

Learning styles of Computer Concepts students in a distance tertiary institution

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Summary

This paper reports on the learning styles of a group of computing students at The Open Polytechnic of New Zealand during three consecutive semesters from 2003 to 2004. The quantitative study explores the relationship between students' sociodemographic characteristics and their preferred learning styles. The learning styles of students in a computer concepts class were evaluated and classified according to the Felder-Soloman Learning Style Index. Using one-way ANOVA we have identified statistically significant differences in learning styles between different groups of students classified according to: age, gender, ethnicity, education level, occupation, date of last study and whether this is their first course with the Open Polytechnic. We found that gender and ethnicity in particular have a strong impact on the way students learn.

These results have important implications for the learning design and for student support in such courses. We make some suggestions on how to cater for different student learning styles in a distance education environment with Internet-based student support.

Keywords: Learning Styles, Learning Support, Computer Concepts, Distance Education

Introduction

This paper presents the results of an empirical study of the learning styles of students on a computer concepts course at The Open Polytechnic of New Zealand during three consecutive semesters from 2003 to 2004. The Open Polytechnic is the only specialist provider of open and distance education in New Zealand. Computer Concepts is a compulsory course that forms part of the New Zealand Diploma in Business. The Diploma is a level 4 course on the New Zealand Qualifications Authority 8 level framework. The course emphasises the use of computers and information systems in a business scenario. The course has a large practical component of 60% covering applications, the Internet and the operating system. With a semester length of 17 weeks the course attracts upwards of 160 students per semester. These are some demographics for the students enrolled in the course:

Age group	Percent	Gender	Percent	Ethnicity	Percent
Under 20	3%	Female	75%	NZ European	62%
20-24	21%	Male	25%	Maori & PI	20%
25-29	16%			Asian	18%
30-39	34%				
40 and over	26%				

Education level	Percent	Occupation	Percent	Date of last study	Percent
No tertiary	50%	Wage or salary worker	75%	Before '87	54%
Other	50%	Other	25%	After '87	46%

First time with the Open Polytechnic	Percent
Yes	32%
No	68%

This paper is part of a much larger study into the factors affecting students' success on distance courses. The intention of the several strands of our research is to identify those students who are likely to require additional learning support. In this paper we concentrate on the learning styles of Computer Concepts students and their differences across the various sociodemographic characteristics of learners, other aspects are covered in other papers by the authors: differences in learning and teaching styles (Kovacic, 2004a), participation in the forum (Kovacic, 2004b) and academic performance (Kovacic & Green, 2004a).

More specifically the data gathered for this paper was used to address the following question: do the learning styles vary by age, gender, ethnicity, education level, occupation, the last time they studied, or if they are studying for the first time with The Open Polytechnic? Formally, we are testing the hypothesis that there are no differences in learning style profile among students with different sociodemographic characteristics.

This research has several limitations. Since the data collection method was based on an online questionnaire administered in a single subject area and in a single distance tertiary institution, there are questions regarding whether the results observed are generalisable to other subjects and to other distance tertiary organisations. There is a need for further research that tests the generalisability of the findings via further case studies across subject areas and educational organisations.

The research was undertaken in three consecutive semesters with insignificant variations in results among students learning styles between these semesters. However, there are questions whether these results would be valid when the next cohort of students enrolls to this course, because they may have different learning profiles. In other words, data from three semesters only used in this research were not sufficient to allow definite conclusion in this regard. Future studies may include all the above factors (subject areas, other distance organisations, and different cohorts of students).

While it is preferable that a student uses and develops an array of learning styles to deal with course content and the real world, this research deals only with each student's currently preferred learning style profile. This is in line with the previously

stated purpose of the research, the identification of those students that may require additional learning support. We use the terms 'learning preferences' and 'learning styles' interchangeably throughout the paper though we are aware of the differences between the two concepts as discussed by Sadler-Smith (1997). There have been numerous studies on the relationship between preferred learning styles, sociodemographic characteristics and academic performance. Some studies have focussed on specific characteristics or area, such as gender and learning styles (Blum, 1999; McLean & Morrison, 2000; Shaw & Marlow, 1999), ethnicity and learning styles (Auyeung & Sands, 1996; Jaju, Kwak & Zinkham, 2002), academic performance and learning styles in both IT and non-IT subject areas and in distance and contact courses (Aragon, Johnson & Shaik, 2002; Fowler, Allen, Armarego & Mackenzie, 2000; McKenzie, Rose & Head, 1999; Neuhauser, 2002; Papp, 2001; van Zwanenberg & Wilkinson, 1999; Zywno & Waalen, 2002). Based on these articles evidence of relationship between learning styles, sociodemographic characteristics and academic performance remains inconclusive. For example for first year programming courses, Thomas, Ratcliffe, Woodbury & Jarman (2002) suggest that there is a relationship between student learning style and academic performance, whilst Byrne & Lyons (2001) suggest that no such relationship exists.

Although there have been numerous studies on learning styles using the same learning style model and instrument as we did (Ng Pui, Chan & Andrews, 1999; Fowler, Allen, Armarego & Mackenzie, 2000; Zywno, & Waalen, 2002, to list only a few) none of these studies investigated relationship between learning style profiles based on Felder-Silverman model and sociodemographic characteristics.

In the next section a brief overview of the learning environment is provided. Then the Kolb and Felder-Silverman learning styles models and the learning styles instrument are described. In the third section the data and learning styles results for each sociodemographic characteristic of learners along with critical comments are presented. Finally some suggestions are made on how to accommodate the different learning styles of students by modifying teaching style and using the available communication tools effectively.

Learning environment

This paper presents the results of research with a group of students on a Computer Concepts course at The Open Polytechnic of New Zealand in 2003. We have adopted collaborative learning model on this course and the computer mediated communication tools such as electronic forum create an ideal learning environment to support this model. The course uses electronic forums and bulk email as the main means of learning support in addition to telephone and mail. Both the lecturer and students provide support via the forum. Furthermore, participation in the forums has been built in the course material and is an integral part of the assessment. Weekly bulk email focusing on the work the student will be studying in the following week is a key teaching strategy employed in the course. A questionnaire routinely delivered to students at the end of courses confirmed that our students regarded such bulk email as an effective and much appreciated method of student contact. This contact was even preferred over direct contact with the lecturers (Kovacic & Green, 2004b).

Learning styles models and instrument

An excellent systematic and critical overview of the main learning style models is given in Coffield, Moseley, Hall, & Ecclestone (2004a). In their other study (Coffield, Moseley, Hall, & Ecclestone, 2004b) titled provocatively: "Should we be using

learning styles?” they argued that “*beneath the apparently unproblematic appeal of learning styles lies a host of conceptual and empirical problems.*” However, at the same time they suggested that those “*who reject the idea of learning styles might, nevertheless, see value in creating a more precise vocabulary with which to talk about learning, motivation and the idea of **metacognition** – where better self-awareness may lead to more organised and effective approaches to teaching and learning*”.

Kolb’s experiential learning cycles model (Kolb, 1984) is one of the most cited and the most often used to identify learner’s preferences. The Kolb model uses the learner’s experience as a starting point in the learning process. Learners are perceived as passing through four stages of learning. Initially they are experimenting with the topic, accumulating enough concrete experience to be able to reflect in the second stage, on the observations gathered in the concrete experience stage. As a result of reflective activities learners derive abstract concepts and make generalisations in the third abstract conceptualisation stage. Finally, new concepts are subject to testing to see if they provide a reliable explanation in new situations. In other words, learners begin a new learning cycle, gathering new evidence (concrete experience). Though learners are moving through each stage they are likely to have a preferred learning mode.

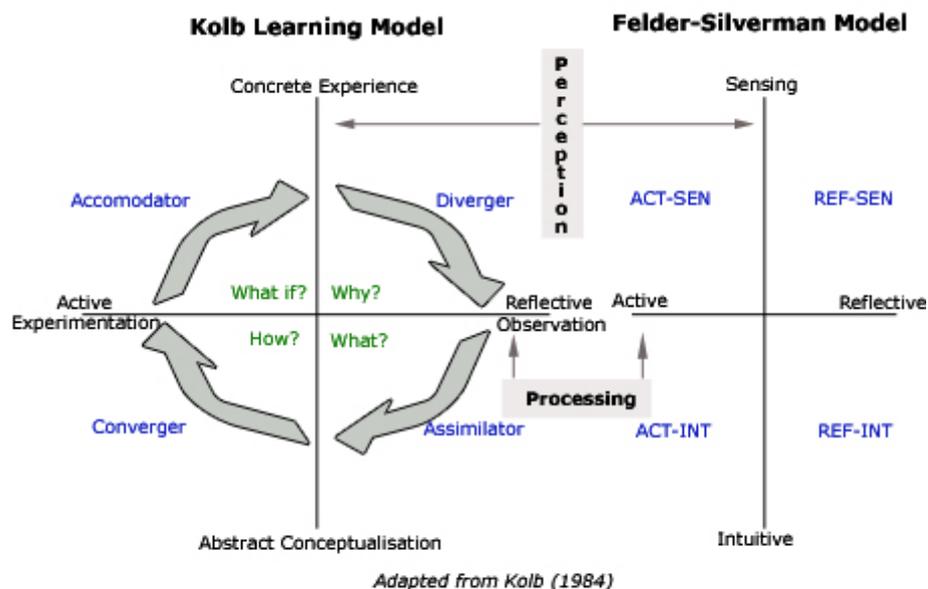


Figure 1: Kolb and Felder-Silverman learning models

By looking at the quadrants, Kolb identified four types of learners in this model: Diverger (creative, generates alternatives), Assimilator (defines problems, creates theoretical models), Converger (practical applications, makes decision) and Accomodator (takes risks, gets things done), as we have labeled them in Figure 1. We can also identify these learners by the type of question they would ask while they learn: “Why?”, “What?”, “How?” and “What if?”

The model we use in this paper is the Felder-Silverman model (1988). There appears to be a close relationship between the Felder-Silverman model and the Kolb learning style model as we have illustrated in Figure 1. They share the same two dimensions: Processing (the preferred way learners are processing information, with two poles: Actively/Reflectively) and Perception (the preferred way learners are perceiving

information, with two poles: Sensing/Intuitive). The Felder-Silverman model adds two new dimensions, which address the learners' approaches to adapting and assimilating information. These two dimensions are: Input (the preferred way learners are inputting information, with two poles: Visually/Verbally) and Understanding (the preferred way learners are adapting information, with two poles: Sequentially/Globally).

In this paper we used the learning styles instrument known as the Felder-Soloman's Index of Learning Styles (ILS) (Felder & Silverman, 2003), which is based on the Felder-Silverman learning style model. The Felder-Solomon ILS questionnaire is constructed as a bi-polar instrument across four dimensions: Processing, Perception, Input and Understanding. The dichotomous learning style dimensions of this model are continuous and not discrete categories. This means that the learner's preference on a given scale does not necessarily belong to either one of the poles. It may be strong, mild, or almost non-existent.

The instrument consists of 11 questions for measuring each of the four dimensions, and thus 44 questions in total. Each question along a dimension is designed to determine if a respondent tends to belong to one category or another on that dimension. It does so by asking the respondent to choose only one of two options where each option represents each category. For example the Understanding dimension has two categories: Sequential and Global. One of the Understanding dimension questions in the instrument is "Once I understand (a) all the parts, I understand the whole thing or (b) the whole thing, I see how the parts fit". A respondent who chooses (a) is one who tends to be a global learner, while one who chooses (b) tends to be a sequential learner. A respondent is classified as belonging to a particular category, for example, global instead of sequential on the Understanding dimension, if he or she chooses more of the options that correspond to those of global learners. Since there are 11 questions for each dimension, a respondent is always classifiable along each dimension. The range of data for each dimension is from 0 to 11. Since there are four dimensions and each dimension has two poles there are 16 possible combinations, or types of learner, in this model.

Data and results

Students identified their learning style by replying to the online questionnaire at the North Carolina State University web site, host of the ILS. Of 482 students in three semesters 244 of them (51% response rate) completed the online questionnaire and sent in their learning style results. All other data came from the enrolment form - the demographic data is a requirement from the Ministry of Education who fund The Open Polytechnic. The data from the enrolment form was in some cases, such as ethnicity, education level, occupation and the date of last study, further grouped to keep the number in each category relatively even and to ensure adequate numbers in each sample to make the statistics more reliable. For example, the occupation category was split to identify those who were studying whilst working (labeled in this paper as wage and salary workers) and those doing the courses while unemployed (labeled as the others).

The following tables (Tables 1 to 7) present the students' learning styles profile for each sociodemographic characteristic. Four columns jointly labeled "Learning styles frequencies (%)" show the percent of students who are active (ACT), sensor (SEN), visual (VIS) and sequential (SEQ) learners. The next four columns jointly labeled "Mean score (0 – 11)" give mean scores for each learning style dimension in the Felder-Silverman model across the different sociodemographic characteristics. Figures in the row labeled "Total" show learning style frequencies and mean scores

for the whole sample of students in these three semesters. For example in Table 1, learning styles frequency in Total row, in column ACT (50%) shows that the class is quite balanced on the Processing dimension (50:50 split between active and reflective learners). The result in column SEN indicates that the computer concepts students are sensor learners (SEN = 86%) with only a few intuitive learners. They prefer visual input of information rather than verbal (VIS = 75%). Slightly more than half of the class understand information sequentially rather than globally (SEQ = 64%). Based on these learning styles frequencies we have defined the 'dominant' student (the most frequent) learning profile as active/reflective, sensing, visual and sequential.

The tables also contain a value of the F-ratio and P-value from one-way ANOVA for each learning styles dimension. The F-ratio is used to test the hypothesis of no differences in learning styles among students with different sociodemographic characteristics. The P-value indicates the likelihood of obtaining a difference between mean values as large as that observed if it occurred simply from randomness in the data. A low P-value implies that we would probably not observe such a large difference from purely random data and the difference must be the result of some systematic effect. By convention, we usually label any difference with a P-value of 0.05 or less as meaningful, that is, statistically significant.

Age: We have tested a hypothesis that there are no differences in learning styles among students from different age groups. If this hypothesis were true then we would expect that the average learning styles scores for each age group would be equal. The only significant difference we found was for the Perception dimension (the preferred way learners are perceiving information). The P-value for the F-ratio was 6%. This result was unexpected as you would anticipate the movement towards the Intuitor with age if only from the viewpoint that as you get older you would have more experiences on which to base your intuition.

Age Group	Number	Learning styles frequencies (%)				Mean score (0-11)			
		ACT	SEN	VIS	SEQ	ACT	SEN	VIS	SEQ
Under 20	6	33	67	100	100	6.17	7.00	8.17	7.33
20 – 25	52	60	79	75	56	5.75	7.29	7.29	5.52
25 – 29	39	41	92	82	69	5.18	8.31	7.56	6.46
30 – 39	84	56	91	76	60	5.75	8.38	7.20	6.00
40 & over	63	43	84	68	68	5.11	8.29	6.63	6.56
Total	244	50	86	75	64	5.50	8.08	7.16	6.15
F-ratio						1.27	2.31	1.21	2.10
(P-value)						(0.28)	(0.06)	(0.31)	(0.08)

Table 1: Age and learning styles

Gender: We have tested a hypothesis that there are no differences in learning styles between females and males students. We have found highly significant (P-values are less than 1%) differences between females and males in the Input dimension (the preferred way learners are inputting information). Both genders are visual but males are about 20% more visual than females. The other dimension where the two genders are different is the Understanding dimension (the way learners are adopting information). The result shows that females are more sequential learners.

The dominant female learner is active (though only a mildly active learner), extremely sensor, visual and sequential. The dominant male learner is slightly reflective, strongly sensing and extremely visual and prefers a global approach to understanding of the information. We could say that female and male students are learning in different ways.

Gender	Number	Learning styles frequencies (%)				Mean score (0-11)			
		ACT	SEN	VIS	SEQ	ACT	SEN	VIS	SEQ
Female	181	52	87	70	69	5.60	8.20	6.82	6.43
Male	63	47	82	92	48	5.21	7.71	8.13	5.32
Total	244	50	86	75	63	5.50	8.08	7.16	6.15
F-ratio						1.48	1.98	12.90	10.71
(P-value)						(0.25)	(0.16)	(0.00)	(0.00)

Table 2: Gender and learning styles

Ethnicity: We found that NZ European learners are more reflective than the other two ethnic groups. The reason for this might be that the NZ European societies are more individualistic than Maori and Pacific Islanders societies so are likely to be more reflective and less active learners than community based societies. Also, Maori and Pacific Islanders live in an environment that emphasises participation and practical skills, so they are more likely to be a sensor type of learner than an intuitor. We believe that Maori and Pacific Islanders are more verbally oriented so are expected to be less visual. At the same time Asian learners are extremely visual and opposite to NZ European, while Maori & Pacific Islanders are almost balanced between the sequential and global approach to understanding information.

Differences between mean scores for these three ethnic groups are marginally significant for the Perceiving dimension and strongly significant for the Understanding dimension.

Ethnicity	Number	Learning styles frequencies (%)				Mean score (0-11)			
		ACT	SEN	VIS	SEQ	ACT	SEN	VIS	SEQ
NZ European	152	45	87	72	66	5.34	8.28	7.11	6.34
Maori & Pacific Island	49	63	92	71	63	5.97	8.10	6.73	6.31
Asian	43	56	77	91	54	5.60	7.33	7.81	5.30
Total	244	50	86	75	64	5.50	8.08	7.16	6.15
F-ratio						1.32	2.72	2.18	3.47
(P-value)						(0.27)	(0.07)	(0.12)	(0.03)

Table 3: Ethnicity and learning styles

Education level: We found no differences between those without tertiary education and those with some tertiary education. This would suggest that the learning style imprinting takes place at an earlier age. In further analysis if we would be able to separate those who were born or raised in New Zealand from an early age from those who came from elsewhere, we might be able to say whether or not the New Zealand education system imprinted the same styles as elsewhere.

Education level	Number	Learning styles frequencies (%)				Mean score (0-11)			
		ACT	SEN	VIS	SEQ	ACT	SEN	VIS	SEQ
No tertiary	122	55	88	79	61	5.54	8.19	7.18	6.09
Other	99	46	84	76	64	5.45	7.84	7.37	6.16
Total	221	50	86	77	62	5.50	8.03	7.27	6.12
F-ratio (P-value)						0.84 (0.77)	1.15 (0.29)	0.33 (0.57)	0.05 (0.83)

Table 4: Education level and learning styles

Occupation: Very significant differences were found in the Processing dimension (the preferred way learners are processing information). Both wage & salary workers and the others are active, but unemployed/unwaged people are more active learners (the difference is statistically significant at 1% level). One possible explanation is that this simply reflects the fact that 50% of the unemployed/unwaged people are under 30, while only 34% of wage and salary workers are under 30. From Table 1 the mean scores for active learners show a higher value for a younger age, suggesting that the higher mean score for unemployed/unwaged people could be attributed to their younger age and not whether they are working or not.

Occupation	Number	Learning styles frequencies (%)				Mean score (0-11)			
		ACT	SEN	VIS	SEQ	ACT	SEN	VIS	SEQ
Wage & salary workers	156	45	89	73	64	5.21	8.17	7.04	6.20
Others	88	55	82	80	64	6.03	7.91	7.36	6.06
Total	244	50	86	75	64	5.50	8.08	7.16	6.15
F-ratio (P-value)						8.15 (0.01)	0.68 (0.41)	0.93 (0.34)	0.21 (0.65)

Table 5: Occupation and learning styles

Date of last study: We have detected marginal differences (P-values between 7% and 9%) in Perceiving (more sensor learners are those who have completed school recently), Inputting (those who completed their previous education much before are slightly more visual learners) and Understanding dimension (those who completed their school in sixties and seventies are slightly more sequential learners). But as we said these result are only marginally significant.

Date of last study	Number	Learning styles frequencies (%)				Mean score (0-11)			
		ACT	SEN	VIS	SEQ	ACT	SEN	VIS	SEQ
Before 1987	129	49	85	78	64	5.64	7.85	7.40	5.91
After 1987	111	53	87	72	64	5.38	8.40	6.85	6.46
Total	240	50	86	75	64	5.52	8.10	7.15	6.17
F-ratio (P-value)						0.86 (0.36)	3.15 (0.08)	2.88 (0.09)	3.24 (0.07)

Table 6: Date of last study and learning styles

First time with The Open Polytechnic: We have found differences between those who studied with the Open Polytechnic before and those who didn't. Differences are detected in Perceiving (those who studied with us before are more sensor learners), and Understanding dimension (those who studied with us before are more sequential).

First timer	Number	Learning styles frequencies (%)				Mean score (0-11)			
		ACT	SEN	VIS	SEQ	ACT	SEN	VIS	SEQ
Yes	77	53	84	82	57	5.65	7.60	7.43	5.68
No	167	49	87	73	67	5.44	8.30	7.03	6.37
Total	244	50	86	75	64	5.50	8.08	7.16	6.15
F-ratio						0.49	4.60	1.31	4.64
(P-value)						(0.49)	(0.03)	(0.25)	(0.03)

Table 7: First timer and learning styles

Implications for course design and teaching

Felder (1993) gave advice to academics to balance between opposite poles in each learning dimension. However, to some extent students should be also exposed to the teaching style which is different from their preferences to prepare them for the real world. Of course when academics try to address the range of learning styles, other factors should be considered as well, such as resources, academic staff skills and the time involved. From the results presented in this paper we can make some suggestions for instructional design and teaching. Distance education courses by the very nature of the learning mode may give advantage to verbal learners. The course material, weekly bulk emails, and newsletters used on this course are all written material, with few graphical elements. Even the discussion forums used for peer-to-peer and tutors support are dominantly written discourse. With the lack of graphical elements (charts, diagrams, multimedia elements, etc.) in the course material, visual learners could be disadvantaged, though they make up 80% of the class. Therefore, multimedia elements should be included in course materials (Montgomery, 1995). With the opportunity for including multimedia components in the course material brought by the Internet technologies, an effort should be made to adjust the learning environment in a way that suits the majority of the learners.

The learning environment should be designed so that students have control of their learning experiences. They should have an option to choose between different paths throughout the course material, for example between one with more visual or more verbal input. For the global learners a course map and learning material that gives a wide perspective, i.e. a global overview of the course, would be likely to improve their course performance.

We have used a list of Felder's (1993) recommendations to suggest a few changes in the learning strategies that would increase students' academic performance of Computer Concepts students:

1. Since discussion forums are written discourse per se, tutors should use attachments with screen shots (visual) of each important step (sequential) in designing a business application (wordprocessing, spreadsheeting and database). Alternatively a PowerPoint presentation with animated slides or multimedia elements (video, Macromedia Flash animation, etc.) and

speaker's notes would probably enrich the learning experience because of students' preference for visual input of information.

2. The final exam questions should include, if possible, flow charts and diagrams (visual) to help students to understand what the question is about. Students could be also encouraged to provide answers in a diagrammatic format where possible.
3. Tutors can help students to develop a broader range of learning styles by creating assignments that access the full spectrum of learning styles. These would be multidimensional packages containing activities suited to each of the learning styles.
4. Felder advises tutors to make more use of handouts for information exchange to allow more time for student interaction around that information, and to allow time for reflection (reflective). Interestingly this is the teaching method used at The Open Polytechnic and many other distance institutions.

Conclusion

This paper has reported the results of an empirical study of the relationship between learning styles and sociodemographic characteristics of students. The differences in learning style profiles were identified using the Felder-Soloman Index of Learning Styles. There are some significant relationships between learning styles and sociodemographic characteristics. We found that gender and ethnicity in particular have a strong impact on the way students learn. Overall learning material design should try and use all of the learning style dimensions so students can choose a suitable pathway or develop their skills in a learning style they do not prefer.

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