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# Selecting the best students for IT Programmes: what determines “best”?

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**Abstract**

For students who enrolled in a Level 5 Diploma (cf 1<sup>st</sup> year degree) in Information and Communications Technology between 2004 and 2009 in New Zealand, data have been gathered for factors that might predict success. These include age, gender, ethnicity, part- or full-time status, previous tertiary programmes completed and length of time between enrolment and start date. Measures of success examined include graduate status, total number of courses passed, total number of merit grades gained, percentage of courses passed and number of semesters taken to reach graduation. The two most important determinants of success are age at start, with older students performing better and number of days between enrolment and start date, with the greater time gap leading to higher success outcomes. The interplay of age and gender suggested that for younger students (under 25), being female was a better predictor of success, whereas for older students this difference disappears. There were indications that Māori students performed less well than NZ European students, but only the number of Merits gained was significantly lower for Māori.

**Keywords**

Student selection, success factors, computing and IT education, tertiary education, New Zealand

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This quality assured paper appeared at the 1st annual conference of Computing and Information Technology Research and Education New Zealand (CITREnz2010) incorporating the 23<sup>rd</sup> Annual Conference of the National Advisory Committee on Computing Qualifications, Dunedin, New Zealand, July 6-9. Samuel Mann and Michael Verhaart (Eds).

## Introduction

Until recently, it has been necessary to accept any applicant for the Diploma in Information and Communications Technology Level 5 (DipICTL5) who met the entry criteria. The current economic recession has resulted in a significant increase in the number of applicants concurrent with the imposition of a government cap on the number of students that can be admitted. As a result, the current policy to accept all applicants on a "first-come-first-served" basis until the cap is reached has come into question. An alternative solution would be to introduce a closing date for applications and then select the "best" applicants. This raises the question as to how "best" should be measured. Clearly "best" should be synonymous with "most likely to succeed". A review of the literature on this topic indicates that factors that have been examined include gender, age, student's self-predicted grade, career ambition, high school grades in general and in specific subjects, previous post-school courses, learning style and problem solving skills (Goold & Rimmer 2000) gender, prior computing experience, learning style and academic performance (Byrne & Lyons, 2001), previous academic ability, personality, learning styles, interview performance, character references, gender and ethnicity (Ferguson, James & Madeley, 2002).

Findings from these studies have been ambiguous. Goold and Rimmer (2000) were specifically addressing computer programming in first year degree students in Australia, comparing results of the "Basic Programming Concepts" course with "Information Technology" taken in parallel. Using Kolb's LS12 (Kolb & Smith, 1986), they were able to measure students on both the Concrete Experience to Abstract Conceptualisation

dimension (Relative Abstraction) and on the Active Experimentation to Reflective Observation (Relative Activity) dimension. Davidson, Savenye and Orr, (1992) had found that abstract learners do better than concrete learners in computer programming. However, Goold and Rimmer's results showed that whilst Relative Abstraction was positively correlated with performance in the Information Technology course, there was no significant relationship with programming results. Previous experience of programming was weakly linked to overall performance, but not to exam marks. Problem-solving ability also had a significant positive correlation with IT results and a weaker positive relationship (not significant) with Programming. They also found that gender affects performance only in the first semester, with females scoring less well than their male counterparts. By the second semester, the difference had disappeared.

Byrne and Lyons (2001) investigated success factors for a programming course delivered to first year Humanities undergraduates in Ireland who had elected to take this course. Unlike computer science/information technology classes that are on average 72% males, 61% of these participants were female. Overall, they found no significant gender differences in performance, although females did score slightly higher. Of the small number of participants who had prior experience of computer programming, the females scored higher than any other sub-group. Also using Kolb's Learning Styles Inventory, they found that students with a "Converger" style (combining greater abstraction with active experimentation) had the best results – although they were not statistically significant. In terms of previous academic study, there was a small, non significant correlation between Maths

and success in Programming (.353) there was a much stronger correlation of .572 with science (significant at 1% level).

Ferguson, James and Madeley (2002) examined possible success predictors for UK medical students. They found that 23% of variance was accounted for by previous academic performance. Women tend to outperform men in this field. However, women's clinical grades were best predicted by "service quality" variables in their personality test outcomes, whereas men's grades were best predicted by "intellectual growth". Interestingly, using Kolb's PSI, these researchers also found that having the "Converger" style was the best predictor of success. However, they caution that learning styles can change over time.

Other possibilities for our students include health status, literacy/numeracy level, having a student loan and/or allowance, social support during study and possibly other factors not yet identified. Observation has indicated a possible link between date of application and enrolment and starting programme of study. The long term intention is firstly to identify past trends, then conduct a longitudinal study to follow a new cohort and finally to identify and test interventions to support those students who would appear to be in "at risk" categories. The purpose of this initial research is solely to examine those factors that are currently recorded in the student application and/or in the Management Information System. The analysis is confined to domestic applicants between 2004 and 2009 who started the Diploma in Information and Communications Technology programme and did not withdraw during the first two weeks. The findings of this initial study will be used to create a number of

tools to assess students at the beginning of 2010. These will include a measure of learning style, an assessment of literacy and numeracy levels, a survey etc. There is no intention to use the findings of this research to exclude potential students. If the findings indicate that there are specific factors that place some individuals at higher risk of failure than others, then the next phase will specifically address the efficacy of interventions intended to create greater equality of opportunity to succeed. Formal approval to conduct this research was given by the polytechnic's research committee.

### **Methodology**

Data for all New Zealand domestic students (i.e. this data did not include International students) who had enrolled in the Diploma in Information and Communications Technology Level 5 (DipICTL5) at a Polytechnic on the North Island of New Zealand between 2004 and 2009 was extracted from the Polytechnic's Management Information System. This data was then checked manually for obvious input errors. The researcher's knowledge of these students and information contained in their student records was used for this purpose. It should be noted that students can join the DipICTL5 programme in either February or July of any year and a full-time student would take two semesters to complete if they passed all courses at the first attempt. This left 250 usable student records, 181 males (72.4%) and 69 females (27.6%). Data collected included gender, date of birth, date enrolled, ethnicity, full- or part-time status, number of courses in which enrolled by semester and whether they had withdrawn, no passed, passed or passed with merit. Students must pass a total of 18 courses, including 9 compulsories obtaining at least 80% in each to graduate. A mark of

95% or higher produces a merit grade. Whether or not students had graduated was also recorded.

In order to ascertain the date of application, student files were examined. It was discovered that this data had not been collected consistently and so no further investigation of this specific variable was possible in the current study. Similarly, details of previous academic achievement at other institutions including high school were only recorded for some students. Records were also used to ascertain whether or not each student had undertaken previous tertiary study and if so, at what level and computing content.

Two additional independent variables were derived, age at start and number of days between enrolment and course start. Other possible measures of “success” in addition to graduate status were derived. These were percentage of courses passed, number of courses for which a merit was gained, total number of courses passed and time taken from first enrolment to graduation. For some calculations, grouped variables were created e.g. age at start, number of courses passed, in order to allow for calculation of statistical significance using chi squared.

## Results

Figures 1 – 5 below give percentages for demographic and success variables by specific criteria. Figures in red italics indicate statistical significance at a confidence level of <0.5.

| <i>Percentages within Gender</i> | Male        | Female      |
|----------------------------------|-------------|-------------|
| Full-time                        | <i>90.1</i> | <i>66.7</i> |
| NZ European                      | 74.6        | 72.5        |
| NZ Māori                         | 18.2        | 21.7        |
| Other ethnicity                  | 7.2         | 5.8         |

| <i>Percentages within Gender</i>            | Male        | Female      |
|---|-------------|-------------|
| Aged under 19 at start                      | <i>39.2</i> | <i>26.1</i> |
| Aged 19 - under 25 at start                 | <i>23.2</i> | <i>21.7</i> |
| Aged 25 - under 35 at start                 | <i>22.1</i> | <i>21.7</i> |
| Aged 35 and over at start                   | <i>15.5</i> | <i>30.4</i> |
| Days enrol to start <30                     | 60.2        | 60.3        |
| Days enrol to start 30>                     | 39.8        | 39.7        |
| Graduated                                   | 30.9        | 33.3        |
| Left without graduating                     | 56.4        | 55.1        |
| Passed less than 5 courses                  | 37.0        | 39.1        |
| Passed between 5 and 17 courses             | 32.0        | 27.5        |
| DipICTL5 still in progress                  | 12.7        | 11.6        |
| Obtained 5 or more Merits                   | 10.5        | 5.8         |
| Obtained between 1 and 4 Merits             | 35.4        | 40.6        |
| Passed no courses                           | 14.9        | 18.8        |
| Passed some, but less than 50%              | 26.5        | 13.0        |
| Passed more than 50% but not all            | 34.3        | 31.9        |
| Passed 100% of courses taken                | 24.3        | 36.2        |
| Graduated in 2 semesters                    | 57.1        | 62.5        |
| Graduated in 3 or 4 semesters               | 30.4        | 16.7        |
| Graduated in 5 or more semesters            | 12.5        | 20.8        |
| Completed previous course Level 2 or higher | 19.9        | 30.4        |

**Figure 1:** Demographics and success criteria by gender

| <i>Percentages within Ethnicity</i> | NZ European | NZ Māori   | Other       |
|-------------------------------------|-------------|------------|-------------|
| Full-time                           | 83.2        | 85.4       | 82.4        |
| Aged under 19 at start              | 40.0        | 25.0       | 17.6        |
| Aged 19 - under 25 at start         | 20.0        | 29.2       | 35.3        |
| Aged 25 - under 35 at start         | 18.4        | 33.3       | 29.4        |
| Aged 35 and over at start           | 21.6        | 12.5       | 17.6        |
| Days enrol to start <30             | 57.5        | 78.7       | 58.8        |
| Days enrol to start 30>             | 42.5        | 21.3       | 41.2        |
| Graduated                           | 30.8        | 27.1       | 52.9        |
| Left without graduating             | 57.3        | 56.2       | 41.2        |
| Passed less than 5 courses          | 35.7        | 45.8       | 35.3        |
| Passed between 5 and 17 courses     | 33.5        | 27.1       | 11.8        |
| DipICTL5 still in progress          | 11.9        | 16.7       | 5.9         |
| Obtained 5 or more Merits           | <i>9.7</i>  | <i>4.2</i> | <i>17.6</i> |

| <i>Percentages within Ethnicity</i>         | NZ European | NZ Māori | Other |
|---|-------------|----------|-------|
| Obtained between 1 and 4 Merits             | 41.1        | 27.1     | 17.6  |
| Passed no courses                           | 15.1        | 20.8     | 11.8  |
| Passed some, but less than 50%              | 21.6        | 31.2     | 11.8  |
| Passed more than 50% but not all            | 32.4        | 35.4     | 41.2  |
| Passed 100% of courses taken                | 30.8        | 12.5     | 35.3  |
| Graduated in 2 semesters                    | 60.3        | 38.5     | 77.8  |
| Graduated in 3 or 4 semesters               | 29.3        | 23.1     | 11.1  |
| Graduated in 5 or more semesters            | 10.3        | 38.5     | 11.1  |
| Completed previous course Level 2 or higher | 22.2        | 25.0     | 23.5  |

**Figure 2:** Demographics and success criteria by ethnicity

| <i>Percentages within Age Group</i> | Under 19 | 19 – under 25 | 25 – under 35 | 35 and over |
|-------------------------------------|----------|---------------|---------------|-------------|
| Full-time                           | 37.8     | 22.0          | 22.5          | 17.7        |
| Days enrol to start <30             | 52.8     | 63.6          | 68.6          | 61.2        |
| Days enrol to start 30>             | 47.2     | 36.4          | 31.4          | 38.8        |
| Graduated                           | 37.1     | 28.1          | 29.1          | 28.6        |
| Left without graduating             | 52.8     | 66.7          | 60.0          | 44.9        |
| Passed less than 5 courses          | 33.7     | 40.4          | 47.3          | 30.6        |
| Passed between 5 and 17 courses     | 29.2     | 31.6          | 23.6          | 40.8        |
| DipICTL5 still in progress          | 10.1     | 5.3           | 10.9          | 26.5        |
| Obtained 5 or more Merits           | 2.2      | 5.3           | 14.5          | 20.4        |
| Obtained between 1 and 4 Merits     | 44.9     | 28.1          | 27.3          | 42.9        |
| Passed no courses                   | 16.9     | 19.3          | 18.2          | 8.2         |
| Passed some, but less than 50%      | 27.0     | 29.8          | 20.0          | 10.2        |
| Passed more than 50%                | 36.0     | 35.1          | 30.9          | 30.6        |

| <i>Percentages within Age Group</i>         | Under 19 | 19 – under 25 | 25 – under 35 | 35 and over |
|---|----------|---------------|---------------|-------------|
| but not all                                 |          |               |               |             |
| Passed 100% of courses taken                | 20.2     | 15.8          | 30.9          | 51.0        |
| Graduated in 2 semesters                    | 54.5     | 56.2          | 62.5          | 66.7        |
| Graduated in 3 or 4 semesters               | 33.3     | 25.0          | 25.0          | 13.3        |
| Graduated in 5 or more semesters            | 12.1     | 18.8          | 12.5          | 20.0        |
| Completed previous course Level 2 or higher | 24.7     | 15.8          | 21.8          | 28.6        |

**Figure 3:** Demographics and success criteria by age group

| <i>Percentages within Previously Studied Tertiary Programme at Level 2 or Higher</i> | Level 2 or higher | No previous programme above level 1 |
|--|-------------------|-------------------------------------|
| Full-time  | 80.7              | 19.3                                |
| Days enrol to start <30  | 63.2              | 59.4                                |
| Days enrol to start 30>  | 36.8              | 40.6                                |
| Graduated  | 31.6              | 31.6                                |
| Left without graduating  | 56.1              | 56.0                                |
| Passed less than 5 courses   | 36.8              | 37.8                                |
| Passed between 5 and 17 courses  | 31.6              | 30.6                                |
| DipICTL5 still in progress   | 12.3              | 12.4                                |
| Obtained 5 or more Merits  | 8.8               | 9.3                                 |
| Obtained between 1 and 4 Merits  | 36.8              | 36.8                                |
| Passed no courses  | 7.0               | 18.7                                |
| Passed some, but less than 50%   | 33.3              | 19.7                                |
| Passed more than 50% but not all   | 33.3              | 33.7                                |
| Passed 100% of courses taken   | 26.3              | 28.0                                |
| Graduated in 2 semesters   | 52.6              | 60.7                                |
| Graduated in 3 or 4 semesters  | 15.8              | 29.5                                |
| Graduated in 5 or more semesters   | 31.6              | 9.8                                 |

**Figure 4:** Demographics and success criteria by level of previous tertiary programme

| <i>Percentages within &lt;30 or &gt;30</i> | <30  | >30  |
|--|------|------|
| <i>Days between Enrol and Start</i>        |      |      |
| Full-time                                  | 58.3 | 41.7 |
| Graduated                                  | 27.9 | 33.0 |
| Left without graduating                    | 61.9 | 50.5 |
| Passed less than 5 courses                 | 45.6 | 27.8 |
| Passed between 5 and 17 courses            | 26.5 | 39.2 |
| DipICTL5 still in progress                 | 10.2 | 16.5 |
| Obtained 5 or more Merits                  | 8.2  | 10.3 |
| Obtained between 1 and 4 Merits            | 29.3 | 46.4 |
| Passed no courses                          | 19.7 | 11.3 |
| Passed some, but less than 50%             | 23.8 | 22.7 |
| Passed more than 50% but not all           | 32.7 | 34.0 |
| Passed 100% of courses taken               | 23.8 | 32.0 |
| Graduated in 2 semesters                   | 50.0 | 68.8 |
| Graduated in 3 or 4 semesters              | 31.0 | 18.8 |
| Graduated in 5 or more semesters           | 19.0 | 12.5 |

**Figure 5:** Demographics and success criteria by enrolment more or less than 30 days before start

It can be seen from the previous Figures that only a few relationships between variables were sufficiently strong to be statistically significant. More females study part-time and they tend to be older. Students who identify as NZ Māori were less likely to achieve merit passes. Age was also a factor in predicting merit passes, with older students gaining more. Pearson Product Moment correlations were significant at the 0.01 level for this and for the relation between increasing age and percentage of courses passed. Students who enrolled more than 30 days before the programme started were more likely to graduate and gain more merit passes. The actual number of days between enrolment and programme start has a positive correlation with total number of courses passed (<0.01) and with percentage of courses passed (<0.05).

A number of gender differences emerged which did not prove statistically significant. However, when gender and age-group were both factored in, some interesting patterns emerged. For example, only 16.9% males who were under 19 at the start of the programme graduated within two semesters, in comparison with 33.3% of females. Also in the under 19 age group, 33.8% of males ever graduated in comparison with 50% of females. This difference continued into the 19 – under 25 age group with 26.2% of males and 33.3% females graduating. However, in the older age groups, gender did not predict success by any criterion.

Finally, a number of Stepwise Multiple Linear Regressions were used to identify the most parsimonious set of predictors of each measure of success. The potential predictors in each case were Age at Start Date, Gender, Time difference between enrolment and programme start (Time Diff), ethnicity, being part-time or full-time, and having completed a previous tertiary programme at Level 2 or above. For total number of courses passed, analysis terminated after two steps with two predictors extracted, Age at Start,  $sr_i^2 = .08$ ,  $t = 4.775$ ,  $p = <0.05$  and Time Diff,  $sr_i^2 = .03$ ,  $t = 2.952$ ,  $p = <0.05$ . At step 2, with Age at Start and Time Diff entered into the equation the multiple correlation coefficient ( $R = .331$ ) was significantly different from zero,  $F(2, 241) = 14.841$ ,  $p = <.05$ , and 10.2% of the variation in the dependent variable was explained by the set of independent variables ( $R^2 = .110$ , adjusted  $R^2 = .102$ ).

For other regressions only Age at Start was extracted accounting for 5.6% variance in percentage of courses passed and 5% in number of merit passes.

## **Discussion**

These results indicate that of the independent variables studied only two had a statistically significant relationship with the various measures of "success" for students on the Diploma in Information and Communications Technology Level 5 programme. The most important factor overall is age at start, which had a positive correlation with total number of courses passed, total number of merits gained, percentage of total courses passed and a negative correlation with number of semesters from start to graduation. However, age does not predict whether or not a student will actually graduate. It would seem that the older the student, the better they will do on each course in which they enrol, but that older students are also less likely to complete the whole programme and graduate. It is possible that older students have more constraining factors such as family and financial responsibilities but also more work experience which might enable them to get jobs with only partial qualifications. This is worthy of further investigation using interviews. The other implication for the importance of age at start is that as educators, we need to see how we can support the younger students. Future studies could examine the importance of social support during study, using a mixed age range in group assignments, pastoral care requirements etc.

The other factor that has correlations with a number of success measures is the time between enrolment and start of programme. The initial enquiry that was the catalyst for this research was that our current practice of accepting students on a first-come-first-served basis might need to be reviewed to ensure we enrolled the students most likely to succeed. However, these findings show that the earlier a student commits to

their programme of study, the more likely they are to succeed. In the second stage of this research, the application date will also be taken into consideration. Clearly, it is unlikely to be simply the act of enrolling early that makes the difference. The next questions to be asked concern the specific characteristics of those who make an early commitment. These could include social support, encouragement from High School tutors, previous success in computer-related courses, passion for computing, being highly organized, being eligible for a scholarship etc.

Neither age at start nor time difference between enrolment and start have been reported in previous studies as predictors of success. It is worthy of note that although Byrne and Lyons (2001) were working in Ireland, they also stated that the average male:female split in Computing classes was 72:28. They indicated that although females might have a slight disadvantage in terms of having less familiarity with computing and computer teaching environments, they soon overcame this. Females with prior computing experience were the sub-group that obtained the best results. In this study, females tended to pass a higher percentage of the courses in which they enrolled and be more likely to finish in two semesters but these results were not statistically significant and overall, females were less likely to graduate or to get merits. The fact that more females study part-time and that they tend to be older might be relevant to this outcome. Further investigation is needed. It is also worth exploring what we as tertiary educators can do to help female students overcome any initial sense of being in a male dominated environment.

Ethnicity produced only one statistically significant result. Students who identify as Māori are less likely to achieve merit passes. Although not statistically significant, they are also less likely to graduate and more likely to leave without passing any courses. According to the New Zealand Ministry of Education's website "poor academic preparation, poor cultural preparation, an essentially non-Māori dominated environment, loneliness and isolation, whānau responsibility, lack of availability of academic support from the provider and whānau, low socio-economic backgrounds, teaching and learning methods, identity and a lack of space to simply be Māori" are key factors in explaining the difficulties faced by Māori students. How these issues can be addressed in the tertiary computing education environment requires further investigation and then implementation.

The next phase of this research has already started. More data about incoming students was gathered on the first day and measures such as learning style, literacy and numeracy level are being collected. These students will produce their first set of results in July 2010. Analysis of trends found in semester one may then lead to the collection of further data in semester two.

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