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The medium makes the message: Effects of cues on students' lecture notes

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Abstract

Previous work has shown that students' notes often fail to record key facts and concepts. The relatively recent widespread adoption of PowerPoint slides and handouts might now help students to record key issues, but only if they can recognize the cues that identify these. 238 note-sets were taken from first-year students attending four lectures using copy paper. In each lecture four separate possible cues were identified: a slide, a statement, a discussion and an 'interactive window' (a short problem-solving session embedded in the lecture). Notes were analysed for word counts, abbreviations, note-taking styles and quality of content. Word counts showed non-normal distributions; most students recorded relatively few words but some recorded more than double the modal number. Word counts and the quality of notes were significantly related in three of the four lectures. Most note-sets had no abbreviations and showed a simple linear layout (without, for example, concept maps or new diagrams). Interactive windows produced higher-quality notes than discussions or statements. Hence different cues produce different notes, and lecturers should consider the effects of their lecturing cues on the notes their students will record.

Keywords

cues, interactive window, linear, non-linear, notes, processing

Introduction

The limitations of lectures are well documented (Bligh, 1998). Despite this, they remain dominant in university timetables, and thus the ability to use time in lectures constructively is an important academic skill for most students. Effective note-taking is central to this skill. A large literature documents the importance of the 'external storage' function of notes – of providing a good record that can be used for review and revision (Hartley, 1983; Kiewra et al., 1991). If all that was needed was an accurate factual record, then full printed lecture notes provided by the lecturer should be equal or superior to students' own (often imperfect) records; in fact, lectures themselves might be redundant and could be replaced with sets of notes. However, the balance of evidence suggests that note-taking itself can help with understanding and recall through 'encoding' of knowledge (Kiewra, 1985), particularly when the notes encourage 'generative processing', that is 'actively generating relations among the parts of the learning material or between the learning material and one's prior

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knowledge' (Kiewra et al., 1991). In addition, Crook (2000) found that subsequent study by students based on their own notes was more creative and exploratory than work based on handouts given by the lecturer, which focused instead on 'what was expected'. Whilst expecting students to record all the information in a lecture might be unrealistic and encourage a surface approach to learning, the provision of partial notes – perhaps as 'linear' or 'matrix' frameworks (Kiewra et al., 1991) or as 'guided notes' (Neef et al., 2006) – can encourage active learning whilst still ensuring effective factual transmission.

The research literature thus suggests that effective use of time spent in lectures should involve taking personal notes to supplement those provided by the lecturer, particularly if those notes help make connections between topics, emphasize key points and involve deeper 'generative processing' such as problem-solving. Of particular importance in memorizing and understanding is the subsequent review of the notes taken. However, many practical and theoretical questions remain to be answered. For example, Sutherland et al. (2002) identified the importance of more research on how students respond to the use of PowerPoint slides and acetates, and whether the provision of partial notes consisting of PowerPoint slides helps or hinders note-taking. Previous (and now old) research has shown that students tend to record verbatim notes, without much evidence of generative processing (Bretzing and Kulhavy, 1981). More recent qualitative work, involving small sample sizes, supports this, and also suggests that most students make rather limited use of note-taking techniques such as abbreviations, diagrams and symbols (Badger et al., 2001; Sutherland et al., 2002). However, it is possible that the provision of partial notes (for example as PowerPoint slides), which is now common, has altered note-taking behaviour, by allowing more time for students to focus on key points and connections. The use of partial notes assumes that students will know when to record information – that they will be able to 'read the cues' and 'fill in the gaps'. If they cannot do this, then the alternative strategies of expecting the recording of verbatim notes, or of providing full notes, may be better because they at least ensure a full set of notes for review and revision. Hence further study of how students respond to different cues – of how they identify what parts of a lecture to record – is justified. For example, Huxham (2005) showed that 'interactive windows' (short problem-solving and summarizing sessions involving peer discussion embedded within standard lectures) can produce significantly better test performance. But such a strategy will not work in the long term unless students record their experiences and can review them.

The changing nature of the lecture makes this problem of 'cue reading' particularly pertinent. Interactive windows are just one of the possible responses to Bligh's call for lecturers to 'create opportunities for thinking to flourish' within traditional lectures (Bligh, 1998; Huxham, 2005). In the more formal language of psychology, this might be characterized as encouraging 'deep' or generative processing during lectures. However, a possible conflict arises for lecturers who change their teaching to accommodate this instruction. Deeper levels of processing are likely to necessitate less formal and regulated forms of information transmission. As the lecture moves along a spectrum from verbatim recording of information to totally open discussion and problem solving, so the chances of having a full and accurate set of notes may decrease. Hence it may be counter-productive to introduce too much unusual activity into a formal lecture setting.

The current work had the following objectives:

1 To record the variability in the amount and quality of notes taken by first-year students during lectures.
2 To record the use of abbreviations, symbols, non-linear notes and other note-taking techniques.

3 To explore the effects of different cues on note-taking; in particular, to compare the quality of notes taken in response to cues involving different 'depths' of processing and to experimentally test the effects of presenting material as 'interactive windows' on the quality of the notes produced.
4 To investigate the relationship between the volume and the quality of notes.

Methods

Notes from four lectures on evolution were collected. Two lectures ('evidence' and 'evolution of sex'), given to the same cohort of students, were assessed in 2006. The same two lectures, given to a new cohort of students, were assessed in 2007. Students were in the first semester of their first year of a biology degree. They ranged in age from 17 to over 40 (although the majority were recent school leavers) and the overall gender ratio (of both years combined) was 34:66 male:female. Students had not received any formal training in note-taking on their biology course prior to the lectures. The 'evidence' lecture discussed how the fossil record and comparative anatomy supports the theory of natural selection, whilst 'evolution of sex' considered the taxonomic distribution of sexual and asexual species and the evolutionary forces that favour these two different types of reproduction.

Students were supplied with a module handbook at the start of the module. This contained partial notes, consisting of summaries of the key points and some of the slides used, for all lectures, along with appropriate references, supplementary reading and past papers. Additional supplementary material was also available on the virtual learning environment (WebCT) site used to support the module. Each lecture lasted 55 minutes, was given by the same lecturer and followed a similar format. In particular, four different modes of communication already commonly used by the lecturer concerned and by others (on the basis of self-reflection and peer observation of colleagues' lectures) were identified. These modes represented presumed different points on the continuum between verbatim recording and active learning:

1 Presentation of a slide or overhead for verbatim copying.
2 A key statement or phrase, written on a whiteboard and elucidated further through spoken description and discussion.
3 A discussion of a key idea, involving questions and answers with the students but not involving any writing on slides or whiteboards.
4 An 'interactive window' (Huxham, 2005); the setting of a small problem for discussion between two or more students for 3–5 minutes, with encouragement from the lecturer and at the end. For example, one 'interactive window' used in the evidence lecture was to ask students to work in pairs to list two examples of 'bad design' in nature and to explain to each other why this might provide evidence against 'natural theology'. This is followed by a brief plenary in which students share their examples and a spoken summary by the lecturer.

These four modes were each classified as a different possible cue for taking notes. Each of the lectures contained one of each of these cues identified beforehand that were not covered by the partial notes the students were given. For example, the slide selected for cue 1 was not one of the slides students had in their handouts. The purpose was to investigate the effect of different cues on the accuracy and quality of notes taken. However, it was possible that this quality could reflect the topic or idea covered by the cue, rather than the mode of delivery. For example, better notes for

the interactive window than for the discussion might arise because the topic covered by the window was seen as simpler or more interesting by the students. To avoid this possible confounding between topic and cue, the topics selected for the windows and for the discussions were swapped between the 2006 and 2007 lectures. The two lectures were kept as similar as possible between years, apart from this.

At the start of each sampled lecture, students were issued with sheets of carbon copy paper (which, when inserted directly under the students' note-paper, takes a record of any writing made on the paper above it). The purpose of the research was explained, students were assured of anonymity and were asked to volunteer to leave a carbon copy of their notes at the end of the lecture. These copies were collected and the following variables recorded:

(a) Word count – the total number of words written.
(b) The use of standard abbreviations and symbols (such as 'e.g.', '+', '=', etc.).
(c) The use of any personal or non-standard abbreviations and codes. For example, whether students used symbols to remind them to refer to the handouts.
(d) Whether the notes were 'linear' or 'non-linear'. This was assessed on a scale from 0 (notes were entirely linear, following the order of the lecture from the top of the page to the end of the notes) through 1 (there was some use of alternative structuring, such as arrows linking related points) to 2 (the notes were extensively 'non-linear'; they used concept maps, spider diagrams or similar approaches).
(e) Notes relating to each of the four cues were marked for quality on a scale from 0 (not present at all) through 1 (some relevant notes, but incomplete or showing misunderstanding) to 2 (full notes accurately recording the key concepts or words and showing understanding of the concept or words).

Two of the four lectures were 'double-marked' for linearity and quality by two people assessing them independently using shared marking criteria; a very high degree of consistency was achieved.

Statistical analyses

The relationship between the number of words recorded and the quality of the notes produced was explored for each lecture by producing a total score for each set of notes by adding the scores given to each of the four cues. These were regressed against total word count. Because cue 1 involved verbatim copying (with no requirement for understanding) a positive relationship between word count and higher score for this cue was very (perhaps trivially) likely. Hence further analyses were conducted using scores only from the other three cues (i.e. with a maximum total score of 6 for any single note-set). Note-sets were grouped into three categories: those with scores 0–2, 3–4 and 5–6. The mean word counts were compared using ANOVA (after checking for assumptions of normality and homogeneity of variance) between these three categories for each lecture separately (i.e. four separate analyses were performed). The frequency distributions of scores for the 'interactive window' topics in each of the 2006 lectures were compared using chi-squared analyses with the distributions recorded for the same topics in the 2007 lectures, which had been delivered using the alternative method of discussion.

Results

A total of 238 copies of note-sets were collected. Response rates were good in all lectures, averaging 73% and never dropping below 56% of the students present.

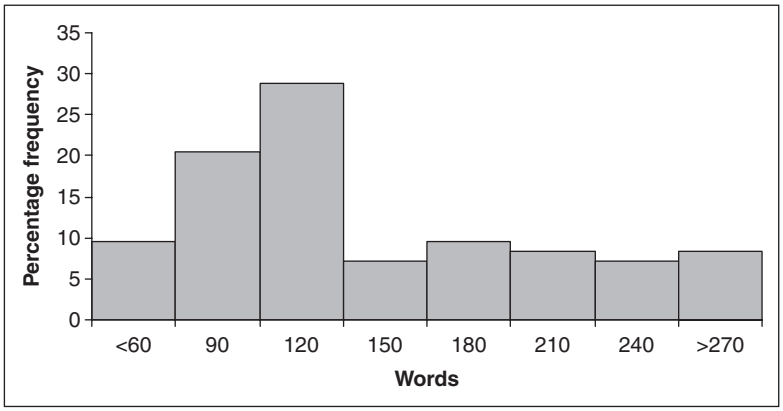

Figure 1. Frequency distribution of words recorded from lecture 4 (shown as a representative example)
Bins are 30 words wide (e.g. 90–119) apart from the two ends of the distribution. All four lectures showed similar distributions.

Word count

There was a large variance in the number of words recorded in each lecture. In each case the frequency distribution of words was highly non-normal and right-skewed (Figure 1). For example, in lecture 4 the modal word count lay between 90 and 119, and 10% of students recorded 60 or fewer words. However, 8% recorded more than 270 words. Hence a significant minority of students were recording twice or more than twice the modal number of words.

Use of abbreviations, codes and non-linear notes

Only a minority (40.5%) of students' note-sets showed any kinds of abbreviations. Of those that did, 'e.g.' and arrows (indicating 'therefore' or 'leads to') were the most commonly used; other standard abbreviations such as 'i.e.' and 'etc.' were rare (~2% for both), as were shortened words (such as des. for desirable etc.). Most students did not use personal codes or prompts (these occurred in only 5% of note-sets), and only three sets of notes (1%) received a score of 2 for 'non-linearity'.

Relationship between words and scores

There was a highly significant positive relationship between the total scores given to each set of notes and the number of words recorded (linear regression, $F = 28$, $P < 0.001$, $R^2 = 0.4$). However, the scores recorded for cue 1, the slide, which did not require any understanding, may have influenced this relationship. Hence the data were analysed after excluding scores for the slide. The pattern was the same for each of the four lectures, with increasing mean word counts for the higher scoring sets of notes (Figure 2). There were significant ($P < 0.05$) differences between the score groups in three of the four cases.

Effects of cues on quality of notes

There were large differences in the scores received by notes referring to the four different types of cue: slide, statement, discussion and window (Figure 3). These differences were highly significant

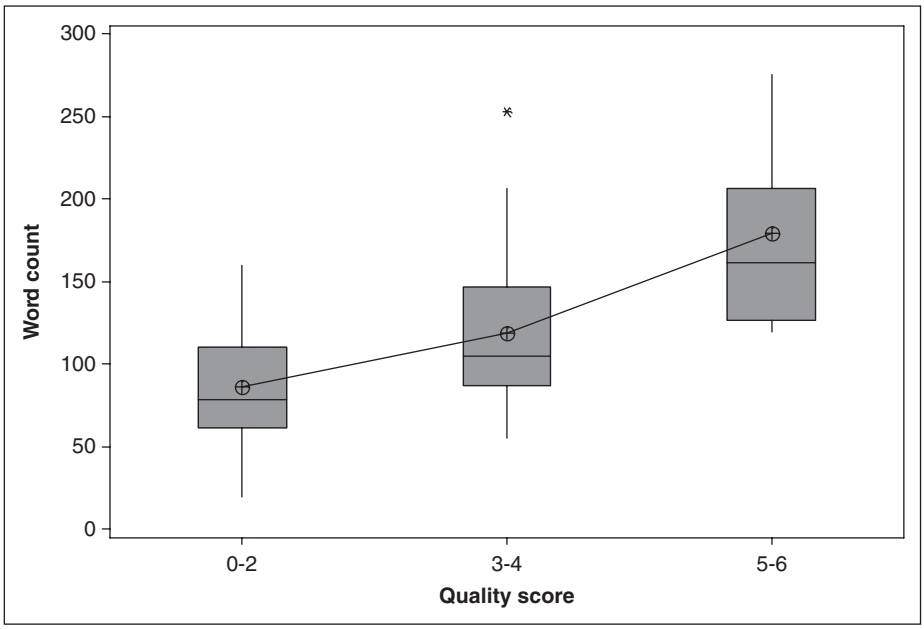

Figure 2. Box and whisker plot showing the relationship between average quality scores assigned to note-sets and number of words recorded in lecture 4 (shown as a representative example)

Boxes show medians (central lines) and means (crosses), with 25 and 75 percentiles (outer sides of the boxes) along with ranges ('whiskers' or lines). All four lectures showed the same pattern, and three of the four showed significant differences between means.

(chi-squared test, $\chi^2 = 214$, d.f. = 6, $P < 0.001$). Only 2% of note-sets scored 0 for the slide cue (implying that there were no notes referring to this cue), and 72% of notes had full records of the slides. In contrast, more than 40% of note-sets failed to make any record of the discussion, and only 16% had a good record of this cue that showed understanding of the key point or points.

Although the slide cue scored best overall, a perfect score for this could be achieved through verbatim copying (which might not imply understanding). Scores for the other three cues showed interactive windows with the highest proportion of 'good' notes, recording the key points and issues, and showing understanding. Whilst most students recorded the written statement, only 22% of notes referring to this were complete enough to show understanding. Scores for the discussion cue were the worst (Figure 3). Note-sets scoring less than 2 for the slide cue did so exclusively because of incompleteness. This was generally true for the other cues, although there were also instances of students making errors of fact or interpretation in these cues.

Effects of topics versus cue on quality of notes

In all four lectures, scores for interactive windows were higher than those for discussions. This was not the result of the topics chosen. For both the evidence and sex lectures, swapping the cue from interactive window to discussion led to a reduction in the quality of notes for a given topic (and vice versa, an increase in the quality of the notes for the topic now covered by an interactive window). For example, in the evidence lecture the topic 'convergent evolution' was considered using a discussion in 2006, and only 15% of notes scored 2. In 2007, the same material was covered using an

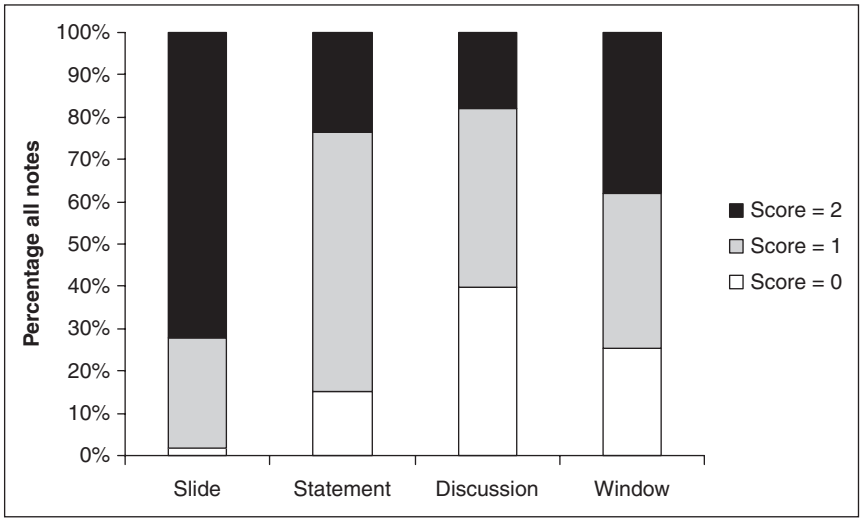

Figure 3. Percentages of all notes achieving quality scores of 0 (missing), 1 (partial description) or 2 (complete description) for each of the four cues investigated

interactive window, and more than 60% of notes scored 2 (Figure 4). Conversely, notes scoring 2 on the topic 'molecular homologies' dropped from 35% to 16% when this was changed from being an interactive window to a discussion (Figure 4). The frequency distributions of marks for the two topics covered in 2006 as interactive windows and then, in 2007, as discussions were compared using chi-squared tests; both were highly significantly different ($\chi^2 = 24$, d.f. = 2, $P < 0.001$; $\chi^2 = 13$, d.f. = 2, $P = 0.002$).

Discussion

Personal observation and experience suggest a wide variety of note-taking approaches and styles among first-year students, from those who tape record every word for subsequent transcription, to those who appear to record nothing. The current work supports this impression of variability; most students recorded less than half the number of words taken by the most prolific writers. Word count alone, however, does not give an indication of the quality of the notes. It is possible that students recording fewer words are more selective, focusing on the key points and concepts and ignoring unnecessary details, whilst prolific note-takers include unnecessary adornment. This sanguine interpretation was not supported by the current work. There was a strong correlation between word count and the quality score of the notes, hence those students who tended to record more also tended to record the most relevant information and to show understanding of key concepts. Previous work has shown that many students produce inadequate notes (Baker and Lombardi, 1985). The current study supports this, indicating that changes in lecture formats and presentation, such as the use of PowerPoint and the provision of lecture handouts, may not necessarily lead to better note-taking. It also shows that lecturers who observe students taking few notes should regard this as an indication that learning is being compromised.

Sutherland et al. (2002) analysed 25 sets of lecture notes and found only 20% used abbreviations, and only 12% included diagrams. The current larger sample size supports this general finding that

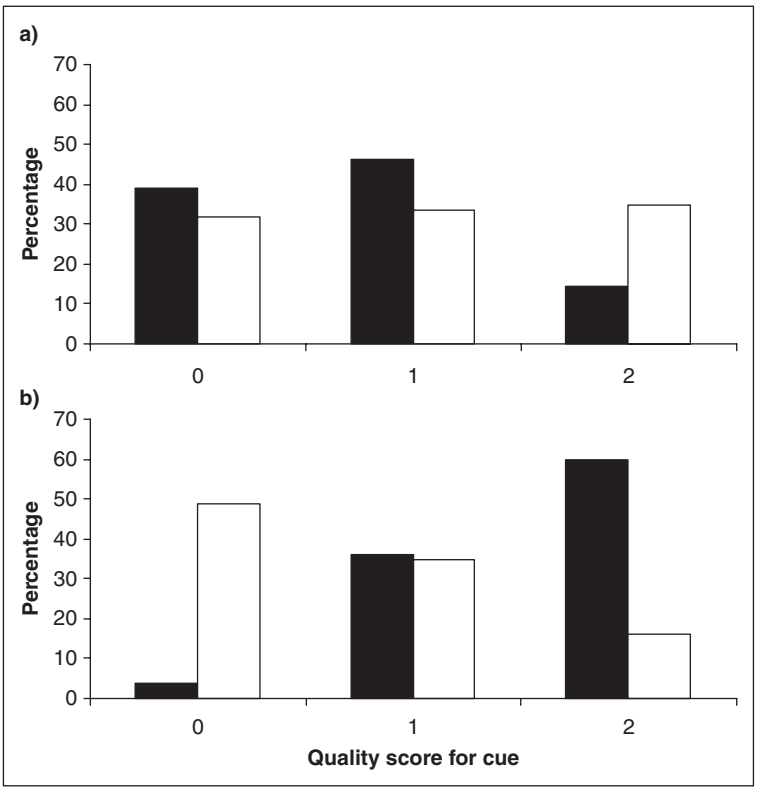

Figure 4. Example of effects of cues on note-quality

(a) shows the frequency distribution of scores achieved by notes in 2006 for the evidence lecture taken during the interactive window (open bars) and discussion (shaded bars) cues.
(b) shows scores for the same topics (shading consistent between topics) covered in 2007, but after swapping the cues.

only a minority of students use advanced note-taking skills (including the use of standard abbreviations or of their own codes). In particular, only 1% of the current sample showed non-linear notes, such as spider diagrams and mind-maps, which might be expected to aid learning and understanding by emphasizing internal connections among lecture ideas. All learners need to develop a note-taking style that suits them best. For some people this will be linear; however, most learners would probably benefit from using some non-linear forms and diagrams. The current results suggest that lecturers cannot expect students to know how to use these techniques without some training.

Some cues for note-taking may involve implicit signals from the lecturer such as tone of voice (Badger et al., 2001). As far as possible such cues were controlled in the current work to prevent bias, and only the four explicit, structural cues of slide, statement, discussion and interactive window were measured. While Hartley and Davies (1978) suggest that 'information recorded in slides or transparencies is unlikely to be recorded in students' notebooks', this research demonstrates the opposite: 98% of the note-sets recorded at least some of the information on the slide, with a large majority achieving verbatim records. Hence the students in this work clearly understood a slide as a cue to note-taking. This was not always the case with the other cues. Badger et al. (2001) interviewed 18 students about their note-taking practices and found that students see PowerPoint

slides as cues for copying, while they might record 'Nothing from the words the lecturer is saying'. The discussion cue involved no writing (on slide or whiteboard) by the lecturer, and 40% of note-sets contained no record at all of topics covered at this cue, corroborating the idea that students may not record information or ideas that are spoken, rather than written, by the lecturer. Similarly, the majority of students recorded the bare information that was written on the whiteboard for the statement cue, but only 22% of note-sets expanded on this information to explain or contextualize it. However, the interactive windows produced a higher quality of notes, despite not involving the copying of any written material; 38% of note-sets achieved the highest score, compared with 23% and 18% for the statement and discussion cues, respectively. Hence students do not rely on written material only as a cue for notes; a key difference here is that the windows involved recording their own thoughts and discussions rather than the words of the lecturer only. Examination questions on topics taught using interactive windows have higher mean marks than those taught using standard discussion (Huxham, 2005). One reason for this might be the better quality of notes.

The better notes resulting from the interactive window cue were unlikely to have been caused by a chance confounding between the cue and the topics chosen. Swapping topics between discussion and interactive windows in the second year of this study resulted in the pattern predicted if windows enhance notes compared with discussion, and in highly significant differences in the frequency distributions of marks awarded for the same topics between years. There will of course be other differences between student cohorts, so changes between years are to be expected (although the two cohorts studied here had very similar demographics and performances, with mean module coursework marks of 69% and 67% for 2006 and 2007, respectively). Repeating the study over numerous years would be the best way of checking whether the notes followed the predicted pattern. In the absence of that, a partial control for differences between these two cohorts comes from comparing the frequency distributions for the statement cue between years, since the topic for this cue was not changed. Doing this gives P values of 0.53 and 0.04 for the two lectures. Hence there was significant change for the second lecture caused by something other than the cue. However, given the pattern of change seen for the windows vs. discussion comparison, and the highly significant differences between years for both of the lectures, the evidence for the enhancing effect of interactive windows on student notes is strong.

The current work showed a number of strengths compared with similar studies; it considered a comparatively large number of note-sets, taken from a large fraction (always a majority) of students present at any one of the lectures, and was able to experimentally test the effects of two cues. However, some limitations are also apparent. Students volunteered to give copies of their notes, hence the sample may not be entirely representative of the whole class and it is possible that students modified their note-taking in the knowledge that the lecturer would see the notes. If true, this would make the rather cursory nature of many of the note-sets even more worrying. Because notes were anonymous, the effects of student characteristics (such as gender, age and educational background) on note-taking, and relationships between notes and assessment scores, could not be examined. It is possible, therefore, that students who took brief and inadequate notes still achieved good understanding, and may have reflected on and supplemented their notes after the lecture; unfortunately, personal experience and previous research (Sutherland et al., 2002) suggests this would apply to a minority only.

In conclusion, the present work showed that different cues resulted in different qualities of notes, and supports the use of interactive windows in lectures. It showed that students who took more notes also generally took better notes, and concurs with previous studies in showing that most students fail to record key concepts and facts during lectures, lack note-taking skills such as the use of abbreviations, and mostly use linear formats rather than, for example, concept-maps and figures.

One response to this might be to provide instruction in these skills. However, I suspect that 'this type of advice, or more exactly, this type of formal instruction, probably has little effect upon student behavior' (Corey, 1935) is still true 74 years after Corey first reported it; in particular, attempts to teach note-taking in 'bolt-on study skills courses' are likely to fail (Wingate, 2006). Hence the challenge is to find ways, embedded within routine teaching, of combining handouts and appropriate cues with techniques to encourage students to reflect on their own notes and on their skills and understanding (such as through peer comparison of notes). The goal should be producing notes that both record and facilitate learning.

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Biographical note

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