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Disciplinary differences in the use of educational technology

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ABSTRACT

In this paper we explore disciplinary differences in the use of Information and Communication Technologies (ICTs) for teaching and learning in five higher education institutions in the Western Cape. We draw Laurillard's conversational framework (2002) as a way of describing ICT use in terms of five key teaching and learning events and use Biglans framework (1973) of classifying different disciplines so that we can compare our findings to other international studies of disciplinary difference. We note that there are indeed difference in both the frequency and type of ways that different disciplines use ICTs and we offer some suggestions as to why this might be so.

Keywords

ICTs, teaching and learning, disciplinary difference

INTRODUCTION

Experience and research tell us that there are significant differences in the way that different disciplines are taught (Hammond and Bennett 2002, Neumann 2001). We therefore assume that the ways in which information and communication technologies (ICTs) are used as part of teaching and learning in specific disciplines will also be different.

In Czerniewicz and Brown (2005) we examined ICT use for teaching and learning in the Western Cape and concluded that ICTs are indeed being used as part of teaching and learning events in higher education with the most frequent uses being for finding information and writing assignments. We found use of ICTs for communication, presentation, and activities that offer opportunities for practices and feedback to be infrequent.

In undertaking this research we became interested in the extent to which ICTs are being taken up in different disciplines as well as the ways they are being used differently. We noticed evidence for such differences emerging in the literature. For example differences in the frequency of use of ICTs by different disciplines in the UK have been noted by Williams, Coles, Wilson, Richardson and Tuson (2000) who report on the high use of ICTs in business and management subjects. Differences have also been noted by UK researchers Hammond and Bennett (2002) who report that the dominant use of computers to support communication occurs in humanities faculties.

In this paper we are explore the following questions;

- Are ICTs being used to different degrees in different disciplines?
- How are ICTs being used for different purposes across disciplines?
- How do the results of this investigation compare with international findings?
- Does the use of ICTs challenge traditional disciplinary approaches to teaching and learning?.

THE STUDY

Between March and May 2004, 6577 students and 515 academic staff responded to a survey in five higher education institutions in the Western Cape. The survey was conducted both in a print and online format in order to maximize response rates. With the exception of one institution, the number of respondents represented 10% of the overall staff and student population¹.

¹ In the case of the exception, the survey was administered entirely online and a response rate of 4% of the student and 8 % staff population was achieved.

Whilst staff and students were invited to participate in the survey online through email invitations, the print survey was distributed using a stratified sample method, (as per Sayed 1998), to students across all faculties and levels of courses in the five institutions. This involved sampling courses at various levels across all faculties in the institution and administering the survey in lectures or tutorials².

Students and staff respondents from a range of faculties were represented with the majority being from business disciplines (28%) and the minority from health science disciplines (11%). The majority of students were at the undergraduate level (64%) and were in the first or second year of study (65%)³.

Student respondents were evenly distributed in terms of gender. Most students were under 20 years old (57%). Their home language varied, with English being the most frequently spoken (39%) followed by Afrikaans (19%) and isiXhosa (14%).

Most staff had worked at their institution for more than 5 years, and were at Lecturer level (42%) or below. The majority were male (59%) and older than 40 years (53%). Only 2 staff members spoke a home language other than English (56%) or Afrikaans (42%).

The investigation was undertaken through a questionnaire comprising three parts: access to computers, use for teaching and learning, and demographics. This paper reports on the results of the last two sections of the questionnaire only i.e. use and demographics, with the latter section allowing the analysis of the results by disciplinary grouping. The discussion in this paper focuses on 31 questions organised around the five key teaching and learning events, and the associated media forms. Details of all questions and how they are related to the analytical framework can be found at http://www.cet.uct.ac.za/pie/Cz_Brown.htm.

FRAMEWORK OF USE

In Czerniewicz and Brown (2005) we describe our analytical framework for thinking about use of ICTs in teaching and learning. We draw on the conversational framework developed by Laurillard (2002) as an explicit way of linking ICT use to pedagogy. The conversational framework provides a way of describing teaching and learning in terms of five key events: acquisition, discovery, dialogue, practice and creation. These events involve specific teaching strategies, roles or actions which interact with specific learning strategies, roles, actions and experiences. The framework then links five media forms narrative, interactive, communicative, adaptive and productive with the key teaching and learning events (Table 2). Together they describe the most dominant learning experiences and teaching strategies currently employed in higher education.

<u>Teaching & Learning Event</u>	<u>Teaching action or strategy</u>	<u>Learning action or experience</u>	<u>Related media form</u>	<u>Examples of non-computer based activity</u>	<u>Example of computer based activity</u>
Acquisition	Show, demonstrate, describe, explain	Attending, apprehending, listening	Narrative Linear presentational. Usually same "text" acquired simultaneously by many people	TV, video, film, lectures, books, other print publications	Lecture notes online, streaming videos of lectures, DVD, Multimedia including digital video, audio clips and animations
Discovery	Create or set up or find or guide through	Investigating, exploring, browsing,	Interactive Non-linear presentational.	Libraries, galleries, museums	CD based, DVD, or Web resources including

² Specific details are provided on http://www.cet.uct.ac.za/pie/Cz_Brown.htm.

³ Detailed demographics of respondents can be found http://www.cet.uct.ac.za/pie/Cz_Brown.htm.

	discovery spaces and resources	searching	Searchable, filterable etc but no feedback		hypertext, enhanced hypermedia, multimedia resources. Also information gateways.
Dialogue	Set up, frame, moderate, lead, facilitate discussions	Discussing, collaborating, reflecting, arguing, analysing, sharing	Communicative Conversation with other students, lecturer or self	Seminar, tutorials, conferences	Email, discussion forums, blogs
Practice	Model	Experimenting, practising, repeating, feedback	Adaptive Feedback, learner control	Laboratory, field trip, simulation, role play	Drill and practice, tutorial programmes, simulations, virtual environments
Creation	Facilitating	Articulating, experimenting, making, synthesising	Productive Learner control	Essay, object, animation, model	Simple existing tools, as well as especially created programmable software
Adapted from Laurillard's Rethinking University Teaching (2002)					

FRAMEWORK OF DISCIPLINE

In order to examine use of ICTs for teaching and learning in terms of discipline we needed to develop an analytical framework that enabled us to both logically group the 34 faculties we surveyed across the 5 higher education institutions in the Western Cape as well as provide a means of comparing our findings internationally.

Firstly we organised institutional faculties into disciplinary groups (Table 2). We are mindful that that disciplinary differences within faculties may be lost in the creation of these groups. However given the diversity of in the way faculties are organised across institutions (the number of faculties ranged from 3-10 in the 5 institutions surveyed) we needed to find a comparable way of grouping disciplines across the region.

Table 2: Organisation of institutional faculty's into discipline groupings

Discipline grouping	Student (n)	Staff (n)	Cape Technikon	Peninsula Technikon	University of Cape Town	University of the Western cape	Stellenbosch University
Science	988	105	Applied Sciences	Science (exclu education)	Science	Natural Sciences	Agricultural & Forestry Sciences Science Military Sciences
Humanities	1125	108	Education	Science (education only)	Law, Humanities	Arts, Education, Law	Arts Education Law Theology

Engineering	977	68	Engineering Built Environment & Design	Engineering	Engineering & Built Environment		Engineering
Business	2405	142	Management Business Informatics	Business	Commerce	Economic & Management Sciences	Economic & Management Sciences
Health Science	708	61			Health Science	Community & Health Sciences, Dentistry	Health Sciences

In order to align with the majority of international studies which have interrogated differences in teaching and learning approaches between academic disciplines, we used Biglan's (1973a, 1973b) framework of classifying different disciplines (see for example, Smeby 1996, Becher 1989, Whitmire 2002, Neumann and Becher, 2002, Fry 2006).

Table 4 summarises the framework which organises disciplines into four fields, these being hard pure fields (natural and pure sciences); hard applied fields (science based profession eg engineering); soft pure fields (humanities and social sciences); and soft applied fields (social science based professions eg business) (Becher 2002). Although there are limitations in categorising disciplines under these broad headings, as for example a discipline may straddle two categories or may differ within a category (Neumann and Becher 2002), this has proved a useful way of examining disciplinary differences in university teaching at a macro level.

Table 3: Our disciplinary groupings organised according to Biglan's framework

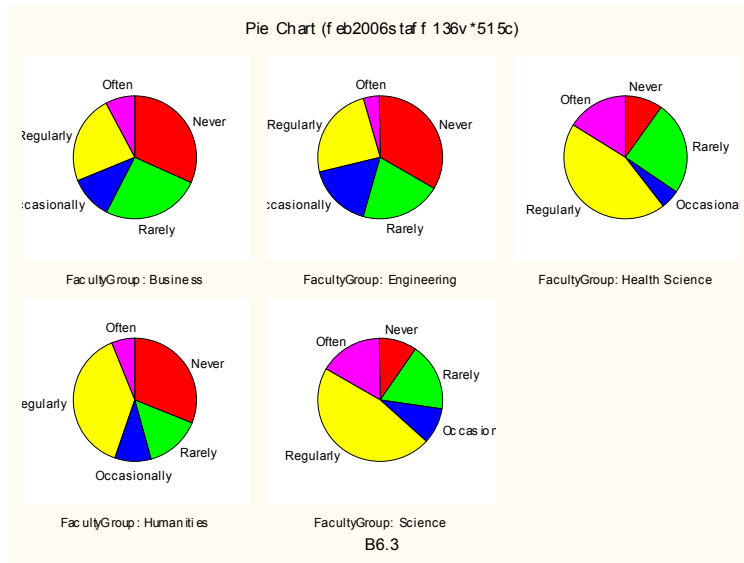
	Hard	Soft
Pure	Science	Humanities
Applied	Engineering Health Science	Business

Calculation of an index for comparing disciplines

Comparing use across the disciplines had its difficulties. We couldn't directly compare the frequency of use as students consistently reported lower frequency of use compared to staff. We have noted the differences in staff and students frequency of use elsewhere (Czerniewicz and Brown 2005) suggesting that discrepancies may well be due to sample size as the 515 staff who responded to the survey were reflecting on their own practice, whereas the 6576 students who responded to the survey were reflecting on their overall experience at their institution (which involved many different courses).

Instead we categorised the responses according to discipline and then ranked the response according to the median response. This created a new index where 1 = most frequent and so on. As an example we can examine staff responses to Question 6.3 asking "How often have you explained or demonstrated a concept using multimedia eg animation?". The science and health sciences disciplines have a median of regularly. They were both given a ranking of 1. The humanities discipline has a median of occasionally, it was given a ranking of 2 and the business and engineering disciplines had a median of rarely and were given a ranking of 3

Figure 1: Example of staff from different disciplinary groupings response to question 6.3 "How often have you explained or demonstrated a concept using multimedia eg animation?"



The ranking for this question was therefore

1. Health Science and Science
2. Humanities
3. Business and Engineering

Where the medians were all the same the disciplines were not ranked.

This ranking exercise was conducted for both staff and student responses. It enabled us to examine in which disciplines students and staff are undertaking a particular activity frequently (in terms of each other) irrespective of the actual percentage frequencies which we know differ.

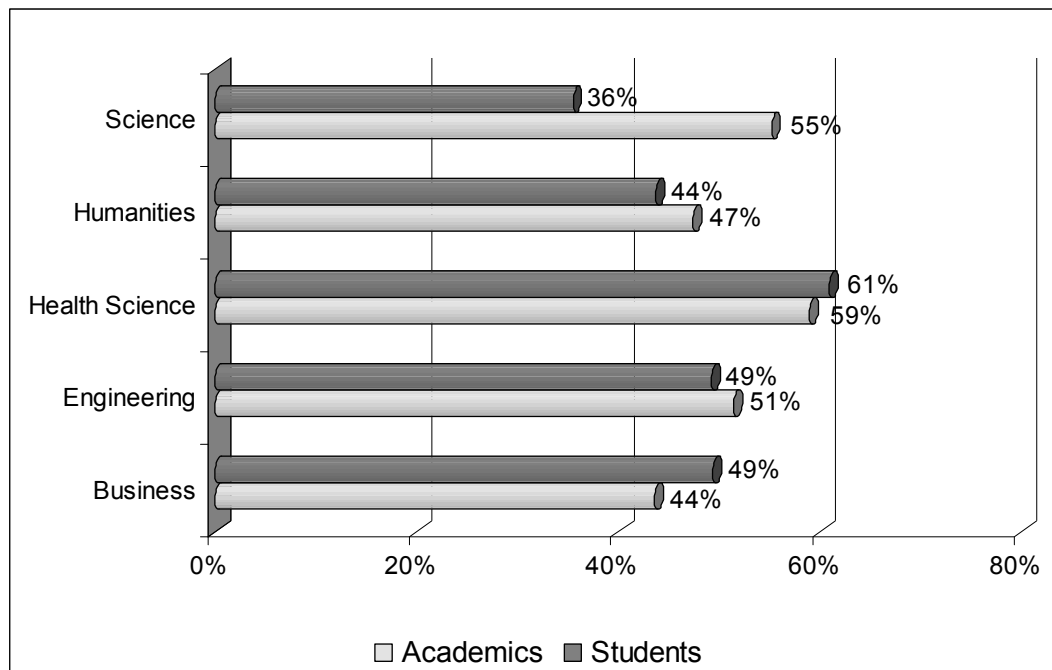
The value of the index we created does not have a meaning in itself other than to indicate where that particular discipline lies in terms of overall ranking. For example, in the example above staff from health science and science disciplines regularly use multimedia as a presentational tool. They report the most frequent use of this activity and are ranked 1. However in terms of another activity the disciplines which are ranked 1 might only be undertaking the activity occasionally. However their occasional use is still more frequent than other discipline which might be reporting rare use so their ranking (in terms of overall frequency of use for that activity) is still 1.

FINDINGS AND DISCUSSION

Are ICTs being used to different degrees in different disciplines?

We first needed to establish whether or not there was variation in the extent of use across disciplines. Figure 2 shows that disciplines are indeed using ICTs to different extents. In this figure we created an index for staff and students frequency of use of ICTs across all teaching and learning events. This index was then categorised into two groups - above and below average frequency of use. We then compared this across disciplines.

Figure 2: Comparison of academics and students' with an above average frequency of use of ICTs for teaching and learning according to discipline.

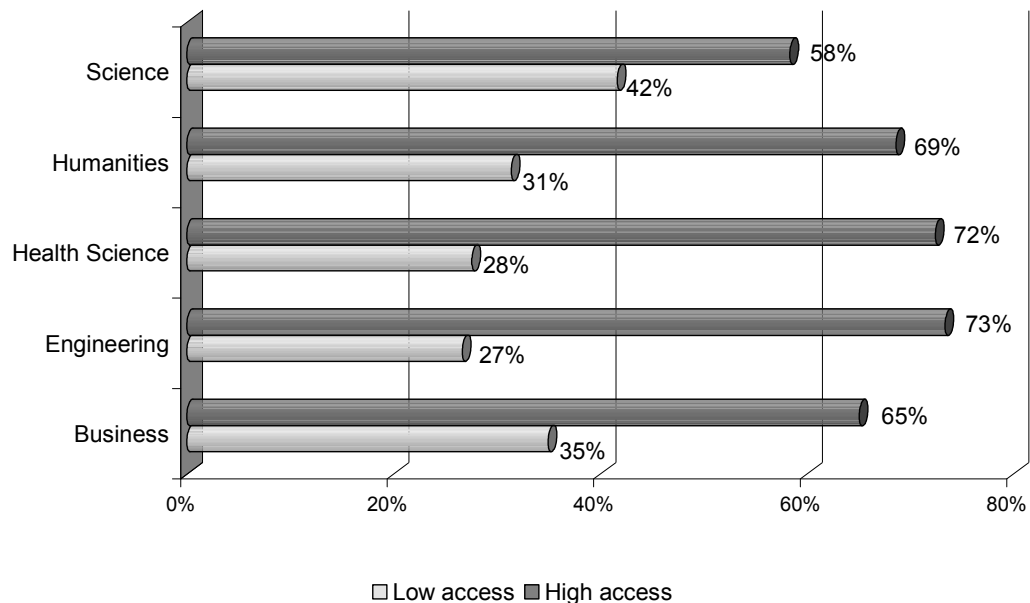


Overall according to both staff and students, Health Sciences has a much more frequent use of ICTs for teaching and learning across all media forms, using ICTs as part of the widest range of activities. This is interesting as over 60% of the respondents in this discipline grouping were drawn from one institution which has undertaken widespread curriculum transformation in this faculty. ICTs are explicitly regarded as an essential graduate competence for a health professional, and have been consciously incorporated into the new resource based curriculum (Oberprieler 2005). This is also in line with medical education internationally which has noted a substantial shift to use of ICTs (Ward, Gordon, Field and Lehmann 2001) and acknowledges that medical education is enhanced by use of computers (Greenhalgh 2001).

Aside from Health Sciences, staff in the hard disciplines of Science and Engineering use ICTs more frequently across the 5 media forms compared to staff in the soft disciplines of Business and Humanities who used ICTs less frequently. At the same time these disciplines do engage in some quite specific ICT based activities). Students from the applied disciplines of Business and Engineering also use ICTs more frequently across the 5 media forms compared to students from the pure disciplines of Science and Humanities who use ICTs less frequently.

Whilst we may postulate that difference in ICT use are a consequence of curriculum approaches we should also consider whether access to ICTs is homogenous across disciplines (Figure 3).

Figure 3: Comparison of students access to ICTs across disciplines



In Brown and Czerniewicz (2005) we describe some of the issues relating to access to ICTs in the region. Whilst this is not described in this paper it is worth noting that when examining an index of students' access to ICTs and then categorising that into two groups - above and below average access - we do note some disciplinary differences. Health science and engineering students are advantaged in terms of access (73% and 72% respectively have above average access to ICTs) whereas far fewer Science students have above average access to ICTs (58%).

How do the disciplinary groupings use ICTs differently?

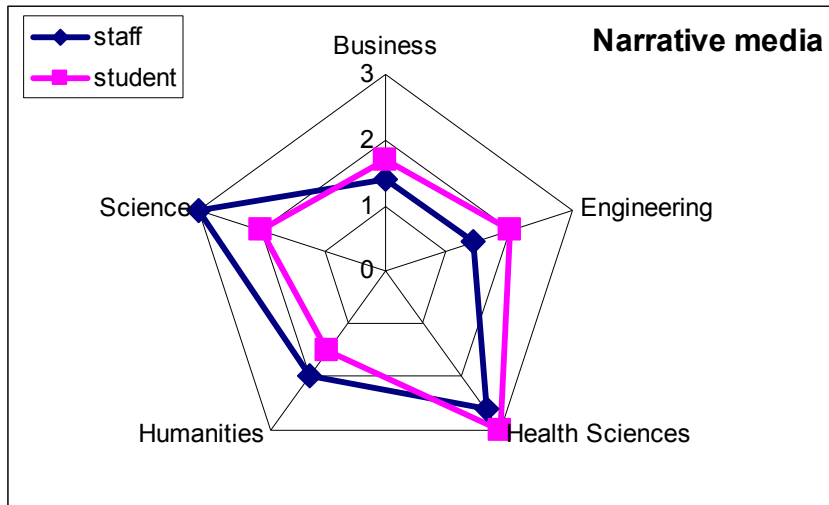
In examining how disciplines are using ICTs for teaching and learning, we draw on our conceptual framework of use and discuss how each discipline uses the five media forms of narrative, interactive, communicative, adaptive and productive to support the teaching and learning events of acquisition, discovery, dialogue, practice and creation.

Figure 4 below visually depicts the way disciplines are using narrative media forms. The closer the point to the centre of the web the less frequent the reported use and the further away the point is from the centre the more frequent the use. This representation enables us to examine: which disciplines have a high and low frequency of use of a particular media form compared to each other; and the differences between what students and staff in each discipline report in terms of frequency of use.

Narrative media

We made the assumption that it was predominately staff who used the associated narrative media forms to support the event of student acquisition of content. Narrative media forms are used to support the explaining, describing and showing of content. This was the one event and the one media form where we explored both ICT and non-ICT related activities and media forms. We also asked both staff and students' to report on academic staff use of narrative media forms.

Figure 4: Summary of staff and student indices of use of narrative media across disciplinary groups



Overall Health Science has the highest frequency of use of narrative media for the event of acquisition compared to other disciplines. Aside from the Health Sciences, students in the hard disciplines of Science and engineering report that staff in their disciplines have a higher frequency of use of narrative media forms than staff from the soft disciplines of Humanities and Business. Staff in the pure disciplines of the Sciences and Humanities report the highest frequency of use compared to staff from the applied disciplines of Engineering and Business.

This is interesting as both students and staff indicate high use of computer based narrative media occurring in the hard pure disciplines of Science which employs a higher frequency of lab and practical teaching modes (Smeby 1996). We wonder if this suggests that computer based narrative media is being used more frequently to explain and demonstrate concepts in lab and practical sessions than in lectures. It is also possible that the nature of knowledge in hard pure disciplines with its tendency towards linear cumulative knowledge that is relatively straightforward and uncontentious (Smeby 1996) makes it more appropriate to use narrative media more regularly.

When examining particular uses of narrative media we note that staff from Health Sciences do not use slides and images and text as frequently as staff in other discipline, favouring computer based presentational forms such as powerpoint, audio/video clips and multimedia. Staff from Business and Engineering disciplines report lower frequency of use of visual mediums such as audio/video, multimedia animations and images and slides compared to staff from other disciplines.

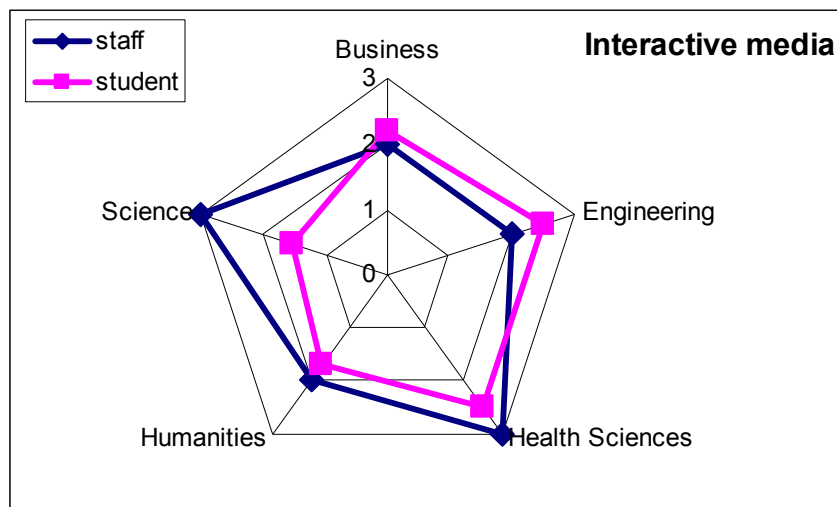
We were interested that staff from the sciences report the most frequent use of audio/visual and multimedia activities to explain and demonstrate key concepts and suggest this is because multimedia resources in the form of video clips and applets are increasingly being made available as part of textbook packages and on the internet (Freed 2004). We need to establish whether visual and multi-dimensional representation of concepts are particularly important in the Sciences. This is an area for closer investigation.

Interactive media

ICTs are most frequently used by staff and students to support the event of discovery (Czerniewicz and Brown 2005). The types of media forms which support this event are multimedia resources such as CD-ROM or DVD, and Web resources which include hypertext, enhanced hypermedia⁴, and information gateways.

Figure 5: Summary of staff and student indices of use of interactive media across disciplinary groups

⁴ Navigation and annotation, and through various media elements such as images and videos e.g. image maps.



When looking at the use of computers for the event of discovery, staff report a higher frequency of use of interactive media in the hard disciplines of Science and Health Science compared to the soft disciplines of Humanities and Business, whereas students note more frequent use of interactive media in the applied disciplines of Engineering, Health Sciences and Business compared to the pure disciplines of Science and Humanities.

These findings are contradictory to a US study which found that undergraduates in soft disciplines engaged in more information seeking behaviour than those in hard disciplines and undergraduates in pure disciplines engaged in more information seeking behaviour than those in applied disciplines (Whitmire 2002).

There is concurrence between staff and students from humanities and business disciplines in terms of their frequency of use compared to other disciplines. However, as with narrative media, students from science disciplines report less frequent use of interactive media compared to students from other disciplines whilst staff from engineering disciplines report less frequent use of interactive media compared to staff from other disciplines.

In examining specific uses of interactive media we see no disciplinary differences in terms of students' use of the internet. This is one of the activities that is most frequently used by all students across the region (Czerniewicz and Brown 2005). Unlike a recent UK-based study (Hammond and Bennett 2002) which found that a predominant use of ICTs in the humanities was individual study of resource materials, we found that resource materials were important across a wider range of disciplines.

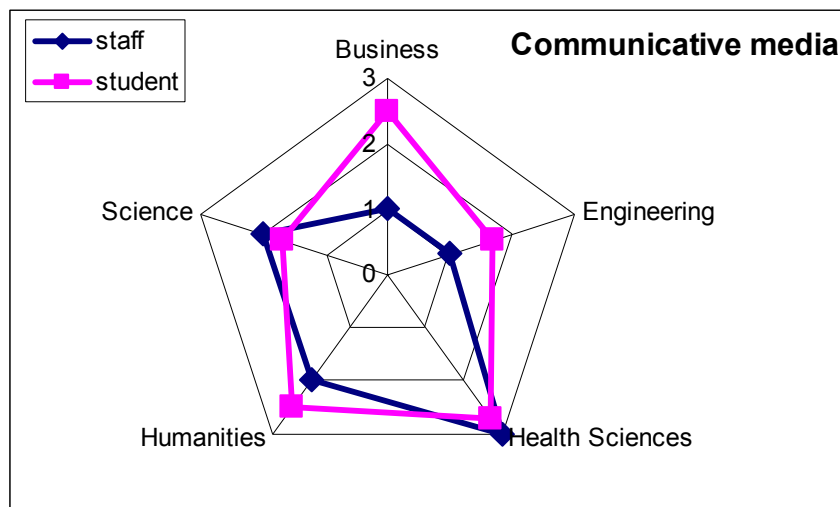
Science students report less frequent use of computers for electronic reading and lecture notes compared to students from other disciplines. This contradicts findings from the United Kingdom which demonstrate that clinical and science students make greater use of databases and electronic journals than humanities and arts students (Urquhart, Thomas, Armstrong, Fenton, Lonsdale, Spink and Yeoman 2003).

We also note that Science and Health Science academics report a high frequency of asking students to use a computer to look for examples of previous assignments, and imagine that this reflects common strategies for teaching and learning in those disciplinary areas. We are curious however about why these and not other discipline groups specifically adopt this strategy.

Communicative media

Using computers for dialogue has been argued to be one of the most significant offerings of the networked computer terrain (Baillie and Percoco 2001). Yet the use of ICT based communicative media forms is not widespread with only 55% of students being asked to use a computer for communicating as part of their courses and the frequency of use for specific activities being surprisingly low (Czerniewicz and Brown 2005).

Figure 6: Summary of staff and student indices of use of communicative media across disciplinary groups



Health Sciences is the most frequent in their use as reported by both staff and students. The pure disciplines of humanities is the next most frequent and the applied disciplines of business and engineering have the lowest frequency of use.

There is concurrence between staff and students from humanities and science disciplines in terms of their frequency of use compared to other disciplines. However staff from the business and engineering disciplines are reporting less frequent use of communicative media compared to staff from other disciplines.

Business, humanities and health sciences students have a more frequent use of computers for participating in email discussion and communication with lecturer by email compared to students from other disciplines. Engineering and science students report less frequent use of computers for participating in online discussion, compared to students from other disciplines.

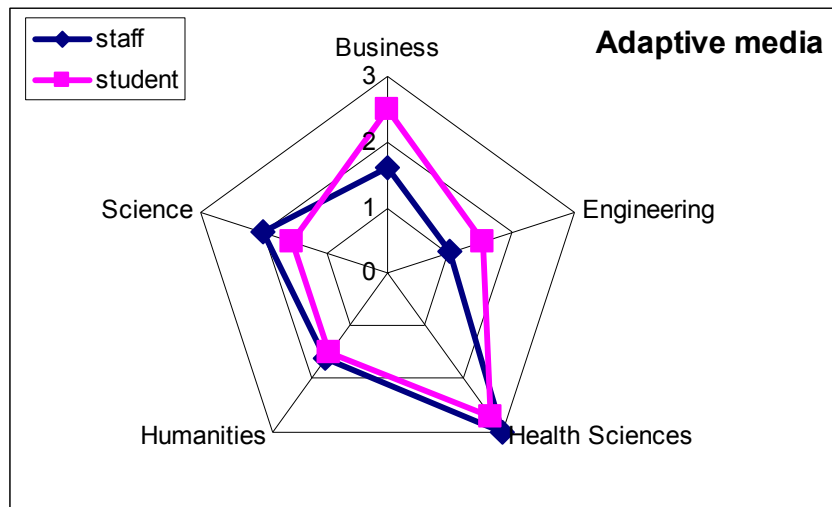
This is consistent with disciplinary differences in classroom teaching practices. Hard fields place greater emphasis on common paradigms and have more tightly structured courses with highly related concepts and principles whereas soft fields focus on development of critical perspectives and had open structures that were more loosely organised and development of students ability to communicate was important (Neumann 2001). We would therefore expect Humanities and Business disciplines to have a greater focus on use of ICTs for communication.

Whilst use of online discussion is not very frequent in the humanities, it is very low in sciences. This is also consistent with Hammond and Bennett's study that found online discussion to feature less frequently as an activity within the physical sciences (2002).

Adaptive media

Computers are often touted as being unique in offering opportunities for practice, self paced learning, feedback, drill and practice, and automated feedback (Cantoni et al 2004). Yet ICTs in our region are hardly being exploited for the event of practice, with only 51% of staff and 53% students reporting use of ICTs for this kind of event (Czerniewicz and Brown 2005).

Figure 7: Summary of staff and student indices of use of adaptive media across disciplinary groups



In the use of adaptive media students report frequent use in the applied discipline of Health Sciences, followed by Business as compared to Science, Engineering and Humanities disciplines. Staff from hard disciplines of Science and Health Science have a higher frequency of use compared to staff from soft disciplines of Humanities and Business. Staff from Engineering have the least frequent use of this type of media form.

There is no difference between disciplines in terms of use of drill and practice activities. Health science had the most frequent use for all activities, except for using a computer to undertake a game (which students reported doing most frequently in Business disciplines). In addition to the frequent use in Health Sciences, students from Business and Engineering also make frequent use of using a computer to undertake a simulation, role play or case study compared to other disciplines. Aside from health sciences, students and staff in Business had a high frequency of use of multiple choice quizzes (MCQ's) whereas students and staff in engineering had the lowest frequency of use for undertaking MCQ's.

These results are particularly interesting when one examines different approaches to assessment between disciplines. Hard disciplines require memorisation (mastery of techniques, factual understanding) and application of course material with a strong practical focus and soft disciplines are more likely to favour accumulation and shaping of knowledge and require analysis and synthesis of course content. Knowledge acquisition is emphasised more in pure than applied disciplines with multiple choice questions being favoured as a method of assessment in applied but not pure fields. (Neumann 2001).

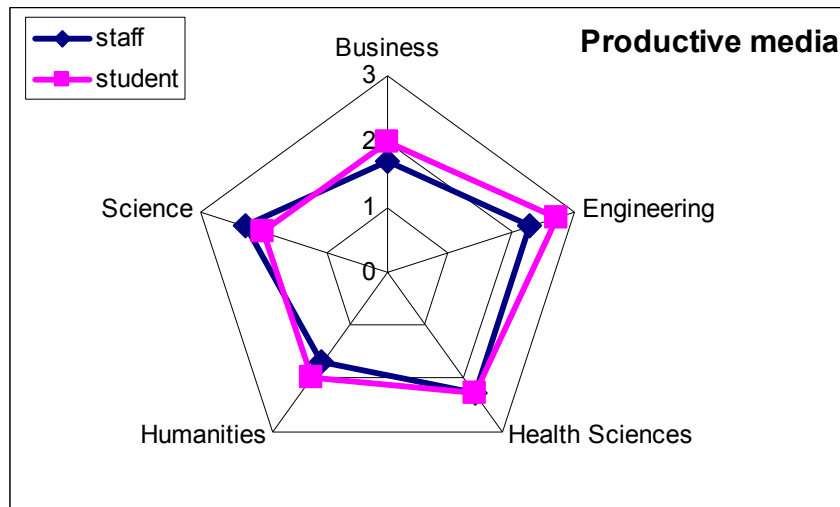
One would therefore expect these types of adaptive media activities to be more predominant in hard applied disciplines such as Health Sciences and infrequent in soft disciplines such as humanities. This is certainly the case in this study with health science and business using MCQ's frequently and humanities less frequently. However we would have expected a higher use of this type of activity in the Sciences as other studies have demonstrated frequent use of ICT's to support individual task based activities such as MCQ's in the physical sciences (Hammond and Bennett 2002).

On the other hand, the frequent use a computer to undertake a simulation, role play or case study in Engineering is consistent with another study that found that technical subjects in Engineering have high use of simulations, modelling and use of real software (Baillie and Percoco 2000).

Productive media

The use of ICTs for the teaching and learning event of creation was the second most frequent use overall. The possibilities that computers offer for user control and intervention enables users to make, create and change what exists. We found that 63% of students and 66% of staff report using computers as part of a productive activity (Czerniewicz and Brown 2005).

Figure 8: Summary of staff and student indices of use of productive media across disciplinary groups



For this event there was strong concurrence between staff and students in terms of their frequency of use compared to other disciplines. Hard disciplines of Science, Engineering and Health Science had a higher frequency of use of computers of productive media (both as reported by staff and students) than the soft disciplines of Humanities and Business.

Humanities has the more frequent use of using a computer to write assignments, health science and engineering for using a computer to create something and engineering for using a computer to build something using specialised software compared to other disciplines.

Whilst engineering academics rarely require the use of ICTs to support events such as communication or practice, it is unsurprising that they are the academics who most often ask students to use computers to build something, especially using specialized software.

Literature on differences in approaches to assessment in the hard and soft discipline points towards hard disciplines requiring memorisation and mastery of techniques which favour a strong practical focus (Neumann 2001) such as building and creating things.

DISCUSSION AND CONCLUSION

In conclusion, we reflect on whether the use of ICTs challenges or changes disciplinary approaches to teaching and learning.

Fry (2004, 2006) has made some interesting suggestions on disciplinary adoption of ICTs. She suggests that fields with tightly controlled research cultures such as the hard pure disciplines will develop a coherent field based strategy for the uptake and use of ICTs (Fry 2004). On the other hand, she argues that domains which are less hierarchical and intellectually pluralistic specifically the soft disciplines, are more likely to continue to rely on face to face communication and will appropriate ICTs in an ad-hoc localised manner (Fry 2006).

A coherent strategy would be evidenced by a strong alignment between staff and students reported use and a higher reported frequency of use as the majority of students and staff within the discipline would be using ICT in a particular way and therefore the median frequency use for the discipline would be high.

Certainly there is some evidence of this in our study. The Health Science discipline has a strong coherence between staff and students, and the highest frequency of use across all teaching and learning events. The soft disciplines of humanities and business use ICTs for very specific purposes and have a lower breadth and frequency of use compared to other disciplines. However if research culture were the primary reason for strategic ICT adoption one must consider why other hard disciplines such science and engineering do not demonstrate strong coherence and a high frequency of ICT adoption?

We suggest that the high level of ICT adoption for teaching and learning in the Health Sciences disciplines is likely to be linked more to the curriculum transformation in medical education than to the research culture. However it is not clear to us whether ICTs are the cause or consequence of medical education changes. Is curriculum change driving ICT use or ICT use driving curriculum change? This warrants further investigation. Whatever the cause we are seeing ICTs used for activities beyond the traditional disciplinary teaching practices, with for example the use of ICTs for communication is being more closely aligned with the practices of soft disciplines than hard ones.

For the most part however use of ICTs for teaching and learning appears to conform to existing disciplinary approaches. Our study does however, contradict international literature in two cases.

The first relates to our finding that the use of ICTs for activities which require repetitive memorisation and factual understanding such as MCQ's, drill and practise and automated feedback in the Sciences is low. This contradiction is found only within the Science discipline and not the other hard disciplines of engineering and health science. We are not sure why the science disciplines in our region are not making use of ICTs for this purpose. However we have noted previously that these types of activities are not undertaken very frequently across the curriculum generally. Reasons might include that they are time-consuming to develop, that access to appropriate infrastructure is limited, that lecturers are unfamiliar with the capabilities built into adaptive media forms, or that academics are unconvinced of the value of these possibilities for student learning.

The second example relates to the lack of differences in information seeking behaviour amongst disciplines. This contradicts other studies demonstrating that science students make greater use of electronic databases and journals and that undergraduates in the soft disciplines engage in more information seeking behaviour than those in hard disciplines. It is possible that this is one example of where ICTs are indeed changing traditional non-ICT approaches to teaching and learning amongst the disciplines.

We are also interested that the discrepancy between students and staff is particularly evident in the use of narrative and interactive media in the Science disciplines where staff report more frequent use. A disjuncture also exists in the use of communicative media in business and engineering disciplines where students report more frequent use.

We have previously reported that students are using communicative media forms in their courses even when not required to do so (Czerniewicz and Brown 2005) and this certainly seems to be the case in business and engineering disciplines. We are interested in exploring this further as it opens the door to questions about staff-student interactions, and has implications for institutional staff development strategies.

The low frequency of use by staff in the business disciplines contradicts findings from elsewhere (Williams, Coles, Wilson, Richardson & Tuson 2000) and we wonder why staff do not use communicative media as frequently as students do. The strong discrepancy in patterns of use between science staff and students also needs further exploration especially as access is a more significant issue for science students across the region in comparison with students from other disciplines.

Finally we note that, while extremely valuable, Laurillard's framework has limitations when exploring of disciplinary differences in the use of ICTs. Disciplinary differences are based more on the way knowledge is constructed than on the teaching strategy or learning experience. We found that the broad categories of the teaching and learning events masked some of the subtle difference in disciplinary approaches. For example, it was only when examining use of ICTs at the level of approaches to teaching and learning that we were able to understand certain differences. An example is the way that the event of practice incorporates activities that focus on memorisation (such multiple choice quizzes and drill and practice activities) as well as practical applications, such as role plays, case studies and simulations which involve problem solving. The event of discovery involves activities that require both open exploration of electronic journals and websites and closed scaffolded seeking of information about the course and the lectures. On the other hand, the event of creation is comprised of activities that require both mastery of techniques as well as imaginative development. These observations lead us to the conclusion that that future investigations of disciplinary differences will need to focus on the different ways ICTs are used for knowledge construction both within and between each teaching and learning event.

REFERENCES

Baillie, C., and Percoco, G 2000. A study of present use and usefulness of computer-based learning at a technical university. *European journal of Engineering Education*. 25 (1) 33-43

- Becher, T. 1994. The significance of disciplinary difference. *Studies in higher education*. 19(2). 151-162.
- Biglan, A. (1973a). Relationships between subject matter characteristics and the structure and output of university departments. *Journal of Applied Psychology*, 57(3), 204-13.
- Biglan, A. (1973b). The characteristics of subject matter in different academic areas. *Journal of Applied Psychology*, 57(3), 195-203.
- Cantoni, V., Cellario, M., & Porta, M. 2004. Perspectives and challenges in e-learning: towards natural interaction paradigms. *Journal of visual languages and computing*. 15, 333-345.
- Czerniewicz, L., and Brown, C. (2005) The uses of Information and Communication Technology (ICT) in teaching and learning in South African higher education practices in the Western Cape. *Perspectives in Education* 23 (4) 1-18
- Freed, G. (2004). Accessible multimedia in e-books. Technology And Persons With Disabilities Conference. California State University Northridge., available at <http://www.csun.edu/cod/conf/2004/proceedings/csun04.htm> Accessed on 20 October 2005
- Fry, J. 2004. The cultural shaping of ICTs within academic fields: Corpus based linguistics as a case study. *Literary and linguistic computing*. 19 (3) 303-320
- Fry, J. 2006. Scholarly research and information practices: a domain analytical approach. *Information Processing and Management*. 42 (1) 299-316
- Greenhalgh, T. 2001. Computer assisted learning in undergraduate medical education. *British Medical Journal* 322. 40-4
- Hammond and Bennett (2002). Discipline differences in role and use of ICT to support group-based learning. *Journal of Computer Assisted Learning*. 18(1) 55-
- Laurillard, D. (2002). *Rethinking university teaching : A conversational framework for the effective use of learning technologies*. 2nd Edition. London: Routledge/Falmer.
- Neumann, R. (2001). Disciplinary Differences in University Teaching. *Studies in Higher Education*. 26 (2) 135-146.
- Neumann, R., and Becher, T. 2002. Teaching and learning in their disciplinary context: a conceptual analysis. *Studies in Higher Education* 27(4) 405-417.
- Oberprieler, G. (2005). Multi-language learning tools - how can IT help? Presented at HERDSA conference "Higher Education a Changing World". 2-6 July, Sydney.
- Sayed, Y. (1998). *The segregated information highway: Information literacy in higher education*. University of Cape Town Press. Cape Town
- Sewell, W.H. (1992). "A theory of structure: Duality, agency and transformation", *American Journal of Sociology*, vol. 98, no. 1, pp. 1-29
- Smeby, J. 1996. Disciplinary difference in University teaching. *Studies in Higher Education* 21(1) 69-79.
- Urquhart, C., Thomas, R., Armstrong, C., Fenton, R., Lonsdale, R., Spink S., and Yeoman A. 2003. Uptake and use of electronic information services: trends in UK higher education from JUSTEIS project. *Electronic library and information systems* 37(3) 168-180.
- Ward, J., Gordon, J., Field, M., and Lehmann, H. 2001. Communication and Information technology in medical education. *Medical education quartet*. 357 792-796
- Whitmire, E. 2002. Disciplinary difference and undergraduates information seeking behavior. *Journal of the American society for information science and technology*. 58(8) 631-638.
- Williams, Coles, Wilson, Richardson and Tuson (2000). Teachers and ICT: current use and future needs. *British Journal of Educational Technology*, 31 (4) 307-320.