CASE STUDY 3

Using visual enhancement to improve student performance in a first-year computing class:

Institutional Report on the Teaching and Learning Enhancement Initiative at Lincoln University[1]

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1 This is a a Teaching and Learning Research Initiative project: Unlocking Student Learning: The Impact of Teaching and Learning Enhancement Initiatives on First-year University Students

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Introduction

In keeping with other case studies in the Teaching and Learning Research Initiative (TLRI), Lincoln University selected a first-year paper, in this case one with a tail of under-performing students. The selection was made by asking staff to volunteer a paper for the project. Of those volunteered, COMP102 best fitted the criteria. The lecturer for the paper, Dr Clare Churcher, is an experienced teacher who had recently taken over the course and was keen to make improvements in the delivery and learning opportunities for students. The academic developer role was filled by Dr Peter Gossman (Teaching and Learning Services). The collaboration between Dr Gossman and Dr Churcher was productive, but when Dr Gossman moved to a position elsewhere the project was affected by staff changes and institutional constraints. It is, therefore, the results of the early interventions that are reported here.

Identifying the challenge

Comparing COMP102 with another first-year paper, COMP101, and students' performance in other first-year papers showed that students on average performed poorly in COMP102. For all six previous semesters COMP101's average results were higher than the results for all the other students' papers; the reverse was true for COMP102 (see Table 1).

Table 1: Comparative results between Lincoln 100-level COMP papers

All COMP101	S1 2003	S2 2003	S1 2004	S2 2004	S1 2005	S2 2005
Average	59.85	57.67	58.55	55.75	62.05	62.05
Count	331.00	257.00	378.00	332.00	289.00	289.00
Sum	19810.00	14820.00	22132.00	18509.00	17932.00	17932.00
All Others	S1 2003	S2 2003	S1 2004	S2 2004	S1 2005	S2 2005
Average	55.15	55.36	55.94	53.39	54.83	53.52
Count	983.00	734.00	1078.00	964.00	826.00	509.00
Sum	54213.00	40634.00	60304.00	51466.00	45291.00	27242.00
All COMP102	S1 2003	S2 2003	S1 2004	S2 2004	S1 2005	S2 2005
Average	50.10		49.30		51.14	
Count	99.00		91.00		77.00	
Sum	4960.00		4486.00		3938.00	
All Others	S1 2003	S2 2003	S1 2004	S2 2004	S1 2005	S2 2005
Average	55.62		55.65		54.56	
Count	314.00		304.00		239.00	
Sum	17464.00		16918.00		13041.00	

The possible reasons for these results were discussed with the lecturer, and the following hypothesis was developed:

> Given that COMP101, as a 100-level entry paper for students, deals with the basics of application use, while COMP102 covers the basics of code and programming, students 'over perform' in 101 because they have already some familiarity with the functionality of the applications, while 102 contains more unknown and unfamiliar information.

This hypothesis was supported by the fact (see Figure 1) that the patterns of results from COMP101 (approximately 300 students) and COMP102 (approximately 100 students) tracked each other quite closely,

albeit 10 percent apart. However, the results for the in-common group of students (approximately 40) showed an interesting anomaly. The average performance of these students on COMP101 was above that of the whole paper average, but for COMP102 was below the whole paper average.

An explanation postulated for the difference in the average percentages between the papers was that many of the 102-only cohort were students who had either previously taken 101 (and therefore had a better foundation to work on) or were high-performing graduate diploma students who did not require 101. The challenge was therefore to identify and adopt changes in teaching methods that might improve the results of COMP102 students.
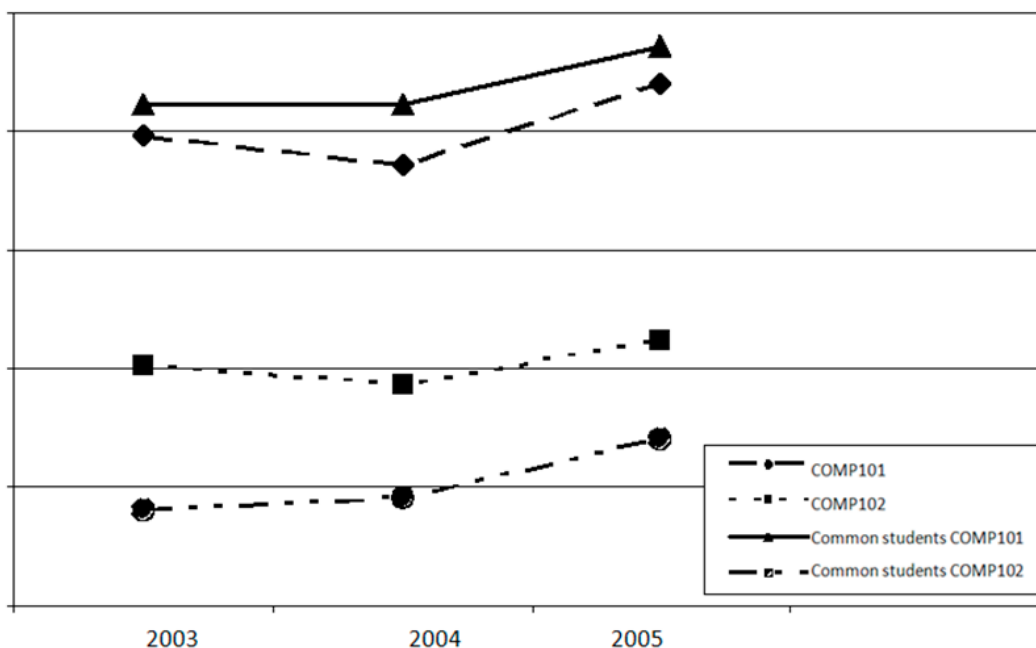

Figure 1. Students' results in COMP101and COMP102 compared

Addressing the challenge

Moreno and Mayer (2000) ask of instruction online, "Should the explanation be given auditorily in the form of speech, visually in the form of text, or both?" (p. 1). However, the question could equally be applied to a lecture scenario. Within the lecture format there are many factors that can be adjusted to promote student learning. Denman (2005, p. 2), writing of the Dr Fox effect (first described by Ware and Williams in 1975), notes that students who are lectured by lecturers who exhibit "expressive behaviour" perform better in subsequent tests than students who are lectured by lecturers who use a "flat, matter of fact style". Expressive behaviour is defined by Denman as "the use of movement, gesture, vocal emphasis, humour and charisma" (p. 2).

Colvin Clark and Mayer (2003) suggest six principles to guide the construction of e-learning courses and to promote student engagement. The first principle they discuss, which they call the "multimedia principle", recommends that, "based on cognitive theory and research evidence, e-learning courses include both words and graphics" (p. 54). The authors cite 10 different studies to support this principle and report that across the studies students performed between 50 and 100 percent better in "subsequent transfer tests" when they had been taught using words and pictures rather than just words. Mayer and Moreno (2003), in an article entitled "Nine ways to reduce cognitive load in multimedia learning" (defined as learning from words and pictures), offer specific solutions to cognitive overload. For example, to eliminate redundancy, they suggest teachers "avoid presenting identical streams of printed and spoken words" (p. 46), colloquially referred to when reading slides as "PowerPoint karaoke". The principle of avoiding oral and written repetition to reduce overload was incorporated into this study.

The second principle adopted was Colvin Clark and Mayer's "personalisation principle": the use of a conversational style and virtual coaches. Although Colvin Clark and Mayer's book deals with e-learning, we considered how the two principles could be applied to a lecture-based first-year course in computing.

It was decided to revise the PowerPoint presentations in line with the two principles described above, principles expanded by Mayer (2003):

> A review of research on the design of multimedia explanations conducted in our lab at Santa Barbara shows a multimedia effect—in which students learn more deeply from words and pictures than from words alone—in both book-based and computer-based environments.....and a personalization effect—in which students learn more deeply when words are presented in conversational rather than formal style—both in computer-based environments containing spoken words and those using printed words.

The Derek Bok Centre for Teaching and Learning at Harvard University (1992) recommends that lecturers "create an atmosphere that encourages student participation by using a conversational tone". To this end, these governing principles, adapted from Newble and Cannon (1995), were adopted for the project to improve the quality and effectiveness of teaching materials.

1. *Relevance:* the material should be relevant—to the purpose for which it was designed, to the aims and objectives of the course, to the specific aims of the teaching session and to the students' ability level and prior knowledge.

2. *Linkage:* the purpose of the material and how it links to known content should be made clear to the students.

3. *Simplicity:* the language should be clear and concise, and graphics should be as simple as possible.

4. *Emphasis:* the design should emphasise important and new ideas.

5. *Structure:* the material should be organised logically, and the layout should emphasise the structure.

6. *Consistent:* the material should be consistent, so that students know what to expect.

In line with the principles expressed in the literature, Dr Gossman screened and commented on the format and layout of the slides in the PowerPoint presentations, after which Dr Churcher revised the slides for incorporation into the classroom lecture. Examples of the former and new styles for the presentations are given below.

Figure 2. Former style of presentation

Figure 3. Revised style of presentation

Figure 3 illustrates both the use of conversational style in the text and in the virtual coach's question, and also the reduction in the amount of printed text on the slide (which was replaced with instruction spoken by the lecturer).

Results and discussion

At the end of the semester in 2006 in which the interventions were implemented, data were collected and compared with those for the previous year. The data (Figure 4) showed that significantly higher pass rates and an improved grade profile were associated with the revised course delivery. That is, there were greater numbers of A and B grade passes and fewer numbers of C, D and E grades when 2005 and 2006 results are compared. The 'did not submit' (DNS) remain roughly the same.
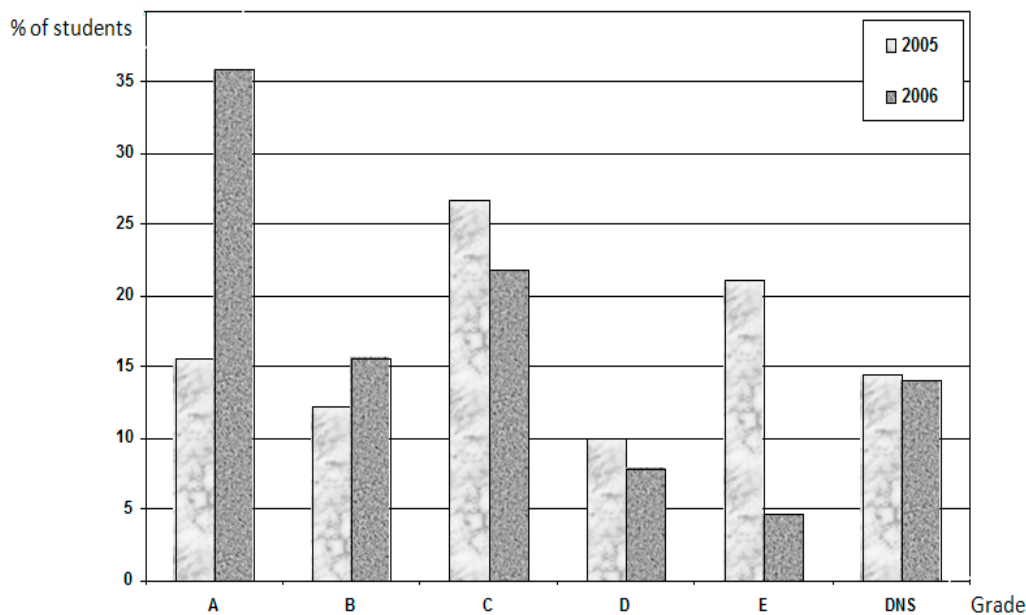

Figure 4. Grade profile change, COMP102

The mean percentage mark changed from 51.1 percent to 62.5 percent, and the grade profile also altered, as the above graph shows. The change in the proportion of students awarded a particular grade altered positively; for example, in 2005 15 percent of students received an A grade, and in 2006 this rose to 35 percent, an increase of 20 percent. More students received B grades when the paper was taught in the revised manner, while fewer received Cs and Ds. Dr Churcher reported that student performance was maintained in the higher-level paper, for which this paper was a precursor, supporting the contention that the measured improvement in the student grades was the result of improved student learning.

Student opinion

To provide a further dimension to the discussion, students were questioned using an 18-item bipolar semantic differential instrument (Appendix 1). Students were given pairs of phrases and asked to select their responses on a four-point scale, with one indicating strong agreement with the positive statement and four strong agreement with the opposed negative statement. For example, one question used the following statements at opposite ends of the scale:

- The lecturer's presentation style in this paper was more engaging than in my other 100-level (first year of a degree) papers (one)

- The lecturer's presentation style in this paper was less engaging than in my other 100-level papers. (four)

The questions relating to student engagement were aggregated and compared with an expected average distribution (Figure 5).
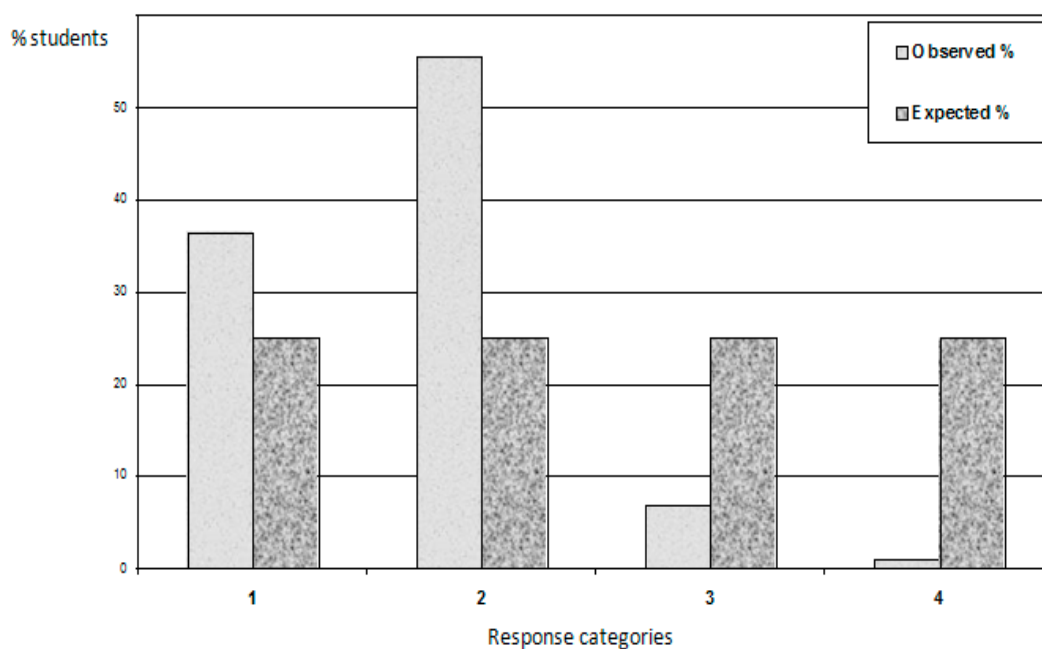
Figure 5. Average responses to the questionnaire on student engagement

The results indicate that students rated the paper as more engaging, interesting and enjoyable when they compare it, within the statements, with other papers. It can be concluded that, due to the intervention documented here, not only did the average result for the paper improve along with the grade profile, but the students also identified the paper as being more engaging than others they were concurrently undertaking.

The improvement in student marks and percentage passes continued into the next semester, as Table 2 shows.

Table 2. Comparative data, 2003–2007, showing changes in variables and student performance

	Pre-TLEI 3	Pre-TLEI 2	Pre-TLEI 1	Iteration 1	Iteration 2
Date	Sem 1, 03	Sem 1, 04	Sem 1, 05	Sem 1, 06	Sem 1, 07
No. of teaching staff	1 lecturer 1 tutor 2 student lab assistants	1 lecturer 1 tutor 2 student lab assistants	1 lecturer 1 tutor 2 student lab assistants	1 lecturer 1 tutor 2 student lab assistants	1 lecturer 1 tutor 2 student lab assistants
No. enrolled	126	120	91	67	59
No. sat exams	102	93	77	56	47
Percentage pass	48.8	44.1	53.8	70.1	59.3
Percentage fail	54.2	56.8	46.2	29.9	40.7
Average mark	50.1	49.3	51.1	62.5	61.1

The table shows the improvement in student performance, as measured by the improvement in pass rates and average marks. It also provides information about variables other than the changes in presentation, such as a change in the number of students enrolled, which may have affected student performance. As is always the case in such studies, it is difficult to quantify these effects. However, data from the questionnaire suggest that students had a higher level of engagement with the paper. Furthermore, the teacher's perception may also be pertinent in establishing the effects of the intervention.

Teacher comment on academic developer involvement

Dr Churcher noted that she found the interaction with a teaching and learning professional particularly helpful while redeveloping the course.

> While the initial ideas were mostly mine, it was great to have someone to bounce the ideas off and to get feedback as to their usefulness. As the course progressed the developer attended some classes and gave useful feedback. It was particularly helpful to have some analysis for the results of the class (both qualitative and quantitative). While improved performance cannot definitively be attributed down to the actual changes, it was certainly comforting to know that the students were happy with the class and the results were good. However it was having someone with expertise being interested in my teaching and offering encouragement and advice that made the most difference. It has encouraged me to continue trying to adapt and improve my courses.

Conclusion

As part of the larger project considering teacher professional development and its impact on student learning, this project involved Teaching and Learning Services at Lincoln University having discussions with lecturing staff in order to effect change in first-year student learning, in this case measured by student results.

The change in presentation of the course resulting from the refinement of the PowerPoint presentations and discussions between the lecturer and adviser was undertaken in the hopes of getting a change in pass rates. Although, based on the results, this intervention cannot conclusively be claimed to have made the difference in this case study, there are strong indications that the changes did affect student performance and satisfaction.

This conclusion is in line both with the intuitions of the teacher, drawing on her many years of experience, and with the theory espoused in educational literature, which informed the advice of the academic developer, as teacher and developer worked co-operatively to improve student learning. Furthermore, the teacher's

reflections suggest that the assistance she was given by the academic developer provided encouragement for her ongoing commitment to improving her teaching and student learning.

References

Colvin Clark, R., & Mayer, R. (2003). *E-learning and the science of instruction.* San Francisco, CA: Pfeiffer.

Denman, M. (2005). How to create memorable lectures. *Speaking of Teaching*, *14*(1), 1–5.

Derek Bok Centre for Teaching and Learning. (1992). *Twenty ways to make lectures more participatory*. Retrieved 13 April 2006 from http://bokcenter.harvard.edu/docs/TFTlectures.html

Mayer, R., (2003). The promise of multimedia learning: using the same instructional design methods across different media. *Learning and Instruction, 13* (2), 125-139.

Mayer, R., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*(1), 43–52.

Moreno, R., & Mayer, R. (2000). *A learner-centered approach to multimedia explanations: Deriving instructional design principles from cognitive theory.* Retrieved 12 April 2006 from http://imej.wfu.edu/articles/2000/2/05/index.asp

Newble, D., & Cannon, R. A. (1995). *A handbook for teachers in colleges and universities* (3rd ed.). London, UK: Kogan Page.

Appendix 1

Student perception questionnaire

This questionnaire was distributed to the students in COMP 102 in order to provide a further information as to the students' perception of their level of engagement with the paper after it had been revised.

You are invited to participate in a teaching and learning project by completing the following questionnaire. The aim of the project is to investigate how students' views of the teaching and learning in COMP102 compare with other 100 level subjects. The information collected will be used to improve future teaching in this subject.

Your optional participation in this research will have no impact upon your assessment in this subject. You will not be identified as a respondent in this research. You may at any time withdraw your participation, including withdrawal of any information you have provided. If you complete the questionnaire, however, it will be understood that you have consented to participate in the project and consent to publication of the results of the project with the understanding that anonymity will be preserved.

	Place a tick in a box along the scale to indicate your degree of agreement with the statements.				
The lectures in this course were **more** formal than other 100 level courses.					The lectures in this course were **less** formal than other 100 level courses.
The lecturer's presentation style in this course was **more** engaging than my other 100 level courses.					The lecturer's presentation style in this course was **less** engaging than my other 100 level courses.
The style of PowerPoint presentation in this course was **more** interesting than my other 100 level courses.					The style of PowerPoint presentation in this course was **less** interesting than my other 100 level courses.
The lecturer's presentation style in this paper, compared with other 100 level papers, **encouraged** my learning.					The lecturer's presentation style in this paper, compared with other 100 level papers, **discouraged** my learning.
The lecturer used question and answer technique **more** effectively in this course than my other 100 level papers.					The lecturer used question and answer technique **less** effectively in this course than my other 100 level papers.

Please turn over …/…continued

	Place a tick in a box along the scale to indicate your degree of agreement with the statement.				
Lectures in this course were presented **more** enthusiastically than my other 100 level papers.					Lectures in this course were presented **less** enthusiastically than my other 100 level papers.
I learnt **more** in lectures for this paper than in my other100 level papers.					I learnt **less** in lectures for this paper than in my other100 level papers.
I have enjoyed the lectures for this paper **more** than for my other100 level papers.					I have enjoyed the lectures for this paper **less** than for my other100 level papers.
The PowerPoint style in this paper motivated me to learn **more** than the style used in other papers.					The PowerPoint style in this paper motivated me to learn **less** than the style used in other papers.

Lead researchers and authors

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