In search of factors that influence academic success: A comparison between on-campus and distance students

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Abstract*: This study examines the key predictors of academic success for both distance and on-campus engineering students at an Australian regional university. An online survey was used in 2006 to measure individual differences in personality, spatial abilities, and learning approaches. A total of 287 students (92 on-campus and 195 distance students) are participating in the longitudinal study, and their progress is being tracked through to graduation or departure from the university.*

This paper reports on a preliminary analysis of the predictive relationships between spatial abilities, personality, learning approaches, and academic success in first year for on-campus and distance cohorts. As expected, previous academic achievement is a key factor in predicting academic success for first year, on-campus students. Personality traits also contribute to the prediction of academic success for on-campus students - Extraversion is a negative predictor and Conscientiousness a positive predictor. In contrast, previous academic achievement is not relevant to the prediction of academic success for distance students. The three learning approaches, combined with Conscientiousness, significantly positively predict first year academic success for distance students. Surprisingly only one of the three spatial ability traits, Spatial Scanning, correlated with academic success, and then only for the on-campus student cohort. It did not add to the prediction of academic success for either cohort. Further research is warranted.

Introduction

Over the last decade many engineering schools in Australia have experienced increased diversity in the characteristics of their commencing cohorts and, consequently, the diversity of factors that may influence student success in their study programs. This trend is likely to continue in the coming decade as the federal government implements the many policy initiatives included in its "Transforming Australia's Higher Education System" report in 2009 (Australian Government, 2009). For example, the government plans to "radically improve the participation of students from low socio economic backgrounds" and build "stronger connectivity between the higher education and vocational education and training sectors" to improve tertiary pathways (Australian Government, 2009, p. 9).

Venter (2003) suggested that teachers must respond to student diversity so they can enable each student to become a confident, self-directed, and independent learner. An inclusive learning environment that caters for the increasing diversity among commencing student cohorts may make the difference between success and failure. The challenge, then, is how to better understand the characteristics of the students in the commencing cohort and, in so doing, provide a nurturing educational climate in which the prime goals are quality learning and academic success.

To achieve this goal engineering educators should have some understanding of the demographics, personal characteristics and prior educational and work experiences of their student cohorts and the how these factors may influence their successful transition into university and in their studies.

There is an extensive literature about studies into the influence of one or two factors on student success. For example, McInnis, James, and Hartley (2000) found that a large proportion of first year students in Australia were not fully prepared for tertiary education, were uncertain about what was expected of them, and were not motivated to achieve in their studies. Other factors also recognised as relevant to academic success include previous academic achievement (McKenzie, Gow, & Schweitzer, 2004), and personality and learning approaches (Burton, Taylor, Dowling, & Lawrence, 2009). In engineering programs spatial abilities are also seen to be an important factor for success, particularly in graphics courses (Sutton, Williams, & McBride 2009; Magin & Churches, 1996).

There are, however, few studies that, firstly, test the influence of a broad range of factors and, secondly, include distance students. The authors are not aware of any such studies relating to engineering students. They therefore began exploring these issues in 2004 with a study of a cohort of on-campus first year engineering students (Burton & Dowling, 2005). In 2006 they extended that work by including distance education students in new study that is tracking a larger cohort of commencing engineering students through to the completion of their degrees. The aim of the study is to examine the key individual differences (e.g., spatial abilities and personality) and socio-cultural factors (e.g., previous educational experience and learning approaches) that influence the academic achievement of engineering students over time.

The outcomes of this study, particularly those relating to the distance cohort, will therefore add to the literature in this field.

The context

The Faculty of Engineering and Surveying at the University of Southern Queensland (USQ) has more than 2500 students enrolled in its three undergraduate engineering programs: The four-year Bachelor of Engineering, the three-year Bachelor of Engineering Technology and the two-year Associate Degree in Engineering. More than 80% of the students in these programs study off-campus through the distance education mode, and most of these students study part-time.

The programs are highly articulated and offer existing members of the engineering workforce, and those who are new to engineering, a range of educational options to achieve their career goals, with many distance students beginning with a two year program and then articulating into higher level programs. The Faculty also offers a similar suite of undergraduate spatial science programs, with majors in surveying and geographic information systems (GIS). These programs are also offered on-campus and by distance education.

Given that 80% of the Faculty's students study via the distance mode it was important that data from this cohort be included in any study so that appropriate teaching, learning and assessment strategies can be developed and deployed for the students in that cohort.

The research questions

The aim of this research project was to identify the key factors that impact on the learning outcomes of engineering students in first year and throughout their program. In particular, this ongoing longitudinal study is designed to identify:

1. The extent of the diversity in the on-campus and distance education student cohorts.
2. The individual differences and characteristics that represent student diversity.
3. The influence that those differences and characteristics have on student learning in the on-campus and distance education study modes.

The study will continue until at least 2012 by which time it is expected that the vast majority of students will have departed the university, either because they have completed their program or because they have cancelled from their program. This length of time is necessary because most of the distance students study part-time and may take more than double the time than on-campus students do.

This paper is therefore a progress report on the research undertaken to date. It describes the study, the key individual difference characteristics being measured and analysed, and presents the preliminary findings.

Introduction to the individual differences variables

Spatial ability

Spatial abilities involve the ability to "generate, retain, and manipulate abstract visual images" (Lohman, 1979, p. 116) and influence success in the engineering profession (Strong & Smith, 2002). First year engineering students with poor spatial ability are likely to fail graphics courses and drop out (Magin & Churches, 1996), and this impacts more on the success of female students (Sutton, Williams & McBride, 2009). For this reason it is important to use spatial ability tests to establish the proficiency in spatial abilities of the first year cohort so that intervention programs might be developed to enhance these skills. However, Sorby (2009) believed all engineering students, not only females, can benefit from specific training in spatial and technical skills – it helps them to build confidence and reduce attrition. Sutton et al. found that the more experience in technical drawing and design students have, the higher their spatial skills.

Personality

Debate continues about the exact number of factors comprising personality, however, most research favours a five-factor model (Goldberg, 1999): Emotional Stability, Extraversion, Intellect, Conscientiousness, and Agreeableness. Each factor is bipolar. People low on the Emotional Stability trait tend to experience such negative feelings as humiliation and low self-esteem; emotionally stable individuals are self-reliant and are able to deal with anxiety. Individuals high on the Extraversion trait tend to be social and self-confident and enjoy interactions with others. The Intellect trait is characterised by an open-mind, a willingness to experience new situations, and a preference for novel experiences. Individuals high on the Agreeableness trait are altruistic, adaptable, and supportive; Agreeable individuals tend to cooperate and trust others. Conscientiousness is characterised as being responsible, hardworking, and dependable; conscientious individuals are self-disciplined, reliable and persistent.

Previous research has shown most of the five personality traits predict academic success, although the findings are varied (Diseth, Pallesen, Hovland, & Larsen, 2006). Conscientiousness is the trait most consistently positively correlated with academic performance (Nguyen, Allen, & Fraccastoro, 2005). Intellect has also been positively associated with academic success in undergraduate distance studies (Burton & Nelson, 2006). Introverted students are expected to outperform extraverts (Entwistle & McCune, 2004), however, findings are inconsistent. In contrast, Neuroticism and Agreeableness are generally not associated with academic success (Diseth et al., 2006).

Learning approaches

Researchers have long been interested in how students go about learning, what strategies they use, and why they choose particular approaches (Vermunt, 2007). Approaches to learning reflect the individual differences in strategies used to achieve a particular learning task (Diseth & Martinsen, 2003). The student approach to learning (SAL) tradition distinguishes between Deep, Surface, and Strategic learning approaches (see Entwistle & Peterson, 2004). A Deep approach involves finding meaning in what is being studied to maximise understanding. A Surface approach involves investing little time in the academic task and memorising information with rote-learning. A Strategic approach involves being guided by the assessment criteria and enhancing self-esteem through competition.

Researchers have investigated the relationships between these learning approaches and academic success. The SAL paradigm argues that high achievement can be predicted by a Deep approach, either alone or in combination with a Strategic approach (Diseth & Martinsen, 2003; Diseth et al., 2006). In contrast, low achievement can be predicted by a Surface approach to learning (Diseth & Martinsen, 2003).

Previous educational experience

All high school students who apply for a tertiary place through the Queensland Tertiary Admissions Centre (QTAC), are given an Overall Performance (OP) score of between 1 (highest) and 25 (lowest). An OP is a measure of overall achievement in Years 11 and 12 of high school. All other QTAC applicants, including interstate high school leavers, are allocated a Rank based on their previous studies, work experience, and performance in QTAC tests. This QTAC Rank (the lowest Rank is 1 and the highest is 99) is then used by universities to select students for their programs. For this study, OP scores were converted QTAC ranks and then QTAC rank was used as the measure of previous educational experience for all students.

Method

A battery of tests was developed to create a “learning profile” for each student by identifying students’ learning approaches, spatial abilities, and major personality traits. This online survey was developed for use in the longitudinal study of individual differences in student achievement. As previously discussed, the study was deliberately designed to be broad so that the variables measured were not limited to those factors that have been previously identified in the literature.

Participants and Procedure

USQ Ethics clearance was obtained prior to the commencement of the study. The current data were collected on-line, with students consenting to having their academic performance tracked over time.

The student participants included both on-campus and distance education cohorts, studying either full-time or part-time, drawn from the three levels of engineering and spatial science programs. They were recruited through postings on the USQ Orientation website and on the online discussion board for a common course that is undertaken by most first year students. It should be noted that many students enter USQ programs with advanced standing and do not study this course.

The battery was administered online to the students in the first semester of their studies, providing an efficient data collection process and enabling distance education students to participate in the project. The total testing time for the Internet-administered survey was about 1.5 hours. Testing was carried out over a 4-month period. Individual feedback was provided to each participant summarising their learning approaches, cognitive strengths, and weaknesses and outlining strategies for optimising their learning environments.

Online survey

The online self-report survey incorporated demographic variables including gender, age, language, nation of origin, program of study, program status, mode of study, and previous engineering experience. This was followed by the various measures of spatial ability, personality, and learning approaches.

A total of three marker tests were included to measure spatial ability, comprising the Spatial Relations, Visualisation, and Spatial Scanning factors. The Spatial Relations factor reflects the ability to perceive an object from different positions. Spatial Relations ability was measured by the Spatial Relations test (70 items; Thurstone & Thurstone, 1965). The Visualisation factor reflects the ability to apprehend a spatial form and rotate it in two or three dimensions before matching it with another spatial form. Visualisation ability was measured by the Paper Folding test (10 items). The Spatial Scanning factor reflects the speed with which a person can mentally scan a map or object and find a path or connection between two points. Spatial Scanning ability was measured by the Map Planning test (20 items). The Visualisation and Paper Folding tests were from the Ekstrom, French, Harman, and Dermen (1976) kit of factor-referenced cognitive tests. These tests are recognised as standard measures of spatial abilities. The dependent variable for each spatial marker test was the total number correct.

The short form of the International Personality Item Pool (IPIP, Goldberg, 1999) was used to measure the Big-Five factors of personality: Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Intellect. The IPIP consists of 50 questions, with 10 items used to compute a total score for each of the major personality factors. Respondents used a 5-point Likert-type scale to rate each statement, ranging from 1 (*very inaccurate*) to 5 (*very accurate*). Total scores for each personality factor could theoretically range between 10 and 50. Goldberg (1999) showed that the IPIP scales each demonstrated acceptable internal reliabilities, with coefficient alpha estimates ranging between .79 (Conscientiousness) and .87 (Extraversion). The IPIP scales show acceptable reliability estimates when administered online (cf. Burton & Nelson, 2006).

The 52-item Approaches and Study Skills Inventory for Students was used to measure the three learning approaches (Entwistle & McCune, 2004): Deep, Strategic, and Surface. Participants indicated their relative agreement using a 5-point Likert-type scale, ranging from 1 (*disagree*) to 5 (*agree*). The 16-item Deep approach scale measures whether students (a) seek meaning, (b) relate ideas, (c) use evidence, and (d) show interest in concepts. The 16-item Surface approach scale measures whether students (a) lack purpose, (b) memorise material, (c) are syllabus bound, and (d) show a fear of failure. The 20-item Strategic approach scale measures whether students (a) organise their study, (b) can time manage, (c) are alert to assessment demands, and (d) monitor their performance. Total scale scores for both the Deep and Surface approaches could theoretically range between 16 and 80; total scores ranged between 20 and 100 for the Strategic approach scale. Entwistle and McCune reported acceptable reliabilities for the Deep ($\alpha = .84$), Strategic ($\alpha = .80$), and Surface ($\alpha = .87$) scales.

Academic Success

The current study used grade point average (GPA) as the measure of academic success in higher education studies. GPA is a standardised measure of overall academic performance across all courses completed by the student. A student's GPA is the average of the grades they achieve in the subjects they complete, based on a 7-point scale, with a Fail =1.5, a Pass = 4, a Credit = 5, a Distinction = 6 and a High Distinction = 7. GPA was measured at the end of each semester; however, only first year GPA (GPAY1) is reported here.

Key findings

A total of 287 commencing students (92 on-campus students and 195 distance education students) completed the online survey in Semester one 2006, which represents 96% of the commencing on-campus students and 52% of the commencing distance students in that semester. There were 31 females (12 on-campus; 19 distance) and 255 males (79 on-campus and 176 distance) in the sample (1 student did not indicate their gender), with a mean age of 24.56 years ($SD = 7.27$). The mean age of the females was 22.70 years ($SD = 7.21$), and 24.80 years ($SD = 7.23$) for males. The mean age for the on-campus students was 19.22 years ($SD = 4.37$) and 27.10 years ($SD = 7.00$) for the distance students. This mean age difference was statistically significant, $F(1, 285) = 98.337$, $p = .00$, mainly because the majority of the distance students were mature-age students while the on-campus students were predominantly high school leavers.

Table 1 shows means and standard deviations for the key variables for both the on-campus and distance cohorts. The average GPAY1 was above a pass level (C) for both distance and on-campus students, indicating that both cohorts were, on average, successful in their first year studies.

Comparable results were evident across the three learning approaches, with no statistical mean differences evident between the on-campus and distance education cohorts. For the personality variables, comparable results were evident for on-campus and distance students. Both on-campus and distance cohorts scored highest, on average, on the personality trait Agreeableness and lowest, on average, on the personality trait Extraversion. These findings replicate the findings of Burton and Dowling (2005). However, the distance education students scored higher than the on-campus students on the Conscientiousness trait ($F[1,285] = 6.80$, $p = .01$) and on the Intellect trait ($F[1,285] = 4.86$, $p < .05$). In contrast, on-campus students scored higher than distance-education students on Spatial Relations ($F[1,285] = 10.62$, $p < .01$) ability. No other significant differences were evident.

Correlation and Regression analyses

Pearson's product moment correlations were computed for all key variables. As shown in Table 1, for both cohorts, GPAY1 was significantly positively correlated with the Strategic learning approach and significantly negatively correlated with the Surface learning approach. This finding is as expected.

However, the Deep approach was correlated with GPAY1 for distance students only. GPAY1 was also significantly negatively correlated with the trait Extraversion for on-campus students. This finding is in contrast to Burton and Dowling (2005) where Extraversion was positively correlated with GPAY1 for a sample of on-campus students. As expected, Conscientiousness was significantly correlated with GPAY1 for both cohorts. Contrary to expectations, however, Spatial Scanning was the only spatial test to correlate significantly with GPAY1, and then only for on-campus students.

Table 1: Summary Statistics and Correlations of Key Variables against Academic Success

Scale	On-campus (*n = 92*)		Distance (*n = 195*)		Correlation Matrix On-campus	Correlation Matrix Distance
	M	*SD*	*M*	*SD*	*GPAY1*	*GPAY1*
Learning Approaches						
Deep	60.27	7.81	60.08	9.06	.08	.31**
Strategic	73.74	10.05	73.49	12.10	.23*	.31**
Surface	47.07	9.85	45.06	9.67	-.23*	-.27**
Personality						
Extraversion	31.30	6.78	31.88	7.90	-.23*	-.14
Agreeableness	36.50	6.03	37.71	6.14	.13	-.07
Conscientiousness	33.36	5.37	35.29	6.09	.36**	.18*
Emotional Stability	33.35	6.37	33.66	7.28	-.02	.05
Intellect	34.05	5.40	35.54	5.29	.14	.09
Spatial Abilities						
Spatial Relations	57.53	14.81	50.10	19.19	-.10	-.07
Visualisation	6.91	2.14	6.43	2.41	.03	.01
Spatial Scanning	8.33	3.22	7.88	8.02	.21*	.08
Academic Success						
QTAC	79.71	10.25	77.93	12.47	.54**	.10
GPAY1	4.66	1.11	4.88	1.26	1.00	1.00

Note. GPAY1 is the grade point average for end of first year of study in 2006; QTAC rank is calculated from the year 12 subjects by the Queensland Tertiary Admission Centre. * $p < .05$. ** $p < .01$.

Separate regression analyses were then run to identify the key predictors of academic success for both on-campus and distance cohorts.

Firstly, for on-campus students, given that QTAC rank is significantly correlated with GPAY1 (r = .54, p = .00), this variable was controlled to better establish the contribution of the remaining variables in the survey. QTAC rank was entered at step one of the regression analyses. Step one of the analysis revealed that QTAC rank was a significant predictor ($\beta = .54$, $t = 5.52$, $p = .01$), explaining 29.2% of variance in GPAY1 ($F_{(1,74)} = 30.45$, $p = .01$). When Strategic and Surface learning approaches, Extraversion and Conscientiousness traits and Spatial Scanning were entered next, both Extraversion ($\beta = -.24$, $t = 2.44$, $p = .01$) and Conscientiousness ($\beta = .22$, $t = 2.06$, $p < .05$) showed a unique contribution to the prediction of GPAY1, explaining an additional 13.0% of the variance.

A multiple regression analysis was then performed to investigate the key predictors of GPAY1 for distance students. In contrast to on-campus students, QTAC rank was not significantly correlated with GPAY1, therefore, it was not entered into the analyses. In contrast, GPAY1 was regressed onto the three approaches to learning and the Conscientiousness personality trait. The overall result was significant ($R^2 = .13$, $F[4, 132] = 4.87$, $p < .01$), however, no variable provided a unique contribution to the prediction of GPAY1.

Implications and future research directions

The results in Table 1 provide at best, only partial support for the notion that spatial abilities are related to academic success. Only Spatial Scanning appears relevant to success in first year engineering studies, but for on-campus students only. Further analysis will establish whether these abilities are particularly relevant to success in the graphics and design courses and longitudinal research is warranted.

A key finding of this study is that the on-campus and distance cohorts achieved similar academic success at the end of first year. However, the key predictors of academic success for on-campus and distance cohorts differ.

For on-campus students, the results concur with those of McKenzie et al. (2004) who found that previous academic performance (e.g., QTAC rank) was the most significant predictor of engineering students' university performance, in this case GPAY1. Both Conscientiousness and Extraversion added to the prediction of GPAY1 beyond previous academic achievement (QTAC rank). This finding indicates that on-campus students, normally school leavers, are conscientious and responsible, efficient, self-disciplined and organised, and have high aspirations for academic success. In contrast, Extraversion negatively predicted academic success for first year, on-campus engineering students. This is consistent with previous research that found introverted and agreeable students were more likely to be successful in their studies (McKenzie et al., 2004). However, it contrasts with a study of on-campus engineering students where extraverted students were more likely to be successful in first year (Burton & Dowling, 2005). Further analysis of this data will be undertaken and the results will be compared with the data from a study of a cohort of 2007 students which is yet to be analysed.

Contrary to expectations, QTAC rank was not relevant to the prediction of academic success for distance students. The Deep and Strategic learning approaches were positive predictors of GPAY1; while the Surface approach was a negative predictor of GPAY1. Conscientiousness also combined with the learning approaches to predict academic success. Conscientious people are determined and strong-willed while Strategic individuals are motivated to obtain the best possible mark by effectively organising their study time and learning environments. It is therefore not surprising that people with these characteristics aim to understand what they learn and relate new concepts to ideas already assimilated, and consequently achieve high academic success in first year distance education studies.

Conclusion

This longitudinal research with a 2006 commencing cohort of on-campus and distance education engineering students showed that prior educational experiences are relevant to on-campus students' academic success in their first year of studies. Conscientiousness was a positive predictor of academic success for on-campus students while Extraversion also contributed (negatively) to the prediction of academic success for this cohort. Unexpectedly, spatial ability did not correlate significantly with academic success in first year engineering studies, with the exception of Spatial Scanning, and then only for the on-campus cohort.

In contrast, each of the three learning approaches together were Conscientiousness were relevant to the prediction of first year academic success for distance students. Previous academic achievement did not contribute to the prediction of academic success for this cohort.

The current preliminary findings thus indicate that a range of factors influence the success of first year engineering students, and that these factors vary with mode of study. Engineering educators who teach first year students should take these factors into account and ensure their students are equipped with self-management and study skills to help them to be strategic and organise their study time more effectively and to understand their learning materials at a deeper level.

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