

suggest that students in early tertiary education required structured and directed learning. This is also supported by the findings of Choy & Delahaye (2003).

In an older study Lewandowski & Morehead (1998) describe how to meet the needs of different learning styles. Descriptions provided of teaching methods required to cater for different learning style matches the characteristics shown in Table 1. Lewandowski & Morehead (1998) suggest that learning material be made available to more students by incorporating teaching methods that cater for all learning styles.

In considering the effects of cognitive and social processes in online learning Maor (2007) maintains that feelings generated in online communities are intertwined with changed learning patterns. Maor does not consider learning styles directly, however when an experience is 'felt' then those students with kinaesthetic learning styles benefit.

Prpic (2003) explores the concept of a 'learning moment' and suggests that the learning moment is 'a stepping stone between experience and possibility'. Learning moments therefore must take in varying forms for different learning styles.

Stahl (1999), in a critique of learning styles suggests that students have different learning styles depending on their stage of cognitive development.

It is apparent from the literature reviewed that a distinction between learning styles and learning skills needs to be made. Tong (2003) identified essential learning skills for students studying engineering as both technical and soft skills (interpersonal, project planning, people management, problem solving and team management). This study was not directly related to learning styles.

Anglo-Saxonisation of education is an interesting concept not discussed in other papers (Vandermensbrugge, 2003). Vandermensbrugge examines the concept of critical thinking and the stereotype that Asian students cannot think critically. Vandermensbrugge suggests that western teachers have not adapted to Asian learning styles.

5 Research Method

In this study undertaken in the period 2003 – 2007 students' learning styles (visual, auditory, kinaesthetic) were tested in the second week of classes in each semester. A total of 180 students took part in this study.

5.1 Research Question

The main research question for this study was:

What are the factors that influence pass rates in first year undergraduate computing education?

5.2 Data Gathering

Each student completed an online learning styles test in the second week of class (www.howtolearn.com/lsinventory_student.html). The students received

immediate feedback of their resulting scores, and passed these on to the lecturer on a signed permission page. Students were also given extra resources by the lecturer in charge of the paper so that each student could use her/his personal results to change, improve, or confirm techniques that would help them individually. Because this material was outside the course specified content, they were not guided any further with this.

5.3 Data Analysis

The results supplied by the students were initially compiled into an excel spreadsheet, the lecturers did a quick analysis of the overall results, and on determining some trends, attempted to change the course delivery and resources (by supplying extra resources). Standard delivery methods of PowerPoint discussions and the use of a textbook were already in place to support the visual students. An expectation that the majority of the students would be kinaesthetic meant that many practical exercises had originally been prepared. Analysis of the test results led to the development of even more practical exercises. The gradual trend over the years to a higher proportion of auditory students was harder to accommodate, with the lecturers having to resort to giving the responsibility back to the students to do their own work in this area (such as taping their own voice reading the notes and then playing it back).

5.4 Final Data Analysis

At the end of the 5-year period, all the results were categorised in the following ways: final grade by learning style; final grade achieved by gender; learning style by gender and grade by learning style by gender by cultural group. Cultural groups initially were analysed separately, and then grouped as results indicated very similar patterns emerging (Tables 8-14) especially for male students. Four groups were considered at this second stage of analysis: Pakeha males; Pakeha females; non-Pakeha males; and non-Pakeha females.

5.5 Learning style by grade

Most failures in first year computing occur for those students who have kinaesthetic, auditory, or a combination of kinaesthetic and auditory learning styles (K, A, KA, VKA) (Table 2). Of all the failures, there are 45/59 (76%) occur for this combination of learning styles.

Table 2 Learning style by grade

L/STYLE/ GRADE	PASS	FAIL	DNC	TOTAL
V	33	8		41
K	31	22	1	54
A	33	19		52
VK	10	3		13
VA	5	3	1	9
KA	4	4		8
VKA	3			3
TOTAL	119	59	2	180

5.6 Grade by gender

In Table 3, it can be seen that of the few females that enrol in first year computing subjects, all pass, even if it is after a second attempt. Only two female students did not complete. The greatest failure rate is with non-Pakeha male students with 47/114 (41%) of this group failing. This is also the largest group enrolling in first year computing.

Table 3 Grade by Gender

Grade	Pass	Fail	Dnc	Total
Female	26	3	1	30
Pakeha	9	0	0	9
Maori	2	0	0	2
Pacifica	6	1	0	7
Chinese	4	1	1	6
Indian	2	1	0	3
Other Asian	2	0	0	2
Other	1	0	0	1
Male	93	56	1	150
Pakeha	26	9	1	36
Maori	4	5	0	9
Pacifica	5	9	0	14
Chinese	30	20	0	50
Indian	6	4	0	10
Other Asian	18	5	0	23
Other	4	4	0	8
TOTAL	119	59	2	180

5.7 Learning style by gender

In Tables 4 and 5, learning styles by gender are displayed. It can be seen that male students who have either a dominant or mixed kinaesthetic learning style (K, VK, KA, VKA) are the largest subgroup in this sample. In the non-Pakeha male sub-group this number is 53/114 or 46%. In the total female population, there is 8/21 or 38%.

Table 4 Learning style by gender - Female

Learning style	Female	
	Pakeha	Non-Pakeha
V	6	6
K		5
A	2	4
VK		2
VA		3
KA	1	1
TOTAL	9	21

Table 5 Learning style by gender - Male

LS/M	Pakeha	Maori	Pacifica	Chinese	Indian	OthAsian	Other
V	9	1	2	10	0	5	2
K	10	5	5	16	2	8	3
A	10	1	5	16	6	7	1
VK	4	1	0	3	1	2	0
VA	0	1	0	2	0	0	2
KA	2	0	1	2	1	1	
VKA	1	0	1	1	0	0	
	36	9	14	50	10	23	8

5.8 Grade by learning style by gender by cultural group

The following set of tables (6 - 13) show the results for this study divided into the subgroups: learning style/gender/cultural group. All non-Pakeha female students have been grouped together because the subgroup sizes were very small.

5.8.1 Pakeha Female by grade by learning style

Table 6 Pakeha female/grade/learning style

Grade Pakeha F	V	K	A	KA
A	3		2	
B	1			1
C	1			
Double Pass	1			
Total	6		2	1

In this group, only three students failed. The dominant learning style is also visual (V, VK, VA).

5.8.2 Non-Pakeha Female grade by learning style

Only 3/21 or 14% female students in this group failed and one student withdrew as shown in Table 7.

Other ethnic groups have been grouped for female students because these were such small groups.

Table 7 Non-Pakeha female/grade/learning style

Non-Pakeha f	V	K	A	VK	VA	KA
B	2	1	3	1	1	1
C	2	2	0			
DOUBLE PASS	2	1		1		
D		1				
E			1			
DOUBLE FAIL					1	
W					1	
TOTAL 21	6	5	4	2	3	1

5.8.3 Pakeha male grade by learning style

In this group, there is an even distribution of students across the learning styles as shown in Table 8. Only 9/36 or 25% male European students failed and one student withdrew before completing the paper.

Table 8 Pakeha male/grade/learning style

Pakeha M	V	K	A	VK	KA	VKA
A						1
B	3	1	3	2		
C	3	2	5	2	1	
DOUBLE PASS		2	1			
D	1	2	1			
E	1	2				
DOUBLE FAIL	1				1	
W		1				
TOTAL 36	9	10	10	4	2	1

5.8.4 Maori male grade by learning style

It should be noted that with this sub group of Maori male most students had a dominant kinaesthetic or an auditory learning style with 5/9 failing.

Table 9 Maori male/grade/learning style

Maori/m	V	K	A	VK	VA
A					1
B	1	2			
DOUBLE PASS					
D		1			
E		1	1		
DOUBLE FAIL		1		1	
TOTAL	1	5	1	1	1

5.8.5 Pacifica male grade by learning style

Table 10 Pacifica male/grade/learning style

Pacif/m	V	K	A	KA	VKA
C	1	1			1
DOUBLE PASS		1	1		
D	1	2	1		
E		1	2	1	
DOUBLE FAIL			1		
TOTAL	2	5	5	1	1

The Pacifica male sub group was dominated by kinaesthetic and/or auditory learning styles with 8/14 failing.

5.8.6 Chinese male grade by learning style

Table 11 Chinese male/grade/learning style

Chinese /m	V	K	A	VK	VA	KA	VKA
B	3	3	1				
C	3	3	5		1	1	
DOUBLE PASS	0	3	3	2	1		1
D	2	2	2	1		1	
E		2	4				
DOUBLE FAIL	2	3	1				
TOTAL	10	16	16	3	2	2	1

Chinese male students made up the largest subgroup (50) with 32/50 in the dominant kinaesthetic and/or auditory learning styles failing.

5.8.7 Indian male grade by learning style

Table 12 Indian male/grade/learning style

Indian M	V	K	A	VK	KA
B			1		1
C			1	2	
DOUBLE PASS			1		
D				2	
E			1	1	
TOTAL			2	6	1

In the Indian male subgroup 4/10 students failed. All of the students that failed were in the dominant kinaesthetic and/or auditory learning style group.

5.8.8 Other Asian male grade by learning style

Table 13 Other Asian male/grade/learn style

Other asian M	V	K	A	VK	KA
B	1			1	
C	3	4	3	1	
DOUBLE PASS	1	1	4		
E		2			
DOUBLE FAIL		1	0		1
TOTAL	5	8	7	2	1

In this group, 4/23 students failed all of whom were from the dominant kinaesthetic and/or auditory learning style group.

5.8.9 Other male grade by learning style

Table 14 Other male/grade/learning style

Other M	V	K	A	VA
C	1	2		
DOUBLE PASS	1			
D				1
E			1	1
DOUBLE FAIL		1		
TOTAL	2	3	1	2

In this group (Table 14) 4/8 students failed all of whom were from the dominant kinaesthetic and/or auditory learning style groups.

5.9 Total non-Pakeha male grade by learning style

Table 15 non-Pakeha male/grade/learning style

ESL M	V	K	A	VK	VA	KA	VKA
A					1		
B	5	5	2	1		1	
C	9	11	9	1	1	1	1
DOUBLE PASS	2	6	8	2	1		1
D	3	5	4	1	1	1	
E		6	10	1	1	1	
DOUBLE FAIL	2	6	2	1		1	
W							
TOTAL	21	39	35	7	5	5	2

In this subgroup of all non-Pakeha male students, 46/114 or 40% failed. Of the students who failed, 41/46 or 89% had kinaesthetic, auditory or a combination of kinaesthetic or auditory (K, A, VK, VA, KA, VKA)

learning styles. This is a major finding for this group of students. If you have English as a second language, are male and have a dominant kinaesthetic or an auditory learning style, then your chances of failing are 89% in this particular sample.

Because for male non-Pakeha students the dominant learning styles were kinaesthetic and/or auditory, these students have been grouped together for the findings.

6 Findings

Students with visual learning styles had a pass rate of 47/65 or 72%, students with kinaesthetic learning styles had a pass rate of 45/75 or 60%, and students with auditory learning styles had a pass rate of 39/64 or 61%. However, the group of students with kinaesthetic and auditory learning styles are dominated by non-Pakeha male students with a failure rate of 89%.

7 Implications

The major finding arising from this study is that the way in which first year computing is presented does not suit the dominant learning styles for the largest subgroup of students (non-Pakeha male students). Initially all ethnic groups were considered separately, but as the same pattern kept repeating in the data analysed these subgroups have been considered together. These results point to an urgent overhaul of the way in which first year computing is taught so that it appeals to all learning groups, not just to those students with visual learning styles.

When the characteristics of kinaesthetic learners are considered, more hands-on experiential laboratory work, flexible seating arrangements (so students can move around), smaller exercises to accommodate shorter attention spans, frequent breaks during the class, relating first year computing to everyday experiences through classroom activities and frequent positive tactile feedback would be worth trialling for first year computing students.

Auditory students need to sit where they can hear the tutor, and the time to internalise and verbalise what they have heard. Presentations of solutions to the rest of the class help auditory students acquire knowledge by speaking aloud about what they have learned. Classroom flexibility is also required for auditory students who need to talk to themselves during class. Auditory students prefer to listen than to experience, so there is a need in classes to provide opportunities to listen to the tutor. Auditory students also need to talk to others about what they are learning.

Traditional teaching techniques appeal most to visual students – who performed best in this sample.

Suggestions to improve the pass rate in first year computing are to: (i) test first year computing tutors as well as the students; and (ii) adapt teaching methods to appeal to all learning styles.

8 Limitations

As this was an extended case study that was not statistically significant, the results from this study cannot be generalised, but rather, add to the pool of knowledge about learning challenges for first year computing students in a globally oriented education market. Whilst cultural differences in learning style were considered, there has been no attempt to consider the anglosization of education (Vandermensbrugge, 2003) in this study. The cultural mix of students attending this particular higher education institution over this five-year period has fluctuated, influenced by a number of factors including demographic, immigration, international student arrivals and a strong IT labour demand.

9 Conclusion

To improve first-year undergraduate pass rates there is a need to evolve both curriculum and teaching methods to maximise the fit between teaching and learning. The need to include teaching methods that cater for a mix of learning styles we need to be more inclusive of all students regardless of race, culture and gender, and we need to maximise the appropriate blend of face-to-face and online learning.

In today's world of global internationalised education with a high demand for IT graduates, increasing pass rates is paramount.

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