Students’ Performance and Perception Linked to the Use of Group and Audience Response Systems (GARS) in Large Classes

Linh Nguyen, Bardo Fraunholz, Scott Salzman and Ross Smith
Deakin University, 221 Burwood Hwy, Burwood, Vic
[tlng/bardo/scotts/smithr]@deakin.edu.au

Abstract

This paper reports an investigation into the impact of Group and Audience Response Systems (GARS) on students’ learning outcomes, and perceptions of learning in large classes. Performance is compared between students who used the technology, and students who did not, based on progressive assignment and exam results. Perception is assessed based on an online survey questionnaire. The key findings of this study indicate that students who used the technology achieved, on average, 6.70% higher grades compared to those who did not. Further, use of the technology improved the overall achievement of students, on average, regardless of their perception of whether or not it would provide an academic advantage. Key findings and future use of the technology are discussed.

1. Introduction

Large classes are becoming increasingly the norm for almost all universities worldwide. This is due primarily to the increasing number of enrolled students, most probably motivated by the earning advantage a degree provides. Nevertheless, teaching large classes continues to remain a problem due to: difficulty in maintaining students’ attention; inflexibility of the lecturer; difficulty in stimulating students’ interest; and difficulty in managing valid assessment criteria [9][13].

Many possible strategies for achieving effective teaching and learning in large classes have been developed, including the use of video, OHP, PowerPoint and websites. Despite the apparently large number of options available to assist educators and enhance learning experiences in large classes, there is arguably still few learning technologies that support face-to-face lectures. Group and Audience Response Systems (GARS) is one such technology that allows students to actively and anonymously interact in lectures, by using a small individual keypad to respond to multiple choice questions created in PowerPoint. This is similar to the technology used in the television game show, “Who wants to be a millionaire?”, when the host asks “let’s ask the audience”. The technology is variously referred to as a Personal Response System, Electronic Voting System, Electronic Classroom Communication System, Clickers and Audience Response System. The system consists of two main components: hardware (wireless keypads for students to respond to the questions and a receiver to receive students’ responses) and software (software that calculates real-time assessments of the responses). Students are given a specific time to respond to questions, and results can be immediately displayed on screen. Results can be recorded for later review [20].

Many claims have been made about the potential benefits of such technology in assisting learning in face-to-face large classes, yet limited empirical evidence is available in the literature. This study aims to investigate the possible effect of GARS on students’ performance and perception in large (250 plus students) face to face classes. This paper is divided into four parts: background and motivation; research method; research findings; discussion and future directions.

2. Background and Motivation

Many universities are seeing growth in class sizes which pose major challenges to academics in terms of the quality of students' learning, particularly in face-to-face large classes. GARS has been widely reported as a means of assisting students' learning experiences, which to some extent helps address some of these challenges [4][7][11][19]. However, until recently GARS technology required visual contact and could therefore only be applied in medium size classes.

This section summarises literature related to the challenges in teaching large classes, and provides a summary of previous work in the use of GARS assisted learning.

2.1. Large classes and academics' challenges

A University of Queensland Survey in 2001, (a report on teaching and learning in large classes in Australia)[18], found that the major issues facing academics are: how to stimulate active learning and higher order thinking, maintain the interest of students, diversify teaching strategies and adjust the pace and content of teaching to suit students' comprehensibility. These challenges have also been reported by Mathews [1] and Gilbert [17]. The final report on the Teaching Large Classes Project 2001 in Australia, with the participation of 24 universities nationwide, argues that the issues in large classes are the same as in other class sizes. Principles of good teaching and learning, however, are harder to apply in large classes [18]. It is more difficult to personalise lectures, maintain the interest and attention of students, enhance interactivity between students and lecturers, and students and students. In the Bloom study [2] on the thought processes of students, it was found that only 1% of students' time was used for information processing, in comparison to 60% of their time being occupied with irrelevant or passive thoughts.

Gilbert [17] reviewed the literature for links between class sizes, and the quality of education, and reported that there seemed to be less and less evidence to suggest such a link existed, indicating that class size is less important than the way a course is presented. Aspects that affect a students' outcome include: active learning, thinking and reasoning, and meaningful participation and involvement [12] [17].

2.2. Previous work on the use of GARS

GARS has recently come to the attention of academics, due to its reported benefits in enhancing teaching and learning experiences in large classes. Universities in the United Kingdom and the United States have implemented the system in their large courses [10] [15] and in Australia, the system has recently been widely adopted [5] [14] [8] [6] [11]. Even though the technology itself is not novel, the application in education and especially in classes of more than 200 students is new; therefore, research to evaluate its effectiveness is extremely important.

Work on GARS use can be catergorised into three major directions: suggestions on possible pedagogical uses of GARS; evaluation of students and teachers' perception of the use of GARS; and assessment for learning outcomes associated with the technology.

- Suggestions on possible pedagogical uses of GARS

There are many papers reporting trials and pedagogical initiatives on how to use GARS. Possible uses that have been reported include:

- Concept Questions: students are required to respond to multiple choice questions around a core concept [4][7][16]
- Assessments: the technology is used for assessment in tutorial and middle-semester tests [14]

- Just-in-Time teaching: instructors adjust their teaching based on students' feedback, focusing on students' misunderstanding and difficulties; teachers ask checkpoint questions in challenging topics [14][16][19]
- Attendance checking: attendance of students is automatically checked [14]

- Evaluation of students' and teachers' perceptions of the use of GARS

Most of the evaluation of the use of GARS focuses on the perceptions of students and teachers on their learning and teaching experiences, through interviews and questionnaires [6]. Benefits of the technology are described as:

- Increasing student engagement in lectures, with students being more willing to take part in lectures due to the anonymity of the keypad [8]
- Increasing the interactivity between students and teachers [11]
- Lectures being more interesting [14] [4] [19]
- Increasing students' concentration [4][19]
- Assisting with deeper learning and critical thought [8][14]

- Assessment for learning outcomes associated with the use of GARS

Although much research has been carried out to evaluate the impact of GARS on students' learning habits in large classes, there is very little empirical research to assess the impact of the technology on students' learning outcomes, with the exception of the recent study by Kennedy & Cutts [6]. Kennedy & Cutts conducted a one semester study with the use of an Electronic Voting System (EVS), in a first-year computer science course in Glasgow. There were 241 participants. Performance was measured with an end-of-semester test and a final exam. The findings from this study suggest that "there is a positive association between EVS usage and learning outcomes for students who are, relative to their class, of higher ability". That research has evaluated the effect of the technology on student outcomes, however, can not draw any conclusions on other possible predictors such as motivation, regular attendance or academic ability.

In summary, the preceding literature review has shown that at least some of the challenges faced by those teaching large classes are not insurmountable. Engaging students in class, maintaining their interest and attention, and enhancing their problem solving skills can be improved with appropriate technology. GARS appears to provide, in part at least, this support. There is, however, minimal empirical evidence to support its beneficial impact on students' learning outcomes in particular in classes of greater than 250 students, and the lack of such evidence can only inhibit its large scale acceptance by educators. The present study was motivated by a wish to provide a deeper understanding of the benefits of such technology.

3. Research Method

GARS was implemented during a first semester subject, which is a core unit for first year students in a large Commerce degree. GARS keypads were made available with the recommended textbook for the unit, and students were able to register (on-line) to use them as a matter of choice. A cohort of 267 students out of the 1386 enrolled students was identified as regular keypad users.

The unit was taught over a 12 week period (March to June 2006), of which the first few lectures were used to introduce students to the technology, and the last was used for a mock exam. GARS was used over 10 weeks, during and at the end of each lecture, in the form of multiple choice questions, and a mock exam was conducted at the end of the course. The aim of using GARS during the lectures was to evaluate students' understanding of the lecture content as well as trying to refocus student attention. Each week, students were asked to respond up to five multiple choice questions. Students were given 60 seconds to respond to each question. The results were summarised and reported to students immediately for student reflection.

In order to determine whether the use of GARS had any effect on student performance and perception in large classes, the following hypotheses were developed in accordance with the overall aims of this research.

The first null hypothesis: There is no difference in the performance of students who used the technology and those who did not.

The second null hypothesis: There is no difference in the performance of students who thought the technology would help them achieve better, and those who did not.

Quantitative research methods were employed to test these hypotheses. Where the assumptions for parametric methodologies were not met, alternative, non-parametric techniques were used.

Performance of students who used the technology and those who did not were compared using the assessment results. A survey was used to collect the students' perspectives on the use of the technology, and these perspectives were then correlated with their performance.

During the course, four measurements of student performance were collected and used in this research. Assignment 1 (10%) required students to answer weekly review questions over 10 weeks; assignment 2 (20%) asked for the development of a spreadsheet; the exam (40%) consisted of multiple choice questions covering all aspects of the unit; and the overall results. Assignment 3 was not used, as it was a group based assignment.

An online survey was administered over the two-week period prior to the exam. This was used to determine a metric of student perception. Students were required to fill in a consent form prior to taking part in the survey. Anonymous identifiers were used to match perception and performance. The survey consisted of 17 Likert-scaled questions about students' demographic information, and their perspectives on the difficulties encountered in large classes, their motivation to use the technology, their experience in using the technology, and their suggestions for future improvements. Students were asked to respond to each question by selecting from a scale where 1 represented strongly disagree, through to 5, strongly agree. Students were also able to provide other comments at the end of each question. A total of 145 valid responses were received.

4. Research Findings

4.1. Performance results

H_0: There is no difference in performance between students who used the technology and those who did not.

The assessment scores of assignment 1, assignment 2, and the final exam, for those students who regularly used the technology (n = 267), and those who did not regularly use (n = 1119), were collated and compared.

- *In Assignment 1:*

Assumptions of parametric statistical methodologies were not met; therefore, the Kruscal-Wallis median test was used (H 61.5, p-value < 0.00000). The null hypothesis is rejected in favour of the alternative hypothesis and the conclusion is drawn that a statistically significant difference exists. It is possible that using this technology might provide students, on average, with a statistically significant advantage:

Point estimate of this difference: $Median_{users} - Median_{non\text{-}users}$ = 4/60 grade units (GU) (6.66%)

- *In Assignment 2:*

An independent sample t-test was used to compare the score between the two student cohorts, (df 671, t 7.974, p-value < 0.00000). The null hypothesis is rejected in favour of the alternative hypothesis and the conclusion is drawn that a statistically significant difference exists. It is possible that using this technology might provide students, on average, with a statistically significant advantage:

Point estimate of this difference: $M_{users} - M_{non\text{-}users}$ = 1.57/20 GU (7.85%)
95%CI for this difference: Lower limit 1.19 GU (5.95%) - Upper limit 1.96 GU (8.45%)

- *In the Exam:*

An independent sample t-test was used, (df 437, t 5.287, p-value < 0.00000). The null hypothesis is rejected in favour of the alternative hypothesis and the conclusion is drawn that a statistically significant difference exists. It is possible that using this technology might provide students, on average, with a statistically significant advantage:

Point estimate of this difference: $M_{users} - M_{non\text{-}users}$ = 1.82/40 exam units (EU) (4.55%)
95%CI for this difference: Lower limit 1.15 EU (2.87%) - Upper limit 2.50 EU (6.25%)

- *Overall:*

An independent sample t-test was used (df 637, t 9.145, p-value < 0.00000). The null hypothesis is rejected in favour of the alternative hypothesis; and the conclusion is drawn that a statistically significant difference exists. It is possible that using this technology might provide students, on average, with a possible advantage of:

Point estimate of this difference: $M_{users} - M_{non\text{-}users}$ = 6.70%
95%CI for this difference: Lower limit 5.25% - Upper limit 8.14%

4.2. Perception of students

The results are grouped and summarized under four main headings: the students' perspective on the difficulties in learning in a large class setting (Table 1), their experience in using the technology over the course of the unit (Table 2), their perception on the advantages and disadvantages of the technology (Table 3), and their suggestions for future use and improvements (Table 4). The responses 'Strongly agree' and 'Agree' have been combined and summarized as those who at least 'Agree', and similarly, the responses of 'Strongly disagree' and 'Disagree' are combined and summarized as those who at least, 'Disagree'.

Table 1. Difficulties in large classes

Answers	Sample size (n)	Agree (%)	Neutral (%)	Disagree (%)
I found it hard to interact with lecturers and other students	139	49.64	30.94	19.42
I found it hard to maintain interest during the lecture	138	53.62	25.36	21.01

I found it hard to maintain attention during the lecture	139	54.68	28.06	17.27
I have low commitment to go to a large class	138	28.99	26.81	44.20
I have low motivation to participate in a large class	136	36.76	28.68	34.56
The anonymity discouraged me from attending a large class	142	19.32	36.36	44.32
The anonymity discouraged me from participating in class discussion	76	32.89	56.58	10.53

Table 2. Experience in using the technology

Answers	Sample size (n)	Agree (%)	Neutral (%)	Disagree (%)
GARS increased my attendance in class	136	30.88	30.88	38.24
GARS increased my interest in studying this unit	135	39.26	33.33	27.41
GARS helped to improve my performance	145	52.41	30.34	17.24
GARS helped me to have deeper understanding of the presented material	145	55.86	25.52	18.62
GARS increased my critical thinking when answering the prompted questions	145	61.38	25.52	13.10

Table 3. Perceptions on the advantages and disadvantages of the technology

Advantages	Sample size (n)	Agree (%)	Neutral (%)	Disagree (%)
GARS improves my interactivity in lecture	145	78.62	16.55	4.83
GARS provides me real-time feedback to evaluate my understanding	145	79.31	17.93	2.76
GARS provides me feedback to identify areas for further improvement	145	82.07	13.79	4.14
GARS helps lecturers to personalize the lectures to suit my comprehension capability	145	46.90	33.10	20.00
The anonymity encourages me to answer the questions given	145	80.69	15.17	4.14
Disadvantages				
The only form of multiple-choice questions bores me	145	18.62	24.14	57.24
The anonymity decreases my motivation to answer the questions	145	14.48	17.24	68.28
It is easy to forget to bring the keypad to class	145	55.17	23.45	21.38

Table 4. Suggestions for future use and improvements

Answers	Sample size (n)	Agree (%)	Neutral (%)	Disagree (%)
I would like GARS to be used in examinations	145	34.48	18.62	46.90

GARS will save me time to sit an exam	145	39.31	20.69	40.00
GARS is convenient for me to answer the exam questions	145	38.62	26.90	34.48
GARS provides instant exam results to me	145	66.90	16.55	16.55
I would like GARS to be applied in other units in the future	145	70.34	19.31	10.34
I would like GARS to be used at various times during the lecture	145	81.38	17.24	1.38
I would like GARS to be used at the end of each chapter for consolidation	145	82.07	16.55	1.38
I would like GARS to be used in periodical tests	145	60.00	22.76	17.24
Overall, I like the use of GARS in studying	145	71.72	22.76	5.52
I would like the keypad to have a small display screen for summary of sessions results	145	83.45	8.97	7.59
I would like the keypad to have an alarm reminder so that I do not forget it	145	47.59	24.83	27.59
I would like the keypad to be like a portable key ring	145	60.00	21.38	18.62
I would like the keypad to be able to connect to computers for personal records	145	86.90	9.66	3.45

4.3. Matching between students' perception and performance

H_0: There is no difference in the performance of students who thought the technology would improve their performance and those who did not.

Answers	Sample size (n)	Agree (%)	Neutral (%)	Disagree (%)
GARS helped to improve my performance	145	52.41	30.34	17.24

Students identified as those who believed the technology would help them improve their performance were compared with those who did not. An independent sample t-test was used (df 38, t -.355, p-value 0.725). There is insufficient evidence to reject the null hypothesis and the conclusion is drawn that no statistically significant difference is evident. That is, there is no difference in the overall achievements of those students who thought that this technology would, or would not help them.

In order to check the validity of the responses, a relationship between an expressed disadvantage and an advantage was examined to see if the gradient of the fitted regression line was negative. Specifically, responses on "anonymity decreasing motivation" were examined as a function of "anonymity encouraging students to respond to questions". The hypothesis tested: H0: Slope = 0 (p-value < 0.000). The null hypothesis is rejected in favour of the alternative and the conclusion is drawn that the responses are indeed negatively correlated, therefore, it could be concluded that the responses are providing valid information.

5. Discussion and Future Directions

The findings show that students who regularly used GARS in lectures achieved significantly higher results (6.70%) overall compared to those who did not. Those using the keypad performed better in the individual scores of two assignments and also in the final exam.

Even though non-random assignment (self-selection) of students using and not using keypads took place, and might indeed contribute to the conclusions overall, it is evident that there is a statistically significant difference in the scores of the two student cohorts. The reasons for their statistically significantly higher achievements might be due to their academic ability, regular attendance in class, motivation to study, or perhaps a better understanding of the lecture content. Further research is required to determine which factors are individual characteristics and which are influenced by the use of the technology; however, it is possible that the technology, to some extent, had an effect on motivation, interest, or the level of understanding of students. This raises an interesting question, does the technology facilitates a pedagogical change? It is evident that the presence of technology in isolation does not facilitate change. However there is an indication that the application of technology facilitates a transition from passive learning to active learning, which helps students achieve higher grades.

Students' perceptions of the use of GARS are in accord with the literature regarding challenges to academics [18]. The dominant difficulties that students have to cope with in large classes are maintaining attention, maintaining interest, and interactivity with lecturers and other students.

There is no evidence that the size of a class affects students' commitment to attend lectures, and the implementation of the technology does not significantly impact attendance.

Whilst previous research shows that students greatly enjoy lectures utilising this technology, with some evidence of "deeper learning" and "critical thinking" [6], the present study reveals that a higher percentage of students find the technology assists them build a deeper understanding (55.86%) and critical thinking (61.38%) rather than increase their interest in learning (39.26%). This result might be due to differences in the way questions were asked during lectures. Some types of questions, for example problem solving, require a greater level of thought. Therefore, when students were asked about their experiences in using the keypad, the choice concerning "understanding and thinking" and concerning "interest" differs. It also indicates that, possibly, interest in study is not linked to the active learning method. Some 27.41% of students did not think that the technology increased their interest in study, while only 13.10% did not agree that GARS increased critical thinking and only 18.62% for deeper understanding.

Another interesting issue is that there does not appear to be a correlation between student perceptions on their performance increase and their actual performance increase. Some 52.41% of the students believed that this technology helps them improve their performance and 17.24% did not. When the performance of those two groups was compared, there was no difference in overall achievement. GARS users performed better regardless of perception.

Students' perspectives of GARS advantages are in accord with the literature. GARS was found to increase students attention span, increase interactivity during lectures, encourage students to participate in lectures and reduce resistance to participation due to anonymity. GARS also provides real-time feedback to evaluate students' understanding, and areas for further improvement are identified for students.

In our study, students did not see the technology strongly as a tool for lecturers to personalise lectures (46.90% agreement in comparison to 20% disagreement). This indicates an area where lectures might be improved.

Other findings indicate that, overall, students support the future use of GARS in face-to-face lectures and in other units. They were very interested in being provided summary results at the end of each lecture session.

An interesting observation is that despite students' being in favour of using GARS in lectures, they did not show interest in using the technology in exam situations. They did not see it as time-saving or convenient. Some 34% of students were not sure, or did not think that GARS would provide instant exam results to them. This is interesting as instant feedback is one of the most visible features of GARS available from the first time students participate in a class that utilises the technology. This finding differs to the conclusion reported in the literature. One of the challenges in large classes lies in the assessment of students [18]. Lecturers and tutors see the tasks of assessing hundreds of students as very time-consuming and exhausting. How to assess students in an objective and standardised way is another problem beyond the scope of this research. The possible use of GARS as an assessment tool seems promising in addressing both problems [14]. This study, however, did not reveal strong student approval for such a solution. Reasons may vary from psychological fears to the design features of GARS. Students may struggle with the virtual nature of the system. Prior training in high-school has been paper focused and therefore having to answer questions in a virtual environment might make students feel uncomfortable. Students might find it hard to concentrate when reading questions off a screen, and having to enter answers via a keypad. There is also an issue of trust as students might fear that the keypad does not register answers correctly. One other important design feature of GARS is that students can not go back to previous questions. Once the answer is logged, it is fixed. With traditional paper-based exams, they can skip the difficult questions to do the easier questions first. Students can go back and change answers if they wish to do so. This can not be done with GARS-based tests.

The above results reveal different possible directions for future research. One of the major challenges in research to investigate the association between GARS and students' performance is to rule out other possible variables when assessing the impact of the technology on student's outcomes. Specifically, it would be interesting to see how motivation, attendance, and academic ability play a role in students' use of GARS.

Our study has revealed some exciting findings. As an early adopter of this new technology with a truly large class, we have a clear indication that students using GARS achieved significantly higher marks as compared to non-users. Our research has also shown that student perception of this technology is very positive, with students stating that GARS helped their learning process, and that students would like to see GARS adopted more widely. These findings raise some interesting questions about factors that influence student learning, and about how and why GARS has this positive effect.

6. References

[1] A. Mathews, "Teaching and learning of science in a large class situation". In Black, B. and Stanley, N. (Eds), Teaching and Learning in Changing Times, 194-198. Proceedings of the 7th Annual Teaching Learning Forum, The University of Western Australia, February 1998. Perth: UWA. http://lsn.curtin.edu.au/tlf/tlf1998/mathews-b.html accessed on 06/09/06

[2] B.S. Bloom, "Thought processes in lectures and discussions", Journal of General Education, 7, 1953, pp 160-169.

[3] C.A. Stanley and M.E. Porter, "Engaging students in large classes: challenging some of the learning myths", B-Hert News Issue 18. 2003, p18-19.

[4] C. Elliott, "Using a Personal Response System in Economics Teaching", International Review of Economics Education, vol. 1, issue 1, 2003, pp. 80-86

[5] D.A. Banks, "Using keypad-based group process support systems to facilitate student reflection", in G.Crisp, D. Thiele, I. Scholten, S. Barker and J.Baron (Eds), Interact, Integrate, Impact: Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education. Adelaide, 7-10 December 2003

[6] G.E. Kennedy and Q.I. Cutts, "The association between students' use of an electronic voting system and their learning outcomes", Journal of Computer Assisted learning vol.21 2005, pp.260-68.

[7] H.A. Woods and C. Chiu, "Wireless Response Technology in College Classrooms", The Technology Source, 2003 http://ts.mivu.org/default.asp?show=article&id=1034 accessed on 06/09/06

[8] J.B. Williams, "Learning by remote control: exploring the use of an audience response system as a vehicle for content delivery". In G.Crisp, D. Thiele, I. Scholten, S. Barker and J.Baron (Eds), Interact, Integrate, Impact: Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education. Adelaide, 7-10 December 2003

[9] J. Foreman, "Next – Generation: Educational Technology versus the Lecture", George Mason University, Educause Review, 2003

[10] J. West, “Learning Outcomes Related to the Use of Personal Response Systems in Large Science Courses”, 2005 http://www.academiccommons.org/commons/review/west-polling-technology accessed on 06/09/06

[11] M.D. Sharma, J. Khachan, B. Chan, and J. O’Byrne, “An investigation of the effectiveness of electronic classroom communication systems in large lecture classes” Australasian Journal of Educational Technology, 21 (2), 2005, pp.137-154. http://www.ascilite.org.au/ajet/ajet21/sharma.html accessed on 06/09/06

[12] M. Silberman, “Active Learning”, A Simon & Schuster Company. Needham Heights, Massachusetts. USA, 1996

[13] M. Thoennessen, E. Kashy, Y. Tsai, N.E. Davis, “Application of Technology and Asynchronous Learning Networks in Large Lecture Classes”, Michigan State University (Proceedings of the 31st Hawaii International Conference on System Sciences, Computer Society Press, IEEE, 1997)

[14] Q. Su, “Teaching innovation using a computerised audience response system”, 2002 www.itee.uq.edu.au/~aupec/aupec02/Final-Papers/Q-**SU**1.pdf accessed on 06/09/06

[15] S. Draper, “UK Handset Users and Sites”, 2006 http://www.psy.gla.ac.uk/~steve/ilig/people.html accessed on 06/09/06

[16] S. Gautsch et al, “Networked Interactions for Class Engagement (NICE) with PRS” University of Southern California, 2005 http://www.educause.edu/ir/library/pdf/NLI0522.pdf accessed on 06/09/06

[17] S. Gilbert, “Quality Education: Does Class Size Matter?”, Research File, Vol.1, Number 1, April 1995.

[18] Teaching Large Classes Project 2001, Final Report, Australian Universities Teaching Committee (AUTC), 2003. http://www.tedi.uq.edu.au/largeclasses/pdfs/AUTC_final_report.pdf accessed on 06/09/06

[19] W. Beekes, “The ‘Millionaire’ method for encouraging participation”, Active learning in higher education. SAGE Publications, London, 2006.

[20] http://www.keepad.com/higher-education.htm accessed on 06/09/06