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Student demographics as a predictor of use of an educational software program

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Nearly ten years after the first democratic elections in South Africa, educators are still concerned about the needs of disadvantaged students, particularly when introducing computer technology into the educational process. This article reports on the findings of a research project, which explored the use of a Computer Assisted Education program by students from diverse ethnic, educational and language backgrounds. The results showed that initial presumptions that disadvantaged students would be excluded from the use of the technology may be inaccurate.

Background

Educational institutions throughout the world are increasingly facing classes of educationally, culturally and linguistically diverse student groups. At the same time economic constraints require these institutions to expand their student base.

Rapid advances in desktop computing capabilities and in particular multimedia and the Internet, have revived interest in Computer Assisted Education (CAE). Educators across the globe are reviewing these media and universities in South Africa are no exception to these trends. Increasingly academic staff members are exploring the possibility of using the existing institutional computer infrastructure to assist in delivering quality education, maintaining current standards, and addressing the multiple needs of the student body (Greaves, 1997).

A research project was initiated at the University of Natal, the primary objective of which was to investigate the potential to develop and use CAE at the University. Given the diversity of the student population one of the major concerns was to ensure that all students regardless of ethnic, language and educational background would be able to benefit from access to the resources.

In order to explore and understand all the factors affecting the development and use of computer based systems as educational tools, research was conducted into current worldwide trends in education and the current capabilities within universities in South Africa. Among the aspects considered were instructional styles and learning styles that could be used to support the educational goals of the diverse student population; instructional design methodologies and media production methodologies, focusing in particular on interface design issues in a multi-cultural multi-lingual environment; and an investigation of the broader sociological and historical factors that may influence the way in which CAE can be used effectively in a South African context. Guided by these principals a computer system was developed and used in a case study to investigate the way in which learners would use such a system, and the lessons that need to be learnt in order to make future developments as cost effective, educationally sound, and student friendly as possible.

This paper reports on the findings of this research related to the investigation of whether students from different backgrounds would use a CAE program and the usage patterns of those who did so, both in terms of frequency of use and collaborative use.

The study

The case study was developed predominantly to investigate if there were any discernable and significant differences in the use of the program when correlating the students' usage patterns with ethnic, educational and language backgrounds. The presumption was that students from historically disadvantaged backgrounds and those with English as a second language would be less willing to use technological interventions than those who were more likely to have had access to computers early in their education. The case study set out to investigate if these presumptions were valid, and if so what aspects of design and delivery could facilitate these students' usage of such systems.

The case study was conducted at the University of Natal's Nelson R Mandela School of Medicine where the student demographics are inclusive of most of the population demographics of the region with a variety of ethnic, language, cultural and educational backgrounds. Research by Australian academics such as Henderson (Henderson, 1994) shows the importance of ensuring that cultural issues are taken into consideration when developing online learning, and if properly done it can enhance the accessibility of higher education for communities that have traditionally been excluded. In the sample considered, African and Indian students are almost equally represented whilst Coloured and White students are represented as a small minority. Many of the students are drawn from disadvantaged educational backgrounds and are largely under-prepared for a scientific and medical curriculum. However all medical students take a module in computer literacy during their first year so inability to use computers would not be a factor.

The medium of instruction is English, which for many of the African students is at best a second language. Furthermore, not all faculty teaching the courses are from South Africa and thus the students have to contend with learning in a language that is not their mother tongue spoken by people with a variety of different accents. This is particularly problematic for students when dealing with Latin and Greek terminology.

Medical school curriculum is characterised by vast amounts of factual information across a number of different scientific disciplines. Traditional teaching of this information has taken the form of instructivist lectures and tutorials that are "overly biased in favour of tertiary care medicine" (Ross & Ross, 1989:173). This has had the effect of encouraging students to develop a mastery learning strategy, resulting in a marked decrease in the retention of factual information over time; however, other educational methodologies have been shown to enhance long-term recall, problem solving skills and transference of knowledge (Blunt & Blizzard, 1975; Reeves, 1995).

The University of Natal's Medical School faces not only these problems but also has the added pressure that their undergraduate students will soon be situated in remote rural hospitals whilst undertaking their studies. As a result the University curriculum developers have investigated problem based learning, as initiated by McMasters' Medical School (McMasters, 2000) and emulated by medical schools around the world. The Medical School's entire curriculum has since moved to this mode of delivery, and there is thus a pressing need to be able to distribute learning resources to remote areas whilst remaining in contact with students who will have different scheduling commitments. Distributive processing, telematics, collaborative and situated learning, and CMC facilities become vital for the educational process.

To entice the students to use the system there had to be percei-

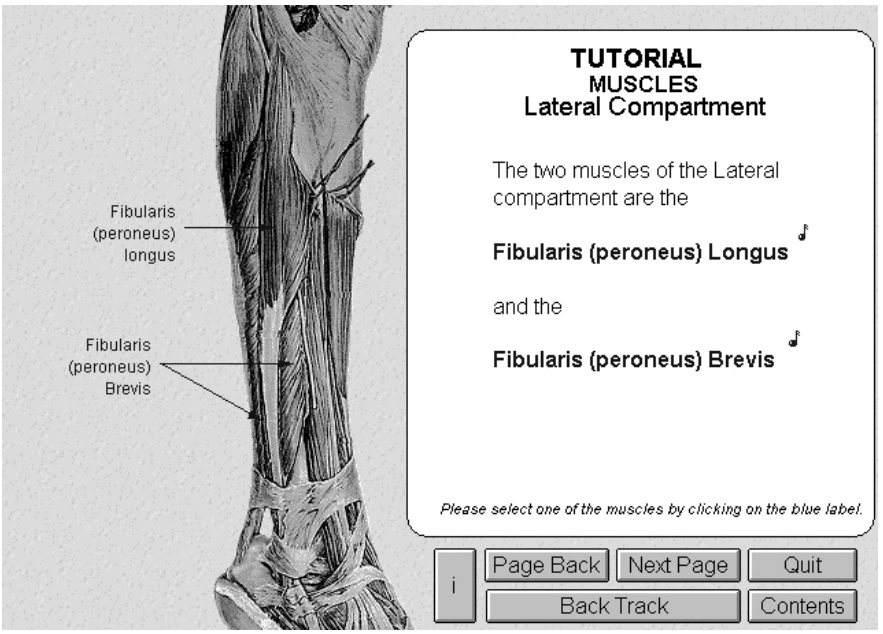

Figure 1 Example screen from the CAE program

vable benefits to them individually, thus the development of the system had to be meaningful and of particular relevance to the subject matter being learned. The Department of Human Anatomy had identified a need to use technology to supplement the traditionally delivered course material, and chose to have a program developed to support the learning of the anatomy of the leg. In order for the program to be meaningful for the students it had to be developed within the educational paradigm used at the time which was largely instructivist in nature, it also had to be able to support the students' primary objective which was to pass a multiple choice exam at the end of the year. This was supported by including self-testing mechanisms to allow the students to get feedback on their understanding of the various elements.

Once developed the program was demonstrated to students and loaded on to the University Local Area Network (LAN) for optional use by any student. During the demonstration, the students were told how to access it on the student LAN, given full details of the research project whereby they were also assured of confidentiality of record keeping and that the use, or lack thereof, would not be reflected in their marks for the course. The students had unlimited LAN access to the program for the semester, but as the LAN is situated in the library their computer time was limited to library hours and totally voluntary. The program stored data via an on-line tracking system that recorded each student's movement through the program. Subsequently an open-ended questionnaire was administered to obtain the students' perceptions of the program. Where possible the two were correlated to ensure validation of the data.

The design

The nature of the subject of human anatomy is such that there are an enormous number of facts to be learnt; specifically the names, anatomical position, functions and clinical aspects of all bones, muscles nerves and blood vessels. The textbooks available to the students are textually dense and require the students to page back and forth to tie together graphics and data. The CAE development focused on factual information as prescribed by the subject experts, but images and text were displayed together in a more interactive manner to facilitate the students assimilation of the information.

A further problem these students have in learning anatomical information is that not all students are able to integrate the conceptualisation of sketched diagrams, realistic pictures and the reality of cadaver dissections. Graphic literacy is a presumption made in most material developed for medical education and it was therefore considered desirable to include the different types of representation in the system and ensure they were presented in such a manner that the students could form an association between them.

Particular care was taken to ensure development for a South African multicultural audience following the issues outlined by Amory and Mars (1994) as well as Andrews (1994). The guiding principles of the design were ease of use and the provision of an environment that was largely intuitive to use.

The design adhered to the usual conventions such as textual hotspots displayed in blue text, mouse icons changed to a hand when the mouse passed over a hotspot. The chosen navigation metaphor was a book, with buttons for next page and previous page permanently available on screen. Students could move through the entire program in a linear "page-turning" mode or use the "Table of Contents" screen to get direct access to any subsection of the program.

Care was taken to ensure that all language was non-sexist, and that anatomically appropriate people of different genders and race groups were used in the images. Iconic images were labelled to ensure all users could understand them.

The subject experts expressed a preference for the visual material to be presented in as anatomically correct position as possible which, given the subject material, lent itself to a vertical rectangular shape for the images. The screen was thus divided into three main sections, the graphics on the left, the text to the right and the navigation buttons permanently present in the bottom right hand corner. To assist students identifying where they were in the program all screens were clearly labelled with the topic and subtopics being discussed (Figure 1).

Sound and animation can be intrusive if not appropriately used (Mayhew, 1992). Sound cues were used to indicate a transition from one major section to another, and students were able to activate hotspots to get the pronunciation of unfamiliar words. Animation was used to highlight various aspects of the anatomy, in particular the blood vessels and nerves, and also to draw the student's eye from the text to a particular portion of the accompanying image.

Evaluation methods

Formative evaluation took the form of informal feedback from subject experts in the department of Human Anatomy and design experts from the Multimedia Research Group. More formal critique was obtained

from Computer Science Honours students. Various initial design elements were altered according to the feedback obtained. The most pertinent alteration was the way the subject material was grouped so that it followed the methodology used by the subject experts when teaching the course.

Data for analysis of actual usage were obtained from two sources. The first of these was an online tracking system that recorded the students' navigation path through the system, the length of time they spent in each component and the month and day they accessed the system. However, as this system did not record the quality of interaction, the students were also asked to fill in an open-ended questionnaire giving details of their use of the program and opinions of its design and usefulness to them.

Student demographics

Ethnicity

In order to consider the use of the system by 'disadvantaged' students, the students were asked to describe to which cultural group they belonged, from which the researcher derived their ethnicity. The racial breakdown of the class is reflected in Figure 2, showing that African and Indian students are almost equally represented and the other groups compose a small minority.

Educational background

The questionnaire asked students to state the type of schools attended and these were equated with the apartheid educational structures for research purposes (Figure 3).

Language

Fluency in English is an area of concern, so the questionnaire asked specifically what languages were spoken at home as these were then considered mother-tongue languages. The responses indicated that the group with the largest proportion of multilingualism are African (38.36%). 13.16% of the next largest group, Indian students, described their home environment as multilingual. Most of the other two groups of students are monolingual, with one white student who speaks English and Afrikaans at home. All monolingual students speak English at home except within the African group where one monolingual African student has English as a home language. 114 of the 166 respondents (68.67%) spoke English at home, but all 52 respondents (31.33%) who did not speak English at home were African.

The findings

Program usage

Student use of the program as indicated by questionnaire responses

Of the 166 completed questionnaires, 82 people (49.44%) chose not to use the program. Of the 84 people who wished to use the program, three (1.81%) stated that they tried but it did not work and 81 people (48.80%) used the program at least once.

Those that did not attempt to use the system

82 respondents stated that they did not use the system at all. The reasons for choosing not to use it varied and are listed in Figure 4, with some people giving more than one reason. Thirty-eight respondents claimed they did not know about the system (four of whom thought it had something to do with a program that should have been available at school) and whilst this high figure is a cause for concern it is probable that a lie-factor is present as attendance at the lecture at which the system was demonstrated was satisfactory. Only two respondents indicated that they had a dislike of computers and one of these specifically stated it was the speed of the computers in the student LANs that made the experience uncomfortable:

> "I meant to and was genuinely interested but the computers here are painfully slow and frustrating" [122].
>
> "I didn't have the time, I don't really like computers and would rather learn from a book" [134].

These comments reinforce the point made by Baeker and Buxton (1987) that the system must be easy to use, transparently available and provided in a manner conducive to quick and seamless access.

Twelve respondents stated that computer systems worked against their specific learning styles, for example:

> "I found using D.H.[1] dissections more useful and also using the textbook and moreover I didn't get a chance to go to the LAN due to some reason" [012].
>
> "I did not think that it will be different from what we do in the DH" [064].
>
> "I prefer text book style to computer aided learning packages" [090].
>
> "It was only visual which is boring" [099].
>
> "Computer aided learning as a means of learning is not very effective" [135.]

Those who tried but failed

For some time the program would not run as a crucial sub-directory had been removed by systems administrators. It appears that during this time four students attempted to use the program. Three of these students simply left it and used other media, for example, the respondent on questionnaire 092 stated that he did not use it and commented:

> "Tried but the program wasn't working properly. I got frustrated and gave up".

The one user who returned to retry the program stated that on one of the two occasions

> " ... the pictures were not appearing on the screen! This disappointed me greatly" [091].

No complaints were reported to the developer although at the demonstration it was agreed that they could contact the developer directly, make representation via the class representative, or send a message through the lecturing staff if they wished. It is clear that if a system is not easily and immediately accessible people will give up and use another medium unless there are external motivating factors such as the material forming an integral and potentially examinable part of the course.

Those that used the system

Eighty-one respondents (48.80%) indicated that they had used the system. These were further analysed against student demographics and usage trends.

Demographics of users

An analysis of the demographics of students[2] who did and did not use the program was done using the Pearson Chi-Squared test calculated with SPSS(tm) (Table 1). The significance level of 0.017, less than the required 0.05, indicated that there was an association between ethnicity of the users and the likelihood of the program being used. More African respondents used the system than would be expected if ethnicity and usage were not related. Conversely fewer Indian respondents indicated they used the system than would have been expected had there been no correlation between ethnicity and usage. Similar tests for association between usage and English as a home language as well as usage and educational background indicated no significant association.

The commonly expressed fear that 'disadvantaged' students could be further disadvantaged by the use of technology in the learning process is shown to be unfounded by this significance level. However, further investigation is required to understand why the other group appears to be reluctant to use the system as neither language nor educational background emerge as reliable predictors.

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[1] Dissecting Hall

[2] Note for the purpose of this analysis the 'coloured' and unidentifiable and single foreign student were removed as they were small numbers.

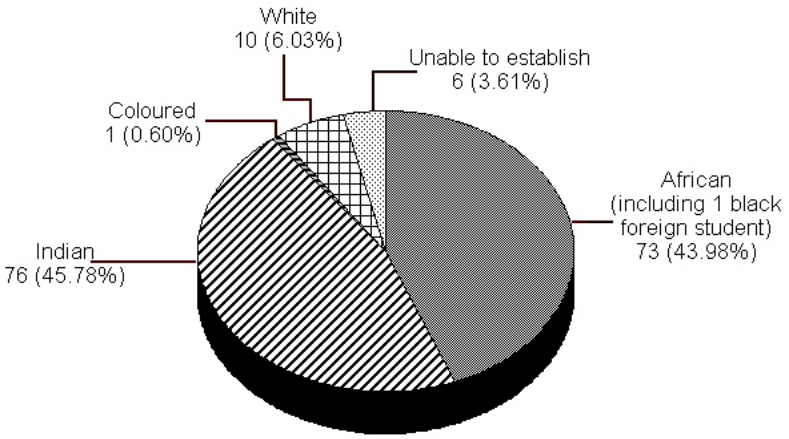
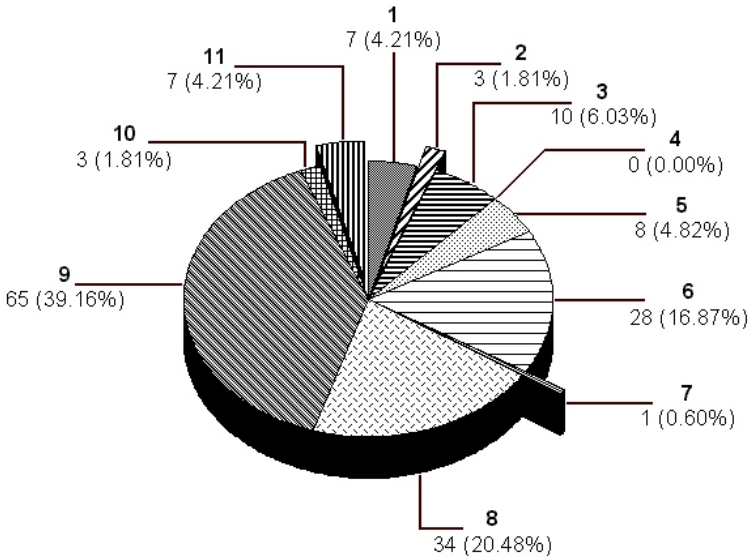


Figure 2 Racial breakdown of students (n = 166)



Key :
1. Historically advantaged independent school
2. Privately run cram college/school
3. Historically religious run "black" school
4. Historically religious run "white" school
5. Historically religious run "Indian" school
6. Historically govt. English "white" school
7. Historically govt. Afrikaans "white" school
8. Historically govt. "black" school
9. Historically govt. "Indian" school
10. Other schools
11. Not specified

Figure 3 Type of school attended

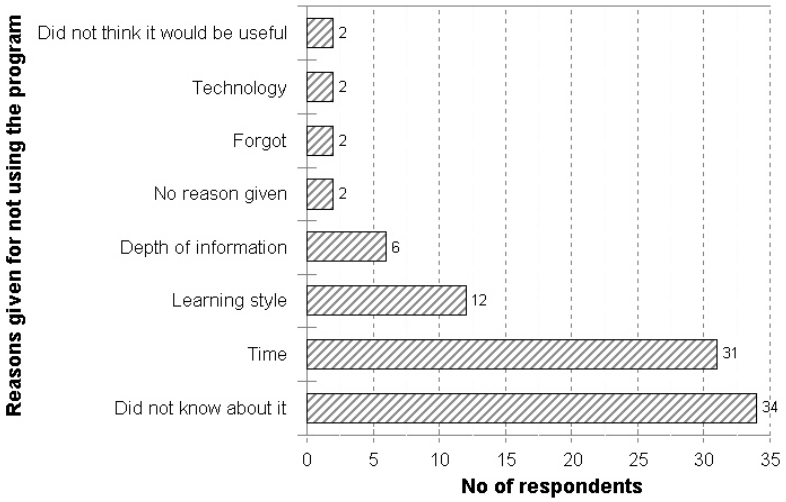


Figure 4 Reasons given for not using the program

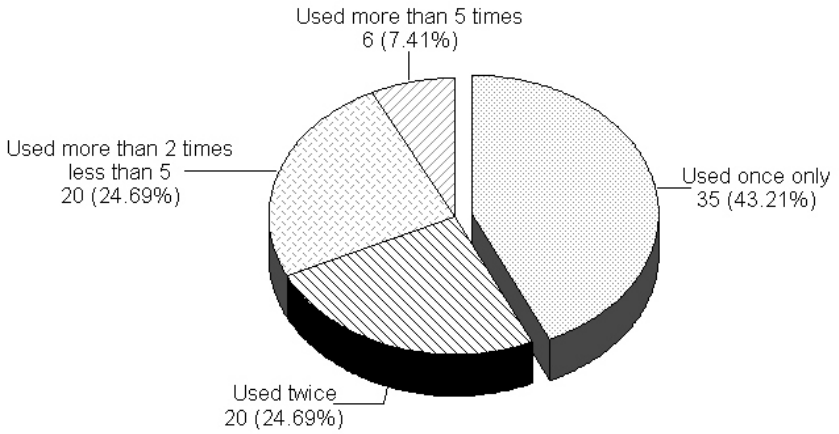


Figure 5 Number of times the program was used

Usage patterns

Number of times used

Figure 5 depicts the number of times the program was used. Of the respondents who used the program, more than half (56.79%) returned and used it again.

Table 1 Demographics of those who did or did not use the system

		Ethnic groups			
		African (n =72)	Indian (n =76)	White (n =10)	Total (n =158)
Did not use the program	Count	28	47	6	81
	% of ethnic group	39%	62%	60%	51%
	Expected count	36.9	39.0	5.1	81.0
	Expected %	51%	51%	51%	51%
Used the program	Count	44	29	4	77
	% of ethnic group	61%	38%	40%	49%
	Expected count	35.1	37.0	4.9	77.0
	Expected %	49%	49%	49%	49%

	Value	**D/f**	***P***
Pearson χ^2	8.123	2	0.017
N of valid cases	158		

Collaborative learning

Group work is an essential part of the problem based learning curriculum that the medical school is introducing in 2001. Although this program was not specifically designed to ensure cooperative learning, it was thought that students might work on the program together. Careful analysis of this usage pattern was undertaken to see if there were any reliable predictors for collaborative learning (Table 2). Fifty-five of the respondents who used the program stated they had used it on their own; 8 used it with someone else and 17 had used it on their own and with someone else. One respondent [005] indicated an ambivalent use of the system ticking and crossing out options making it difficult to interpret the questionnaire.

These figures indicated a trend that students are more likely to work alone with only 25.77% of users choosing to work with someone else.

An analysis looking for the significance of language, ethnicity and educational background showed language and ethnicity as worthy of further investigation, but educational background did not appear to play a role.

Language: The Pearson Chi-Squared test showed that a significant proportion (0.013) of students who stated that they used the program with someone else did not speak English at home. Conversely, significantly more people who indicated they spoke English at home were likely to use the program exclusively on their own. (Table 3)

Table 2 Usage of the system

Usage	No. of respondents
Used on their own exclusively	55
Used with some one else exclusively	8
Used with some one else and on their own	17
Unable to interpret	1
Total	81

Table 3 Collaborative use: home language

		Was English spoken at home?		
		No (n =29)	Yes (n =51)	Total (n = 80)
Used it on own only	Count	15	40	55
	% of group that only used it on their own	27.3%	72.7%	100%
	Expected count	19.9	35.1	55.0
	Expected %	36.2%	63.8%	100%
Used it with some one else	Count	14	11	25
	% of group that used it with some one else	56.0%	44.0%	100%
	Expected count	9.1	15.9	25.0
	Expected %	36.4%	63.6%	100%

	Value	**D/f**	***P***
Pearson χ^2	6.138	1	0.013
N of valid cases	80		

Ethnicity: A similar tabulation against race groups divided between African and 'other' (excluding the group where race was unknown) also showed a significant difference (0.007) in that more African students were likely to use the program with someone else than could be expected if the two groups had the same study habits. Conversely 'white', 'Indian' and 'coloured' students as a group were more likely to work on their own than their African counterparts (Table 4).

Educational background: An attempt to correlate the educational

Table 4 Collaborative use: ethnicity

		Grouped by 'African' and 'other' excluding the group whose ethnicity could not be established		
		African (n =44)	Other (n =34)	Total (n =78)
Used it on own only	Count	25	29	54
	% of group that used it on their own	46.3%	53.7%	100%
	Expected count	30.5	23.5	54.0
	Expected %	56.5%	43.5%	100%
Used it with some one else	Count	19	5	24
	% of group that used it with some one else	79.2%	20.8%	100%
	Expected count	13.5	10.5	24.0
	Expected %	56.3%	43.8%	100%
	Value	**D/f**	***P***	
Pearson χ^2	7.301	1	0.007	
N of valid cases	78			

Table 5 Collaborative use: educational background

		Type of school (excluding the 5 unknown)		
		Independent (n =12)	Government (n =64)	Total (n =76)
Used it on own only	Count	8	44	52
	% of group that used it on their own	15.4%	84.6%	100%
	Expected count	8.2	43.8	52.0
	Expected %	15.8%	84.2%	100%
Used it with some one else	Count	4	20	24
	% of group that used it with some one else	16.7%	83.3%	100%
	Expected count	3.8	20.2	24.0
	Expected %	15.8%	84.2%	100%
	Value	**D/f**	***P***	
Pearson χ^2	0.020	1	0.887	
N of valid cases	76			

Table 6 Collaborative use: schooling

	Type of school (see key below)										
	1 (n = 2)	2 (n = 2)	3 (n = 5)	5 (n = 3)	6 (n = 14)	7 (n = 1)	8 (n = 23)	9 (n = 24)	10 (n = 2)	11 (n = 5)	Total (n = 81)
	Used on their own only										
Count	2	1	2	3	9	0	15	19	1	4	56
% of group that only used it on their own	3.6%	1.8%	3.6%	5.4%	16.1%	0%	26.8%	33.9%	1.8%	7.1%	100%
Expected count	1.4	1.4	3.5	2.1	9.7	0.7	15.9	16.6	1.4	3.5	56.0
Expected %	2.5%	2.5%	6.3%	3.8%	17.3%	1.3%	28.4%	29.6%	2.5%	6.3%	100%
	Used it with some one else										
Count	0	1	3	0	5	1	8	5	1	1	25
% of group that used it with some one else	0%	4.0%	12.0%	0%	20.0%	4.0%	32.0%	20.0%	4.0%	4.0%	100%
Expected count	0.6	0.6	1.6	0.9	4.3	0.3	7.1	7.4	0.6	1.6	25.0
Expected %	2.4%	2.4%	6.4%	3.6%	17.2%	1.2%	28.4%	29.6%	2.4%	6.4%	100%
	Value	**D/f**	***P***								
Pearson χ^2	8.876	9	0.449								
N of valid cases	81										

Key: 1 = Advantaged private school; 2 = Private cram college; 3 = Religious 'black' school; 5 = Religious 'Indian' school; 6 = English 'white' school; 7 = Afrikaans 'white' school; 8 = 'black' government school 9 = 'Indian' government school 10 = 'coloured' government school; 11 = Unknown.
(Note that category 4 of the questionnaire "Religious 'white' school" had no entries.)

background of the students against those who chose to work on their own or those who chose to work with someone else showed no significant difference. The first test run against schools grouped by financial sourcing had insignificant results (Table 5). A further recalculation on these figures to serve as a crosscheck against schools grouped by historical educational departments also proved to be insignificant (0.449) (Table 6).

To summarise, in analysing collaborative learning patterns, both language (0.013) and ethnicity (0.007) were significant, whilst educational background was not. Further investigation should be conducted to fully understand the association between language and ethnicity in collaborative learning patterns.

Implications

It was particularly interesting to see that the majority of students in the target group were willing to use a system even though it was not an integral part of their course. However, the reasons for the statistically significant difference in the likelihood of African students to use the program needs to be further investigated. The learning style of African students within the target group was also significantly different to the others, particularly in respect to collaborative use of the system and, again, further research is required to determine if this is simply indicative of this particular group of students or if it is a reliable predictor for future student groups.

It is clear that the premise that computer assisted education pro-

grams will further disadvantage under-prepared students, as defined by ethnic group, is largely unfounded.

Conclusion

The "digital divide" is a catch phrase that looks specifically at the different levels of access to technology and specifically Internet technology across various levels of socio-economic subgroups. However, the concept of "access" should also be defined in terms of the skills required to use the technology as well as the benefits of that technology for the given group. This research has shown that, given a perceived tangible benefit and access to the technology, students have the skills and willingness to participate in on-line learning regardless of their ethnic and educational background.

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