How to Develop 15 Multimodal Design Heuristics in 3 Easy (Not) Lessons

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Abstract

The necessity to establish a range of pedagogically sound delivery guidelines for the development of multimodal learning environments is proposed in this paper. To support this discussion a summary of findings from four research projects investigating three multimodal learning environments delivered at the University of Southern Queensland is used. These findings were also used to help refine a set of 15 multimodal design heuristics (or rules of thumb) to be considered when designing multimedia enhancements for learning environments. In proposing these heuristics, this paper attempts to contextualise the importance of multimodal delivery and considers how catering for a multiliterate clientele, by using a combination of multimedia enhancements, may improve the learning opportunities of students. The studies described in this paper also demonstrate that higher levels of student engagement are possible when using a range of multimedia enhancements in learning environments, whilst also maintaining a balance for more traditional learners.

Introduction

As many universities move towards the use of online and CD-based environments to provide course materials for their students, the necessity to establish a range of pedagogically sound guidelines for the design of these environments is crucial. This is particularly true as the access to computing equipment and high speed Internet connections becomes more ubiquitous among students (Kennedy, Krause, Judd, Churchward, & Gray, 2006). With this increased access to technology universities are moving to provide both an improved ability for students to use online administrative support and the development of quite sophisticated learning environments. This style of technology enhanced course presentation, as against providing print-based documents supported by a learning management system, is seen (by some) as more cost effective, whilst also providing a significant number of students more flexibility in their approach to study (Schoech, 2000).

As a consequence of this shift many distance education universities are now replacing traditional print-based courses with multimodal courses, delivered either online or on CD (McDonald & Mayes, 2005). These courses use a combination of ICT and multimedia to develop dynamic course resources that may also be used to appeal to students' different sensory modes or learning styles (Zywno & Waalen, 2002). With this level of flexibility, major concepts within courses may be presented in a variety of formats (multiple representations). This strategy has been shown to lead students to perceive that it is easier to learn, improve retention rates and improve student performance (Chen & Fu, 2003). However, before embarking on a full-scale

conversion of traditional, print-based courses to a multimodal format, individual academics may require some basic guidelines to help them develop the enhancements required for these environments.

To assist academics in this process this paper first outlines the basic tenets of multimodal design and presents a set of 15 design heuristics (or rules of thumb) to be considered when developing a range of multimedia enhancements. As each heuristic is presented, examples of how it has been applied to the development of three multimodal courses, delivered at the University of Southern Queensland (USQ), are also provided. To support this discussion further, a brief summary of findings from four research projects, investigating the use of multimedia enhancements in these courses, is then presented. The design of the enhancements used in these courses considered the recommendations contained in the heuristics being presented here.

Multimodal Delivery

In recent years multimedia in conjunction with hypermedia have been successfully applied to many courses in order to cater for a wider variety of student learning styles or modalities (Birch & Gardiner, 2005). It has also been demonstrated that students can feel more comfortable when learning in environments that cater for their predominant learning style (Hazari, 2004). Fleming (2001) proposes that learners have a preferred learning modality (style), namely, visual, aural, read/write or kinaesthetic, while many learners (about 40%) are multimodal (using a combination of these modalities). In this context, multimedia can be used to develop a more inclusive and engaging curriculum, appealing to visual, aural and kinaesthetic learners, thereby counteracting some differences in student performance (St Hill, 2000). Indeed, Hazari found that the use of multimedia was able to neutralise many of the differences found in student performance, based on their different learning styles, and that presenting material in a variety of modes would also encourage students to develop a more versatile approach to their learning.

Multimodal courses allow instructional events, or elements, to be presented to more than one sensory mode, and thus have been used by some educators to facilitate enhanced student learning (Mayer, 2003). Mayer, for example, contends that students learn more deeply from a combination of words and pictures than from words alone; known as the “multimedia effect”. Further, Shah and Freedman (2003) discuss a number of benefits of using visualisations in e-learning, including promoting learning by providing an external representation of the information, deeper processing of information and maintaining learner attention by making the information more attractive and motivating, hence making complex information easier to comprehend.

The development of multimodal courses may also result in a more current and relevant curriculum, enhanced course quality and an increased diversification in academic programs (Maguire, 2005). Indeed, the inclusion of multimedia enhancements can significantly change the way in which teaching, learning and assessment may occur (Weston, 2005). This is primarily due to the non-linear design of the multimodal learning environment, which has been found to increase learners’ control over the way that they progress through their materials (Karagiorgi & Symeou, 2005). Thus, when materials are delivered in this way students may become more self-directed, interacting with the various elements housed in these environments. Therefore, depending upon their predominant learning style, students

may self-select the learning object or representation that best suits their modal preference (Doolittle, McNeill, Terry, & Scheer, 2005).

Consequently, multimodal course materials can provide a far richer learning environment for students by incorporating a range of multimedia enhancements, such as simulations, video, audio recordings, Breeze presentations (PowerPoint with audio), interactive applications, quizzes, web-links, etc. (Birch & Gardiner, 2005). If this is to be the case, educators may need to consider their teaching styles and develop new skills to help them integrate multimedia enhancements into their courses. In this process, some understanding of the relationship that exists among learning, interactivity and technology may also be required (Bates, Manuel, & Oppenheim, 2007). Thus, in integrating multimedia enhancements, academics may require a basic understanding of the multimodal design principles that underpin their development.

This paper therefore proposes 15 heuristics, or 'rules of thumb', that may be used as a starting point to developing this understanding. The antecedents of these heuristics were first developed when 'hybrid' delivery was first trialled as a delivery platform at USQ in 2004. Since that time these heuristics have been refined and expanded, based on the findings of four research projects investigating the design of three multimodal courses. This research is discussed after the heuristics have been presented.

15 Multimodal Design Heuristics

Heuristic 1

"Less is more". Lean, précised text gets the point across better than lengthy, elaborated text (particularly in PowerPoint presentations). Students should not have to read large amounts of information from the screen. If extensive reading is required, make this available in a form that does not need to be read on screen – i.e., in an additional printable document (Clark &Mayer, 2003; Doolittle *et al.*, 2005).

Figure 1: A print-based version in PDF format is provided

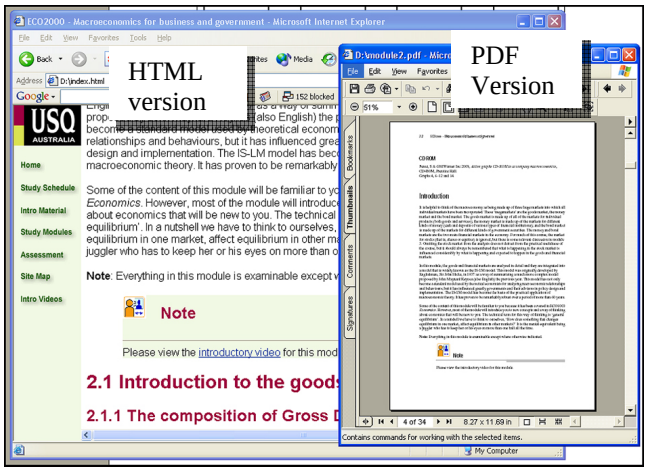


Figure 1 illustrates how a PDF document is provided in the multimodal (transmodal) learning environment, providing the opportunity for students to print their learning materials, if they prefer, as opposed to having to read from the screen.

Heuristic 2

Incorporate, where possible, images that tell a story, giving the learner a reference point or anchor for the information being transmitted. However, do not use images just for the sake of using images. Pedagogical benefit must be present for their use (Clark & Mayer, 2003).

Figures 2: Screen captures showing the use of image and icons in the ECO2000 course (left) and an enlargement of the image (right)

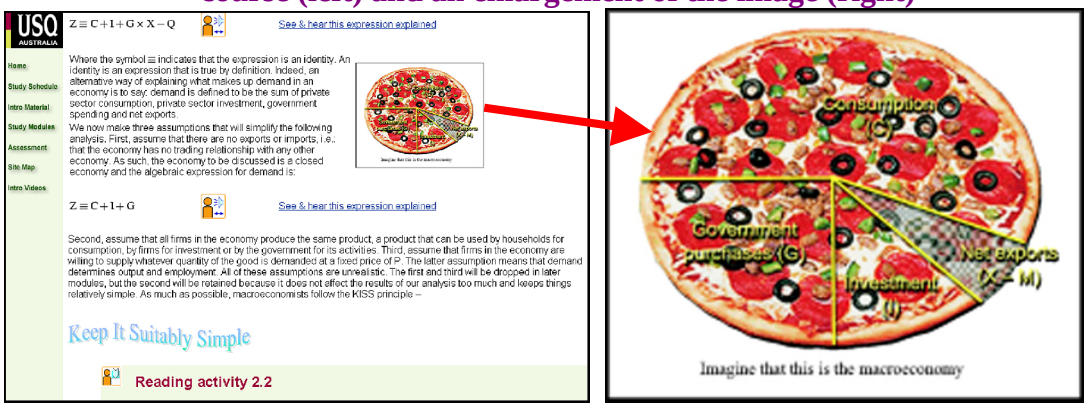


Figure 2 illustrates the use of an image to represent multiply a concept outlined in the text, to the left of the image (in close proximity, Heuristic 10). In this example students are asked to think of the macroeconomy as a pizza, and the different elements of the economy as slices of that pizza.

Heuristic 3

Avoid including additional music or sounds, unless these are an essential component of the learning interaction (Sweller, 1999).

No figure is available for Heuristic 3.

Heuristic 4

Provide the learner with some control over the learning environment, ensuring that the instructional strategy is made clear. In doing so, have a rich set of resources available (as an option) to help the learner make decisions. When providing these alternative representations, allow ample opportunity for learners to make decisions as to how to access these materials (Ainsworth & Van Labeke, 2002).

Figure 3: An audio overview and text of same content in MGT2004

Figure 3 illustrates the use of an audio feature to provide an alternative representation of key introductory information, also represented in the text directly below it. This gives the students the choice between listening to and reading this key information (or of doing both). Instructions on the use of this strategy are provided in the course and students are encouraged to use the representation that best suits their learning style.

Heuristic 5

When creating animation, use image and spoken text. The two sources of information can then be processed concurrently in working memory. If text has to be used with spoken text, keep it simple, preferably in point form only (Clark & Mayer, 2003).

Figure 4: An animated equation in ECO2000 (left) and an animated concept model in MGT2004 (right)

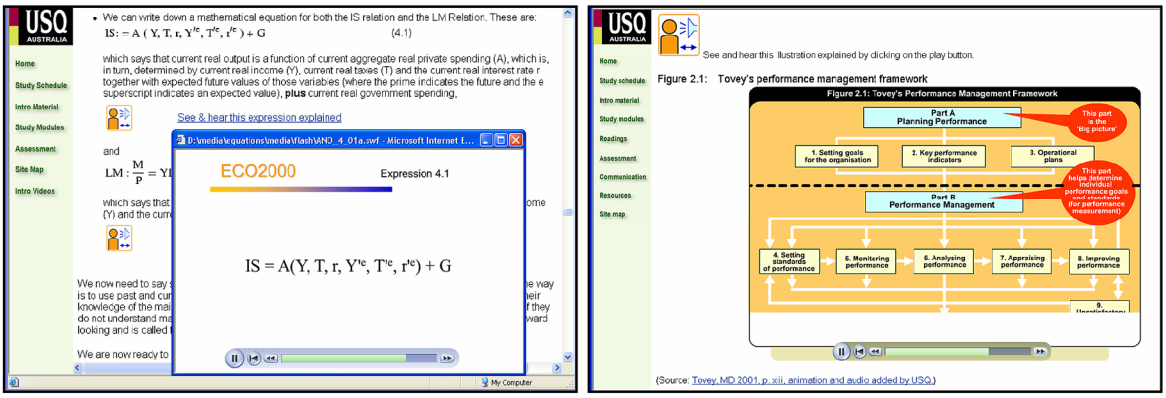
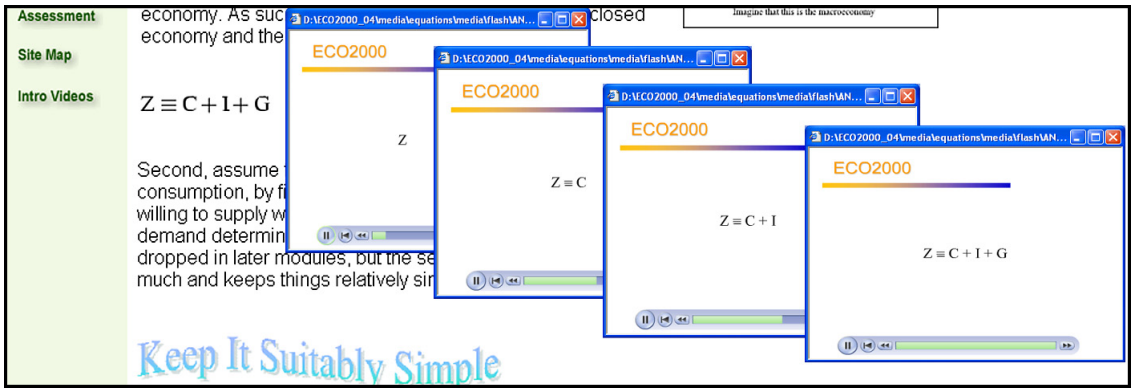


Figure 4 shows two examples of an animated representation. The first illustrates the use of simple text (in this case an equation) that unfolds as the speaker narrates the sequence. The second illustrates the use of a diagram that grows during the narration. In both cases the imagery is kept simple while actively reinforcing the aural content.

Heuristic 6

When using animation, allow access to an alternative version of the material, thereby catering for those learners who prefer to read instructions to viewing or listening to them. This is useful for learners with extensive prior knowledge who may choose not to access the further information (Mayer, 2001). See also Heuristic 1.

Figure 5: The animated sequence of an equation being explained in ECO2000 with alternative text visible



Heuristic 7

Build knowledge gradually with stepwise segments of information (sequentially), not in one long presentation. The e-learning environment may be especially useful to learners when information is presented in smaller "chunks" to hold interest (Kalyuga, Chandler, & Sweller, 2001). Where this includes audio components presentations should not exceed 12 minutes (Sankey, 2005).

Figure 6: Two examples of the animated and narrated diagrams used in CMS1000

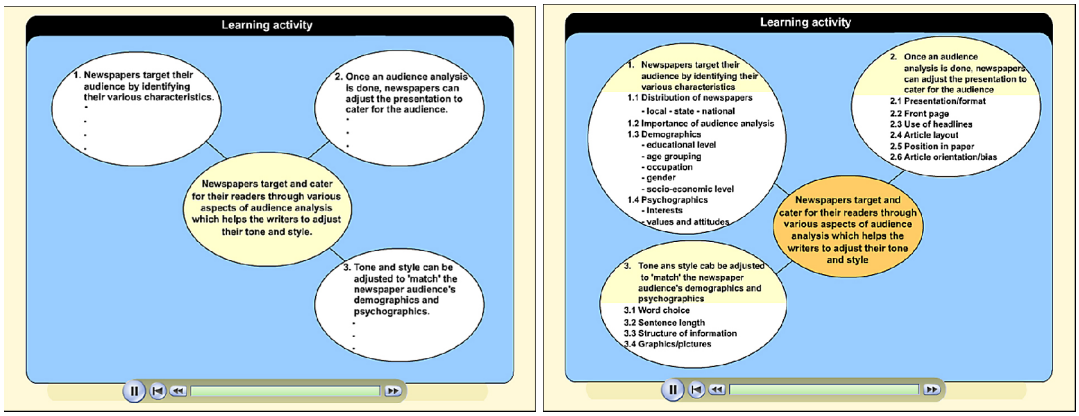


Figure 6 illustrates how students are presented (as a multiple representation) with a series of animated diagrams (4 in total), visually elaborating on the stages of planning for an essay. These diagrams grow as the lecturer explains each of the elements and run between 2 and 4 minutes.

Heuristic 8

Ensure that background image or colour does not interfere with the clarity of information presented in the foreground. Use contracting colours – light on dark, dark on light – as against complementary colours. Use variations in colour or intensity to highlight important information (Doolittle, 2002).

Figure 7: Audio enhanced PowerPoint (Breeze) presentation in CMS1000

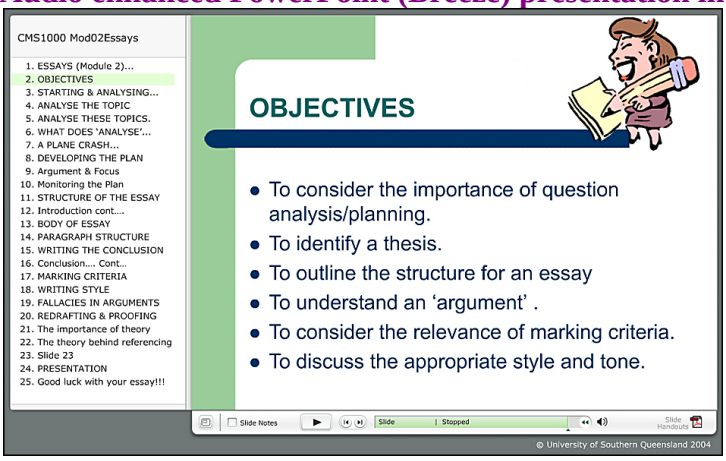


Figure 7 illustrates a Breeze presentation showing clear readable point-form text *(Heuristic 5)* with no background image (see also Figures 4, 5 and 6).

Heuristic 9

Use simple graphics initially where possible, then add to complexity as the learning sequence progresses. Scaffold visual learning where appropriate, by building an illustration sequentially with animation or by a series of still images (Kalyuga *et al.*, 2001) (see also Figures 4, 5 and 6).

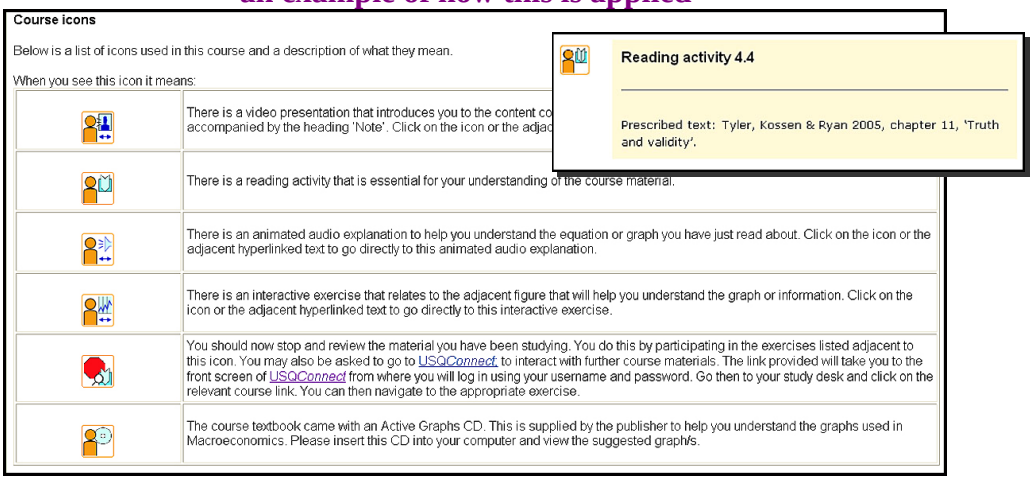
Heuristic 10

Prevent the need for visual search – that is, make it obvious where to find certain elements by placing all related information together. Learners will then not have to hunt for this information (Mayer, 2001). If related pictures and text are to be presented together on a page or screen, present them simultaneously, rather than separately. The two representations can then be processed in working memory concurrently (Mayer). Use captioned images or incorporate the text into the image where appropriate. Avoid referring to an image or diagram that appears on another page or screen (Klinger, 2000) (see also Figure 2).

Heuristic 11

The presence of additional multimedia enhancements should be made explicit by the use of markers or easily recognisable icons. Clear instruction should be given about how to use these elements for maximum benefit. It should be clearly indicated whether these elements are an alternative representation or stand alone (Sankey, 2006).

Figure 8: The icons used in the ECO2000, MGT2004 and CMS1000 courses and an example of how this is applied



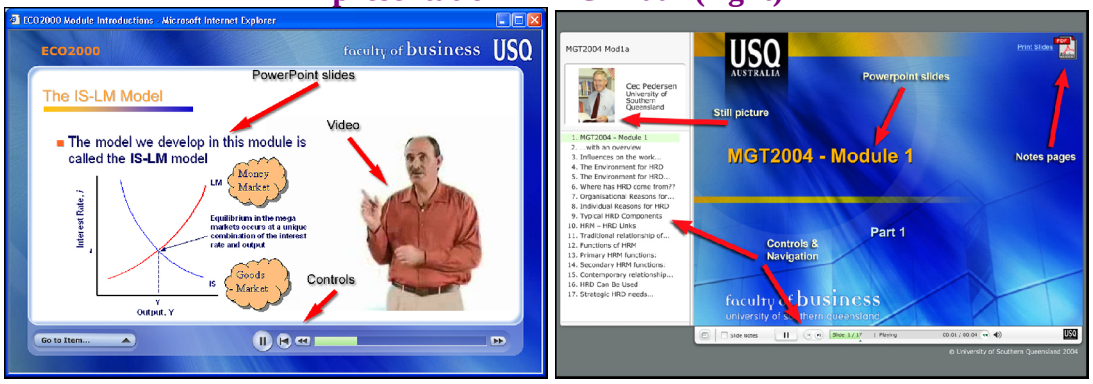
See also Figures 1, 2, 3, 4 and 11.

Heuristic 12

The use of video may be preferred for a lecture style presentation. However, if the speaker is not confident in front of a camera only audio should be used. If only audio is used this should be made lively (Sankey, 2005). This may be achieved by the use of a vibrant voice or multiple voices. More visual material should also be integrated into this style of presentation to reinforce concepts and allow students to concentrate on something which complements the voice (Doolittle *et al.*, 2005).

See also Heuristic 5.

Figures 9: Video PowerPoint presentation in ECO2000 (left) and Breeze presentation in MGT2004 (right)



Heuristic 13

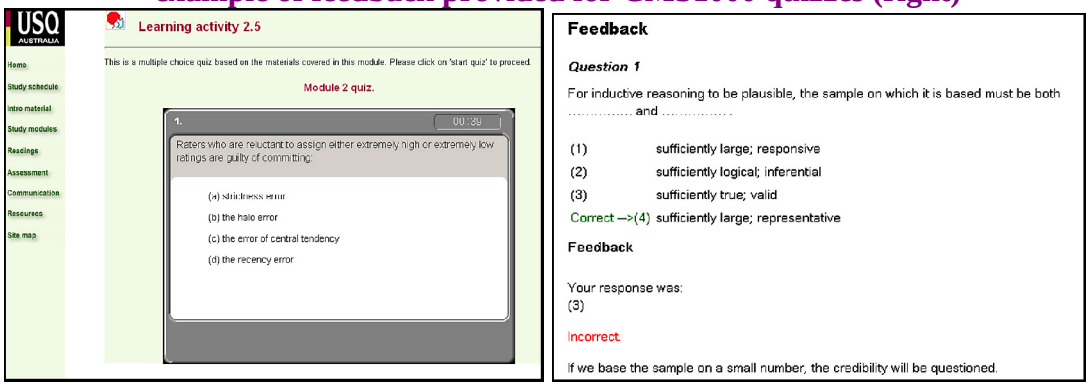
The use of printable resources is important, particularly for mature age students and those with a read/write learning preference. Make printable materials easy to access and give clear guidance as to what these materials contain (Sankey, 2005) (see also Figure 1).

Heuristic 14

If extra elements such as formative quizzes are used, these should be incorporated and contextualised into the environment, rather than requiring students to link to the

Internet, thereby taking them away from the learning environment. Programmed feedback should also be provided with formative quizzes (Neal, 2007).

Figure 10: Interactive quizzes contextualised in MGT2004materials (left) and an example of feedback provided for CMS1000 quizzes (right)



Heuristic 15

If audio and video components are used, transcripts of the text should be made available, if subsequent content does not replicate the audio content. This will allow students to highlight and make notes on a printed copy, if required. This transcript does not necessarily need to be word-for-word, but must contain all the key elements of the audio content and appear in the same sequence (Sankey, 2005).

Figure 11: A video interview in CMS1000, with transcript available directly below

These heuristics are also viewable at: http://www.usq.edu.au/users/sankey/pages/heuristics.html

Researching the Multimedia Enhancements

The research model adopted for conducting the four studies into the courses using these multimodal design heuristics was a "Concurrent Triangulation Strategy" as defined by Creswell (2003). A model of this strategy can be seen in Figure 12. This strategy allowed for the collection of both qualitative and quantitative data with a view to triangulating these data. Quantitative data were collected via online and paper-based surveys consisting of questions using a five point Likert type scale (strongly agree/agree/no opinion/disagree/strongly disagree), and a two point scale (yes/no). Quantitative data were collected by using a combination of six open-ended

response questions in the survey and a series of focus groups, allowing students to give a more in-depth account of their encounter with the courses. A total of 471 students participated in these studies (see Table 1).

Figure 12: The Concurrent Triangulation Strategy (adapted from Creswell, 2003)

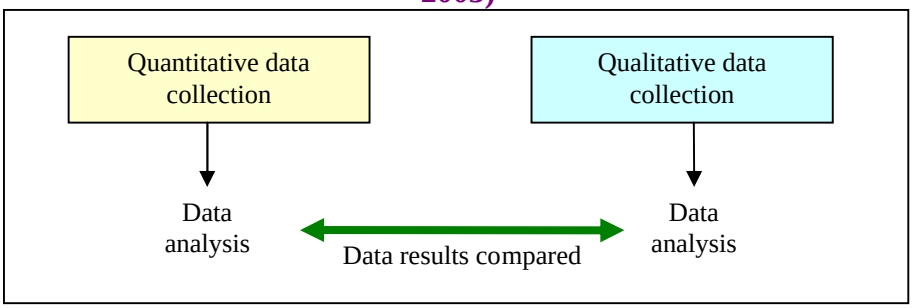


Table 1: Three multimodal courses and when each was researched

Multimodal course researched	Research performed	N =
ECO2000 *Macroeconomics for Business and Government*	Semester 1 2004	62
MGT2004 *People Development*	Semester 2 2004	108
CMS1000 *Communication and Scholarship* (external students only)	Semesters 1, 2 & 3 2005	188
CMS1000 *Communication and Scholarship*	Semester 1 2006	113
Total number of students participating		471

It should be noted that the investigations into these multimodal courses were far broader than is being reported here and are all the subject of individual papers. However, as only limited data may be displayed in this paper, a summary of the key findings related to the use of multimedia enhancements is presented. A more complete summary of these data is viewable at the URLs seen in Table 2.

Table 2: URLs for each research project

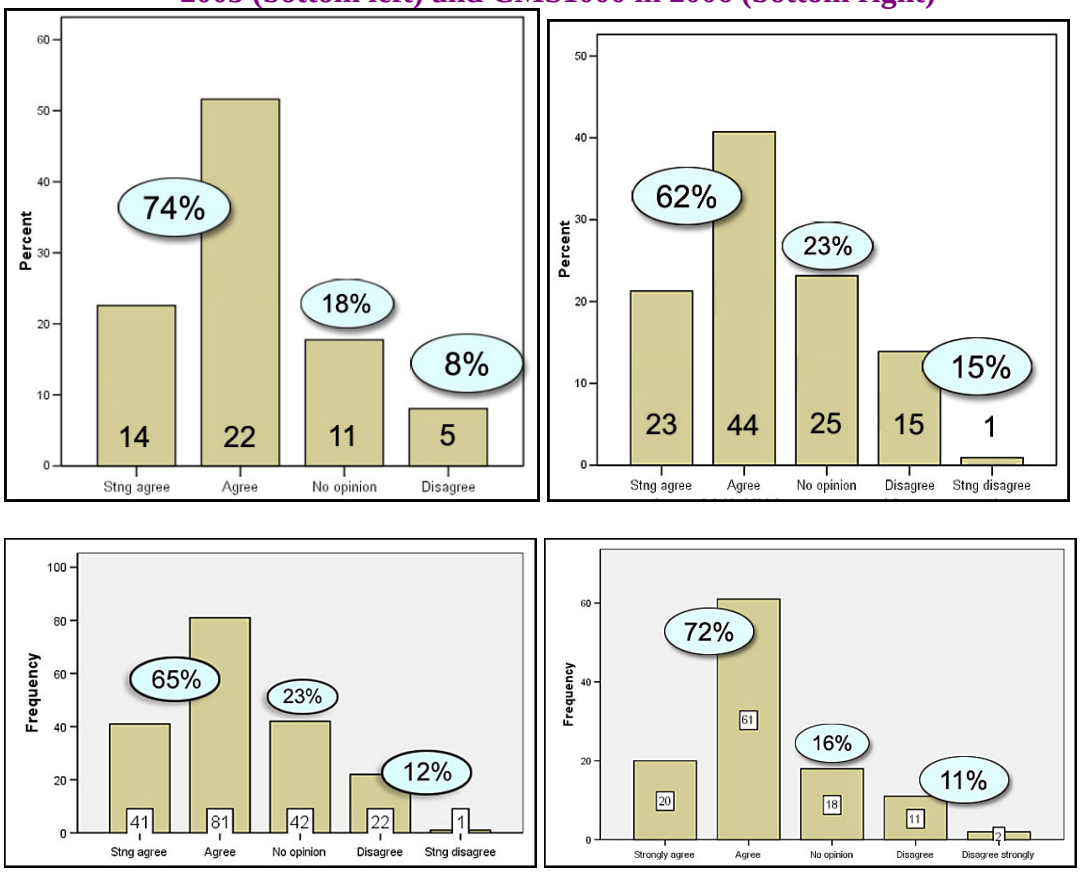
Multimodal course researched	Data available from
ECO2000: S1 2004	http://www.usq.edu.au/users/sankey/MDML/pages/ECO2000results.htm
MGT2004: S2 2004	http://www.usq.edu.au/users/sankey/MDML/pages/MGT2004results.htm
CMS1000: S1, 2 & 3 2005	http://www.usq.edu.au/users/sankey/CMS1000/index.htm
CMS1000: S1 2006	http://www.usq.edu.au/users/sankey/CMS1000S12006/index.htm

Key Findings and Discussion

Students in all four courses strongly endorsed the use of the multimedia enhancements in the materials, indicating that they had suited their approach to learning (see Figure 13). It should be noted that all students in these studies completed the VARK (Fleming, 2001) learning styles inventory and so were aware of their preferred approach to learning. For example, when ECO2000 and MGT2004 students were asked, "The interactive multimedia features on the CD catered for my approach to

learning" and CMS1000 students were asked, "The interactive multimedia features on the CD (such as the diagrams with explanations) catered for my approach to learning", the following data were generated.

Figure 13: Data from ECO2000 (top left), MGT2004 (top right), CMS1000 in 2005 (bottom left) and CMS1000 in 2006 (bottom right)



This weight of sentiment was further highlighted in the focus groups with students reflecting:

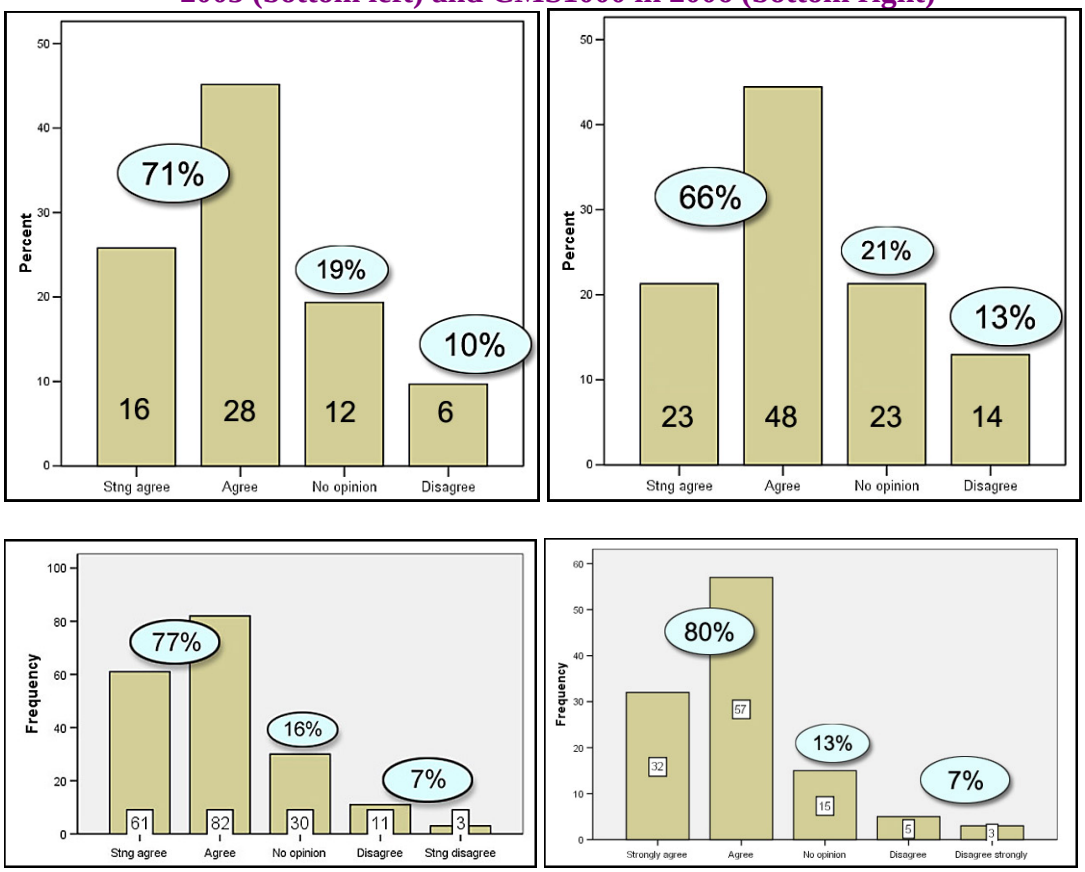
- "…when I just read it [the materials] I don't always understand it but when you have it [see it] spoken and explained it is better" (ECO2000 student).
- "…It gives you a different way of learning so you can do your hard copy reading and all that type of thing, but to have it actually to listen to it reinforces what you have actually been reading as well" (MGT2004 student).
- "Sometimes reading is not enough to get it into your head and it needs to be spoken; the CD [with the multimedia] completes that need effectively" (CMS100 student).

These comments give a clear indication that each student used a combination of strategies to comprehend the concepts. Each mentioned reading and noted that the further representation either explained the concept better or served to reinforce it.

The multimedia enhancements, such as Breeze presentations, were also very highly valued. For example, when ECO2000 and MGT2004 students were asked, "The multimedia introductions used for each module; assessment & course overview helped my understanding of the course content" and CMS1000 students were asked,

"The multimedia introductions (using PowerPoint and audio) used for each module; assessment and course overview really helped my understanding of the course content", the following data were generated (see Figure 14).

Figures 14: Data from ECO2000 (top left), MGT2004 (top right), CMS1000 in 2005 (bottom left) and CMS1000 in 2006 (bottom right)



This sentiment again may be summed up in the following comments:

- "…it's great to have all the different representations to get the picture as a whole" (MGT2004 student).
- "I found them extremely helpful - made me feel more a part of the class as well" (CMS100 student).

Again these comments demonstrate a strong recognition of the advantages of using multimedia enhancements to help form understanding ("get the picture as a whole"), a sentiment repeated many times by students.

There was an unmistakably strong endorsement of the multimedia enhancements in the multimodal courses, though they clearly did not suit everyone. The use of technology, particularly the Breeze and multimedia enhancements, was seen to help the students' understanding of the course concepts and to help break down some of the perceived barriers to their study. Or as these two CMS1000 students said:

- "The different ways of learning catered for my specific needs very well and I appreciated the time taken to include all the different learning methods."
- "Yes. Presenting material in a variety of formats and ways facilitates and stimulated my learning."

Conclusion

This paper has attempted to demonstrate that there are distinct advantages for students in providing course resources designed to suit a range of different learning modalities (multimodal). The findings from four research projects, investigating the use of multimedia enhancements, indicated that students had a positive attitude towards the multimodal courses that they studied. This was primarily achieved by providing a more complete representation of the information being presented in these courses, thereby increasing the opportunity of students to engage with their learning materials. Importantly, this was achieved whilst maintaining a balanced environment for more traditional learners. It is hoped that the findings of this study may encourage more educators to consider the adoption of multimodal design for the purpose of delivering courses and in so doing consider the 15 design heuristics presented above. Ultimately, what this paper is suggesting is that designing for multimodal learners may reduce the impact of providing course materials to a diverse and an increasingly non-traditional student body. It may well be true that 'one size does not fit all', but that does not preclude academics from designing learning environments that cater for a wider range of learners than do traditional print-based course materials, and particularly for those students who learn in non-traditional ways.

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