Full paper

Do computing students have a different approach to studying?

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Abstract

Courses in ICT qualifications have a lower pass rate than other qualifications. We postulate that this might be a result of different pedagogy and that such difference might be reflected in student conceptions of learning. We surveyed students (n=218) from two degree programmes (Nursing and Computing) and one sub-degree programme with a questionnaire based on the ASSIST instrument to identify differences in conceptions of learning, preferences for types of learning, and approaches to studying. We report on the differences we found between the fields of study and consider the implications for teaching.

Keywords: ASSIST questionnaire, education, computing education, retention & success.

1 Introduction

Many researchers and practitioners (E.g. Foster, 2005; McCallum, 2006; Dychtwald et al, 2006) have expressed concern at the recent drop in the number of students enrolling in ICT qualifications. The New Zealand Ministry of Education (2006) in its Tertiary Education Strategy echoes this concern:

> Overall enrolments in advanced-level qualifications have been increasing in some trade, technical and professional fields, such as education and health, stable in others, such as engineering and architecture and building, and declining in information technology. (p35)

According to the Ministry of Education (2009), course pass rates in degrees vary across fields of study. The latest figures available at the time of writing were for courses started in 2006. For these courses, those in Information Technology degrees had the lowest average pass-rate at 74% and those in Health degrees the highest at 89%.

This quality assured paper appeared at the *22nd Annual Conference of the National Advisory Committee on Computing Qualifications* (NACCQ 2009), Napier, New Zealand. Samuel Mann and Michael Verhaart (Eds). Reproduction for academic, not-for profit purposes permitted provided this text is included. www.naccq.ac.nz

It seems unlikely that the low pass rate in Information Technology courses is purely due to the technical content since the same source gives the average pass-rate for courses in Engineering and Related Technologies degrees as 88%.

It seems reasonable to ask whether the lower pass rate in Information Technology courses is associated with different pedagogy or teaching practices. If there is a misalignment between our pedagogy and the needs of our students, then remedying this would improve success rates and, perhaps, go part of the way to making ICT qualifications more attractive to students.

From the perspective of retention and success, students' perceptions of our pedagogy are probably more important than the pedagogy itself. A promising approach may therefore be to look at pedagogy as reflected in the conceptions, preferences and study approaches of the students.

1.1 Conceptions of learning

Marton & Säljö (1976) carried out a study in which students were given a text to read and then asked questions about the experience. They noted different levels of processing and used the terms "surface" where students' focus was on the text in itself and "deep" where they focused on what the text was about; the author's intention, the main point, the conclusion to be drawn.

Biggs (1987) built on this to design the Study Process Questionnaire (SPQ) to classify student approaches to studying along three dimensions: surface, deep and achieving.

Tait, Entwistle, and McCune (1998) designed the ASSIST questionnaire to classify student approaches to studying along three similar dimensions (surface, deep and strategic) and extended these with scales for conceptions of learning (developmental and instrumental) and preferences for types of courses and learning with opportunities for deep and surface learning.

It should be noted that these are not opposites on a continuum but separate dimensions; it is possible for students simultaneously to endorse both surface and deep conceptions. Nor are they necessarily permanent traits;

students will adapt their approaches to their perceptions of the assessment or learning demand.

Säljö (2005) notes that:

> It also follows that we can view students' approaches to learning from texts, and their conceptions of knowledge and learning, as social phenomena that evolve as a response to long exposure to educational situations. (p104).

This observation suggests that assessment of learner conceptions, preferences and approaches might give an indication of student perceptions of the pedagogical environment. We reasoned that contrasting the perceptions of students in an IT degree with those in a Health degree might give us insights into reasons for the difference in pass rates.

1.2 Our research question

Our main research question is thus: What are the differences between Computing and Nursing students in:

- Conceptions of learning
- Preferences for types of learning and
- Approaches to studying?

2 Sample

The courses were selected from three programmes: Foundation Studies, the Bachelor of Nursing, and the Bachelor of Information Systems. Foundation Studies was included to help identify and control for any effects associated with institutional culture or the region's demographic profile.

The sample was a non-random convenience sample in which students were invited to participate by completing a questionnaire. A total of 218 students participated giving a participation rate of approximately 64%. The characteristics of the sample are set out in table 1.

Foundation Studies offers courses that prepare students for further study in other programmes. Students from two career pathways were involved. In the first, students were in one of two level 3 courses on a pathway leading to early childhood or primary teaching. In the other, students were in a level 4 course on a nursing or medical pathway.

Students in the second and third year of the Bachelor of Nursing programme were invited to participate in the research. Participation was voluntary and consent was implied by completion of the questionnaire. Students were recruited at the end of a lecture by a non-nursing staff member who explained the research and allowed sufficient time to consider participation. Questionnaires were returned in a box provided for this purpose at the reception desk of the department.

In the Bachelor of Information systems, participants were recruited from three courses: two at level five, taken by students in their first and second semester of study and one at level 6, taken in either their third or fourth semester of study.

We used a factorial ({Nursing, Computing, Foundation fields of study} x {levels 4, 5, 6, 7}) study design which was sparse (not all domains were sampled at each level) and had unequal numbers in each cell.

Table 1: Sample characteristics

		No.	Valid	%
Gender	Male	72		34
	Female	141		66
			213	
	Missing		5	2
			218	
Age	Under 21	92		43
	21-25	57		27
	26-30	17		8
	Over 30	49		23
			215	
	Missing		3	1
			218	
First Language	English	114		53
	Other	101		47
			215	
	Missing		3	1
			218	
Main focus in prior six months	Working	50		23
	Studying	113		53
	Other	30		14
	Work and study	19		9
			212	
	Missing		6	3
			218	
First semester of study?	Yes	84		26
	No	131		74
			215	
	Missing		3	1
			218	
NQF level of course	3 or 4	82		38
	5	63		29
	6	59		27
	7	14		7
			218	
Field of study	Foundation	82		38
	Nursing	44		20
	Computing	92		42
			218	

3 Instrument

The instrument was a composite questionnaire, based on the ASSIST questionnaire (Tait, Entwistle, & McCune, 1998) and extended to capture basic demographic data. The ASSIST instrument defines a number of scales that aim to quantify:

- Approaches to studying
- Conceptions of learning
- Preferences for types of courses and learning

3.1 Approaches to studying

The ASSIST instrument classifies approaches to studying into three main scales: surface, deep and strategic. Entwistle (2005) gives the following definitions:

A **surface** or "reproducing" approach (our variable Csurf) is associated with apathy or with the intention to cope with course requirements and is characterised by "*studying without reflecting on either purpose or strategy, treating the course as unrelated bits of knowledge, memorising facts and procedures routinely, finding difficulty in making sense of new ideas presented, feeling undue pressure and worry about work*". Subscales are defined for lack of purpose (LP), unrelated memorising (UM), syllabus-boundness (SB) and fear of failure (FF).

A **deep** or "transforming" approach (our variable Cdeep) is motivated by intrinsic interest in the course. The intention is to understand ideas for oneself by "*relating ideas to previous knowledge and experience, looking for patterns and underlying principles, checking evidence and relating it to conclusions, examining logic and argument cautiously and critically and becoming actively interested in the course content*". Subscales are defined for seeking meaning (SM), relating ideas (RI), use of evidence (UE) and interest in ideas (II).

A **strategic** or "organising" approach (our variable Cstra) is motivated by an extrinsic interest in the course. The intention is to achieve the highest possible grade and the approach is characterised by "*putting consistent effort into studying, finding the right conditions and materials for studying, managing time and effort effectively, being alert to assessment requirements and criteria and gearing work to the perceived preferences of lecturers*". Subscales are defined for organised studying (OS), time management (TM), alertness to assessment demands (AA), achieving (AC) and monitoring effectiveness (ME).

3.2 Conceptions of learning

The ASSIST instrument identifies two dimensions of conceptions of learning. An ***instrumental*** conception is defined as viewing learning as reproducing knowledge. An example of a statement offered for endorsement is: "*Building up knowledge by acquiring facts and information.*"

A ***developmental*** conception is defined as a view of learning involving personal understanding and development. A typical statement is: "*Seeing things in a different and more meaningful way*."

3.3 Preferences for courses and teaching

A surface preference is defined as a preference for surface learning in courses and teaching. A typical statement offered for endorsement is: [Definitely Like] *"Assessments which need only the material provided in our lecture notes."*

A deep preference is defined as a preference for courses and teaching with opportunities for deep learning. A typical statement to endorse is: [Definitely Like] *"Courses where we're encouraged to read around the subject a lot for ourselves."*

3.4 Background demographics

Field of study and level of course were identified when the questionnaires were issued. The remaining demographics were captured directly from participants.

4 Method

We used an item response model to derive interval level scale location estimates from the ordinal survey data, non-parametric Kruskal-Wallis tests to compare ranks of the scale variables across categories and linear regression to explore associations between variables.

4.1 Interval level variables

When a scale is used to code responses to questions, we are generally confident in their ordinal properties (i.e. ***strongly agree*** is a stronger endorsement than ***agree*** which is, in turn, a stronger endorsement than ***neutral***, etc.). When we allocate numeric codes to categories, we have less confidence in the interval properties of the codes should we interpret them as numbers. For example, does the difference between the third and fourth category represent the same difference in strength of endorsement as that between the second and third? However, such interval level measurement is required for valid arithmetic on variables.

We used a polytomous Rasch model (Rasch, 1960; Andrich, 1978) to create interval level variables from the ordinal categories; this is a stochastic model that identifies the maximum likelihood estimates of person and item threshold locations by simultaneous modelling of location estimates and the uncertainty in their location.

Figure 1 shows an illustrative probability density map (for question C17 of this study) showing the probability of the categories being chosen for any given location (strength of endorsement) on the deep approach scale. All scales in this study are standardized to the range 0 to 10 and centred at 5.

In this diagram, we can see that for scale locations between 0 and 0.8, the most likely response category is N (Never), from 0.8 to 4.6, the most likely category is R (Rarely), from 4.6 to 6.4 it is S (Sometimes), from 6.4 to 8.3 it is O (Often), and above 8.3 it is A (Always). This diagram illustrates both the varying intervals associated with the categories, and the clear ordinal pattern. We can also see the uncertainty in the scale (e.g. for imputed endorsement strength 2.5, the most likely category is R (70%), but there is about a 15% chance of either N or S being chosen).

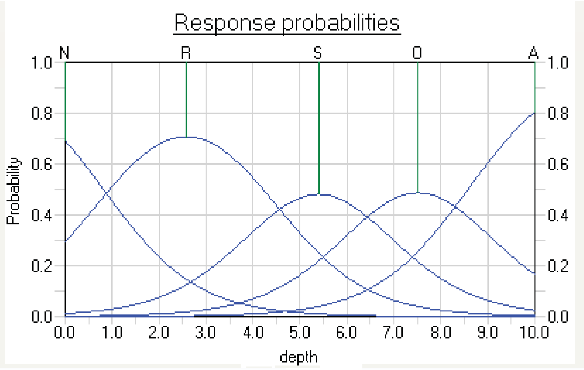

Figure 1: Sample response probabilities for Question C17 in the deep approach scale

A key assumption of the Rasch model is that the construct being measured is one-dimensional; we verified this with a principal components analysis as part of the data screening process. We did not attempt to force participants to respond to questions since the Rasch model handles missing data simply and naturally.

4.2 Partial and multiple regression

We began by calculating pair-wise correlations between the ASSIST variables and the background demographics, to identify potential predictors. Membership or "dummy" variables were used for background variables with more than 2 categories to achieve the correct degrees of freedom.

We then used a step-wise regression technique in which these predictors were first introduced into the regression model. The variables with the smallest unique predictive contribution were then progressively removed until the following stopping condition was reached:

- The overall regression was significant at the .01 level
- The coefficient of each remaining predictor was significant at the .01 level.

Regression residuals were tested for normality, homoscedasticity and serial independence with a Jarque-Bera test (Bera and Jarque, 1980).

5 Results

Because of the exploratory nature of this study we considered a result to be significant only at the $p < 0.01$ level. At this level, all ASSIST scales and sub-scales were positively and significantly endorsed with the exception of (1) a ***surface approach to studying*** (Csurf) which was positively (but not significantly) endorsed ($p=.0437$) and (2) the sub-scale ***unrelated memorising*** (UM) which was also positively (but not significantly) endorsed ($p=.0486$).

Such overall endorsement is common in self-report instruments; the key information we sought was the different relative strengths of endorsement across the fields of study.

5.1 Screening

A key benefit of the Rasch model is that it is readily falsifiable. Standard fit statistics measure the fit between the model and the observed data, enabling identification of poorly fitting items. Linacre (2002) gives some simple standard interpretations as "productive" for measurement, "non productive (but not degrading)", "degrading". With this terminology, all items in all scales were classified as either "productive" or "unproductive". None were "degrading" and no scale had more than 1 unproductive item. We conclude that there is an acceptable fit between the model and the data.

The principal components analysis verified that all sub-scales were uni-dimensional with the exception of syllabus-boundness (SB) and lack of purpose (LP), both of which had a second factor. We formed a second subscale for each of these by deleting the poorly fitting item and carried out subsequent analyses with both versions. (We note, however, that both the original and the modified versions lead to the same conclusions in later analysis.)

Several of the scales failed to meet the parametric assumptions of an ANOVA test of means. In consequence we chose to carry out an equivalent non-parametric Kruskal-Wallis test of ranks to identify the main effects.

5.2 Main effects

The significant results are shown in table 2. In this table, the HSD column represents the "honestly significant difference" for pair-wise post-hoc comparisons, the percentages are the mean ranks, scaled to the range 0 to 100%, φ_C^2 represents the effect size and H can be interpreted as a χ^2 statistic.

Table 2: Main effects

	HSD	FS	Nursing	Comp.
Instrumental conception	7.7%	61.3%	45.9%	37.3%
	$H_{(2)}=10.90$; $\varphi_C^2=2.5\%$; $p=0.0043$			
Surface preference	6.5%	70.4%	39.2%	51.5%
	$H_{(2)}=18.86$; $\varphi_C^2=4.3\%$; $p=0.0001$			
Surface approach	6.7%	58.4%	36.8%	67.8%
	$H_{(2)}=16.22$; $\varphi_C^2=3.7\%$; $p=0.0003$			
Lack of purpose	6.7%	54.0%	33.4%	73.4%
	$H_{(2)}=28.20$; $\varphi_C^2=6.5$ %; $p=0.0001$			
Unrelated memorising	6.5%	62.8%	37.3%	59.2%
	$H_{(2)}=12.20$; $\varphi_C^2=2.8$ %; $p=0.0022$			

Intuitively, we would expect to see a higher endorsement of surface learning in the sub-degree programme and lower endorsement in the two degree programmes.

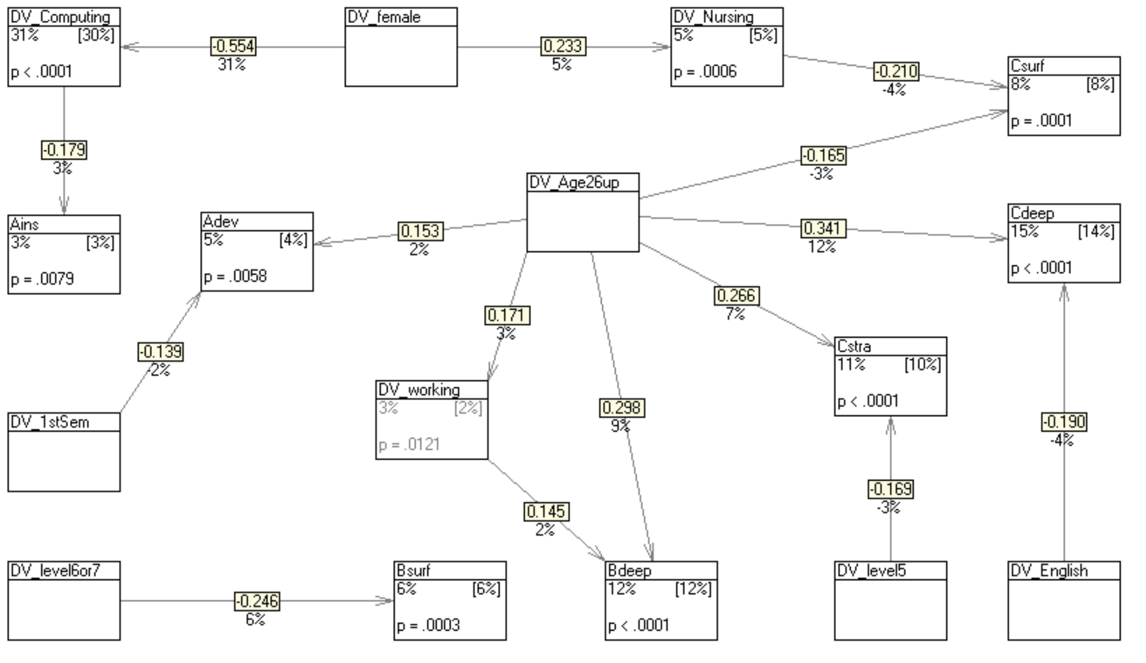

Figure 2. The path diagram

This is indeed the case for the instrumental (surface) conception. There was also a significant difference between the degree programmes, with nursing students endorsing instrumental concepts more strongly than computing students.

Preference for courses with surface learning was again significantly higher in the sub-degree programme but the situation in the degree programmes was reversed with computing students preferring courses with surface learning more than nursing students.

In the approach to studying scale, computing students endorsed a surface approach more strongly than both nursing and sub-degree students. We can begin to understand the reasons for this when we look at the two significant sub-scales of the surface approach.

Lack of purpose is clearly strongest in the computing students, significantly more than for students in foundation studies which, in turn, is significantly stronger than for nursing students.

There is no significant difference in the endorsement of unrelated memorising between computing students and foundation studies students, but both endorse unrelated memorising significantly more than nursing students.

No significant differences were found between the fields of study for developmental conceptions of learning, preferences for courses and learning with opportunities for deep learning or for deep or strategic approaches to studying. This is an interesting finding; endorsement of deep and strategic values is relatively uniform across the fields of study, significant variation was only found in surface endorsement.

5.3 Path diagram

To investigate possible interactions we carried out the step-wise regression procedure described earlier. The resultant path diagram is shown in figure 2.

In this path diagram, variables are shown in a titled box containing the variance explained, adjusted R^2 in square brackets and the significance of the overall regression. The boxes on the paths show the beta weights of the paths with the semi-partial correlation squared shown underneath. This last represents the unique contribution made to the explanation of the criterion variable over and above that shared with other predictor variables. The direction of the arrows should not be interpreted as evidence of causation (although that is of course plausible).

6 Discussion

We believe the key finding in the results presented above is the endorsement of the "lack of purpose" sub-scale by computing students. It seems reasonable to assume that Nursing students have a clear idea of the career they wish to pursue. Foundation Studies students may have a less clear idea although the main streams of learning are targeted at entry into a subsequent programme for Nursing, or Early Childhood Education. Many computing students may be unclear about possible careers. Perhaps they just like working with computers and haven't really thought about a career?

If this is right, the other indicators may just be a natural consequence of such lack of purpose.

We begin our discussion of the path diagram with gender. 89% of the Nursing and Foundation students were female, whereas, only 35% of the computing students were female. Although this disparity is well known, it is interesting to note that there are no other significant interactions.

Age has a significant effect on most of the "deep" aspects with older students (age 26 or more) more likely to endorse a developmental concept of learning, a preference for courses with opportunities for deep learning, a deep approach to studying, and a strategic approach to studying.

We note that students who do not have English as their first language are more likely to endorse a deep approach to studying and that those who are not in their first semester at the institution are more likely to endorse a developmental conception of learning.

7 Conclusion

An exploratory study such as this can only hint at possible reasons for the lack of success in computing courses. However, the "lack of purpose" finding resonates with our intuition and suggests a possible short-term strategy. Reducing the core computer science content at the early stages of the programme and replacing it with broader, more authentic, tasks and learning might help students gain a better sense of the various computing careers and give context to subsequent core computer science content. An approach using PBL (Problem Based Learning) might be worth exploring.

Further research targeted at conceptions of computing careers and a possible lack of purpose in students at the time of enrolment would help to clarify whether the lack of purpose is due to:

- Misconceptions of the nature of computing careers or
- A mismatch between pedagogy and student needs.

8 Acknowledgements

This research was supported in part by Contract no. TLRI-9233 awarded to Victoria University with sub-contracts to Massey University, the Manukau Institute of Technology, and Te Whare Wananga o Awanuiaranga from the New Zealand Ministry of Education through the New Zealand Council for Educational Research.

The questionnaire used was based in part on the ASSIST questionnaire © 1997 Centre for Research on Learning and Instruction, University of Edinburgh.

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