hours per week towards the development of a working prototype

Research Question

1. Which application parameters are most predictive of academic performance in the CSU program regarding topic completion and design challenge marks?

Data Collection

Data was collected from the entire cohort of 28 student engineers and included standard University Admissions Centre (UAC) metrics, a Secondary Application Form (SAF), an Interview Score, and a Combined Entrance Score (SAF + Interview Score). From the UAC procedures, the raw Australian Tertiary Admission Rank (ATAR) was provided for all applicants and is a percentile ranking out of 100 (University Admissions Centre, 2016). The Secondary Application Form asked candidates about their thoughts on the role of engineers in society, attributes of a successful engineer, career goals, etc. For applicants who submitted strong SAF forms, they were invited to participate in a final interview that either took place on campus or through Skype depending on the distance between where the candidate lived and the CSU campus.

Interviews were scored by a committee of three academics and final scores were reported out of 10. The last tabulated value of “Combined Entrance Score” represents the sum total of the SAF, Interview, and any additional ATAR weighting adjustments from high school location or other diversity metrics.

Data Analysis

Statistical analyses were performed using IBM SPSS Statistics (version 20, IBM SPSS Inc., Chicago, IL). After checking for normality using the Shapiro–Wilks test, along with visual inspection, non-parametric statistical tests were used for analyses.

The Spearman model was used to compare selection parameters (Raw ATAR, SAF, Interview Score, and Combined Entrance Score) and performance parameters (Total Topic

Completion, ENG161 Marks, Math Topic Completion, and CSU Engineering Topic Completion) and statistically significant correlations were identified. A p-value less than 0.05 was considered statistically significant.

Results

Table 3 highlights several points related to topic completion and design challenge performance. All significant correlations are represented in bold.

Table 3: Spearman's Rank Correlation Coefficient and P-values for Selection and Performance Parameters

		Total Score	SAF Scaled	Interview Scaled	ENG 161	CSU Topics	Statics Topics	Math Topics	Total Topics
ATAR	Correlation Coefficient	-0.211	-0.291	-0.226	0.332	0.276	0.287	0.617	0.554
	p value	0.291	0.141	0.257	0.104	0.172	0.281	**0.002**	**0.004**
Total Score	Correlation Coefficient		0.565	0.611	-0.017	-0.029	-0.428	-0.107	-0.123
	p value		**0.002**	**0.001**	0.933	0.886	0.086	0.629	0.550
SAF Scaled	Correlation Coefficient			0.271	0.076	0.185	0.000	-0.203	-0.034
	p value			0.147	0.700	0.336	0.999	0.331	0.863
Interview Scaled	Correlation Coefficient				-0.002	-0.131	-0.100	-0.056	-0.112
	p value				0.993	0.498	0.682	0.791	0.570
ENG 161	Correlation Coefficient					0.372	0.278	0.328	0.405
	p value					**0.051**	0.263	0.109	**0.036**
CSU Topics	Correlation Coefficient						0.622	0.369	0.707
	p value						**0.004**	**0.070**	**0.000**
Statics Topics	Correlation Coefficient							0.538	0.798
	p value							**0.026**	**0.000**
Math Topics	Correlation Coefficient								0.911
	p value								**0.000**

Topic Completion

With 28 participants, four groups of seven students were analysed based on their raw ATAR score. From this groups, differences emerged in terms of both mean topics completed per category as well as the maximum number of topics completed by an individual within each group.

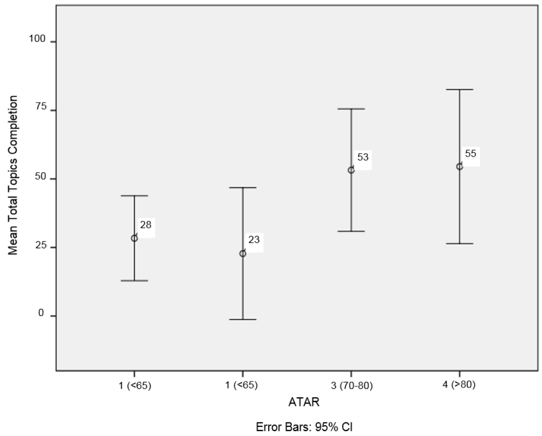

Figure 1: Topic Completion vs. ATAR

The mean number of topics completed for ATARs less than 70 was approximately 25 topics, whereas for ATARs greater than 70 was approximately 55 topics. Overall, the sub-groupings of ATAR less than 70 and ATAR greater than 70 perform quite similarly if you remove the outliers with no statistical significance between the max and outlier in with ATAR between 65 and 70. While each of these trends confirm performance metrics from high school, notable outliers remain. Contrary to the philosophy that ATARs should not correlate with future performance, currently, this does not appear to be the case. ATAR is the best indicator for predicting the first year performance of fresh school leavers, and while non-school leavers perform better than school leavers, their total topic completion is only about 25% higher. With such a small sample size, the outliers of these trends need to be investigated further, preferably through qualitative means to identify the reasons for these results.

Design Challenge Performance

In addition to Topic Completion, student engineers were evaluated against their marks in the first design challenge ENG 161. As Table 3 shows, the variables that correlate to design challenge performance was Total Topics completed and CSU Topics completed. While not causal in natural, it would be worth further investigating if the technical content gained through the topic completion enabled a higher a level of performance on the design challenges (as they were intended).

Overall

Overall, correlations between ATAR with Math Topics and Total Topics may imply greater high school preparation in mathematics as a key indicator of course performance. Additionally, correlations between CSU Topics, Math Topics, Statics Topics, and Total Topics may imply that strong student engineers have the ability to apply themselves across a wide range of technical content made easier by their entry strength in mathematics and physics.

Alternatively, novel admission procedures, such as the SAF, and Interview were not strong predictors of Topic Completion or ENG 161 marks. With the main goal of these procedures to identify potential candidates independent of traditional metrics, the success of these methods still remains to be seen. While seeking to avoid false positives and trying to identify potentially successful student engineers who otherwise would have been excluded from pursuing engineering, there are still many challenges that need to be overcome.

Conclusion

Admitting student engineers is fundamentally a difficult process as the goal of finding potentially successful candidates with limited information on their ability to perform in a self-directed manner is difficult to assess. The main goal of identifying potential student engineers with the right combination of academic preparation and intangible character traits is consistent with the CSU Engineering values of identifying potentially successful engineers whose abilities are not currently being captured by the ATAR metric. While a majority of universities in New South Wales rely heavily on ATAR scores to make their admissions decisions, CSU's approach has been able to identify a few exceptional cases of high student performance independent of this metric that warrant further investigation.

Heading into the second year of the program, extended recruitment efforts have targeted a larger applicant pool through school visits, engaging with various outreach programs targeting underrepresented groups in engineering, and an enhanced online presence. In addition to these efforts the SAF and interview protocol have been modified to focus more on clarifying the expectations and realities of the self-directed learning environment that CSU offers. Lastly, current student engineers have joined the admissions committee to help better articulate the realities of the program and offer their input on how best to identify potentially successful candidates for the program moving forward.

References

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