

Lectures: electronic presentations versus chalk and talk – a chemist's view.

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Abstract: An extensive survey of undergraduate Chemistry lectures from years 1-4 during 2004-2005 has been undertaken. They were categorised according to the method used for delivery, where category 1 used only electronic media to deliver courses, category 2 used a mixture of electronic and non-electronic and category 3 used non-electronic only. Analysis of student questionnaires, coupled with interviews with a selection of students and lecturers from each category, revealed that the impact of the method of lecture delivery is very slight indeed. Non-electronic methods were preferred, but the differences were not significant. The main problems identified with electronic presentations were: that too much material was covered, hard copies of the notes were not provided, the presentation contained particularly complicated diagrams or seemingly irrelevant images, and lectures were presented too quickly. In addition, it was observed that there was a tendency for lectures given using electronic media to have fewer (or no) breaks, natural or otherwise. [*Chem. Educ. Res. Pract.*, 2007, **8** (1), 73-79]

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Introduction

Lectures can be traced as far back as the Greeks of the fifth century BC, and in medieval times lectures were the most common form of teaching (Brown and Atkins, 1988). Therefore, the lecture has its merits, otherwise this form of teaching would have ceased. Cannon (1988) noted that research comparing lecturing with other teaching methods provides insufficient evidence to favour one method over another. However, he also notes that discussion methods in small groups appear to be a superior method of attaining higher-level intellectual learning. Once students enter University, it is almost inevitable that they will experience lectures, irrespective of the chosen subject. It is often impossible, given the limited number of academics in any University department, to provide small group classes to cover a particular course or module when the number of students attending is so large. In some countries limited resources, e.g. where perhaps only the lecturer has a textbook, force the wholesale use of lectures as the medium for education. Hence, as Walton (1972) notes, the lecture is here to stay, so it is imperative that it should be as an effective teaching method as possible.

In recent times the use of electronic media has become commonplace in Universities, as well as secondary and primary schools. Recent studies have sought to determine whether using PowerPoint or other such media are superior forms of delivery for lecturing over the traditional 'chalk and talk' or the use of transparencies and an overhead projector (TOHP). The study of Bartsch and Cobern (2003) noted that students preferred PowerPoint over the

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use of TOHP, but that in some instances the content of the PowerPoint presentation distracted students and they performed less well on tests compared with a control group. Szabo and Hastings (2000) carried out an extensive study comparing PowerPoint and TOHP and observed no difference in student performance in tests; the most important factor was lecture subject difficulty in determining the students' performance in these tests. They concluded that the efficacy of using PowerPoint was case specific rather than universal. The study of Lowry (1999) saw a marked improvement in examination results when PowerPoint replaced the use of TOHP. Therefore, there is a mixture of views based on recent studies. In this study we investigate students' opinions of the impact of electronic presentations in lectures in undergraduate chemistry compared with TOHP and other traditional non-electronic approaches, and compare the impact on examination results.

Methodology

The School of Chemistry at Bristol is one of the largest undergraduate teaching institutes in Chemistry in the UK with 130-200 students in any one year. Lectures are arranged, for administrative purposes, under the traditional headings of Physical and Theoretical, Inorganic and Materials, and Organic and Biological. Students either take a 3 year course leading to a B.Sc. or a 4 year course leading to an M.Sc. This work is based on data taken from the academic year 2004-2005. We first invited lecturers to declare which of three categories they fall into for each course that they lecture. The categories are; 1, always uses electronic based media (mainly PowerPoint), 2, uses a mixture of electronic media and traditional methods such as TOHP, or chalk and blackboard, and finally those who use only non-electronic methods are in category 3. The responses to student questionnaires on all courses have then been analysed; first, from the perspective of each category of delivery as a whole, and second, the differences between undergraduate years 1 to 4, and third, differences between lecture groupings of Physical and Theoretical, Inorganic and Materials, and Organic and Biological. Some students and lecturers were interviewed further in the light of the analysis of questionnaires, and the salient points will be discussed later. The student questionnaire asked the students to rank the following (among other questions), where the scale of 1 (Agree strongly) to 5 (Disagree strongly) could be augmented by written comments on the particular lecture course.

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|---|---|---|---|---|---|
| 1. The lectures were well organised | 1 | 2 | 3 | 4 | 5 |
| 2. The lecturer was audible | 1 | 2 | 3 | 4 | 5 |
| 3. The board work and/or visual aids were clear | 1 | 2 | 3 | 4 | 5 |
| 4. The associated handouts and/or web pages were useful | 1 | 2 | 3 | 4 | 5 |
| 5. The lectures stimulated my interest | 1 | 2 | 3 | 4 | 5 |
| 6. This course of lectures advanced my understanding | 1 | 2 | 3 | 4 | 5 |

Between 1999 and 2003, a variety of audio-visual aids had been added to lecture theatres and lecturers began to use electronic media for lectures. In 2004 the lecture theatres were refitted and in each one there is the option to use the web, PowerPoint and other packages, TOHP, blackboard and chalk, a volumiser (where writing can be projected onto a screen from a normal piece of paper), as well as videos.

Results of the questionnaires and their discussion

First, of the 45 academics interviewed, 9 (20%) of lecturers fell into category 1, *i.e.* they used electronic media only, 22 (49%) of lecturers fell into category 2, *i.e.* they used a mixture of electronic and non-electronic and 14 (31%) of lecturers fell into category 3, *i.e.* they used

no electronic media. Second, the overall score from the questionnaire was used in these results. The results from the analysis are presented in Tables 1 and 2.

Table 1. Questionnaire scores expressed as a percentage for each of the 5 options for lecturers in the 3 categories of preferred presentation medium, first for all four years and then in individual years. See text for comments on year 4 data in categories 2 and 3.

All years

Questionnaire Scores %	1	2	3	4	5
Category 1	6	60	33	1	0
Category 2	10	63	27	0	0
Category 3	12	70	16	0	0

Year 1

Questionnaire Scores %	1	2	3	4	5
Category 1	11	68	19	2	0
Category 2	12	75	12	1	0
Category 3	14	78	8	0	0

Year 2

Questionnaire Scores %	1	2	3	4	5
Category 1	6	59	34	1	0
Category 2	8	65	27	0	0
Category 3	11	67	22	0	0

Year 3

Questionnaire Scores %	1	2	3	4	5
Category 1	8	58	31	3	0
Category 2	13	75	12	0	0
Category 3	11	75	14	0	0

Year 4

Questionnaire Scores %	1	2	3	4	5
Category 1	7	60	33	0	0
Category 2	6	49	39	6	0
Category 3	35	64	1	0	0

Comparisons across all categories

Table 1 shows the questionnaire scores for each category of lecturer for all years and also split into individual years. In year 4 in category 2 there were two courses given by the same lecturer that skews the result and in category 3 there was just one course given. Although the scores for years 1-3 and also the overall scores are very similar across categories, it could be argued that there is a small but consistent pattern in years 1-3 where category 1 fares less well than categories 2 and 3. The observation that there is neither a negative or positive effect of using electronic media is consistent with the work of Szabo and Hastings (2000). Many examination questions contain elements from several courses, and in each examination paper there is an element of internal choice. Therefore, an analysis of examination score from every course is difficult to obtain. However, where it is possible to compare examination result with

a course there is a clear trend; lecture courses that yielded a higher score on questionnaires (less well received) had the lowest examination score. Where courses are perceived to be hard to understand or contain difficult material, examination marks are lower (Szabo and Hastings, 2000). Accompanying comments on questionnaires suggest that the courses which suffer poorest examination results are indeed the ones difficult to understand. We find no statistical difference between method of delivery and poor examination score. Our evidence does not support the study of Lowry (1999) and Bartsch and Cobern (2003) and this will be discussed later. There is also a remarkably consistent pattern across the years.

On interviewing students from various years and lecturers in each category, some useful practical comments were recorded.

- The most effective lectures, regardless of the method of delivery, were ones where lecture notes were supplied that could be annotated during the lecture. Students wanted to be able to listen to the lecturer and make their own notes, in addition to the material presented. They did not want to be simply writing material down all the time. They particularly stressed that copies of diagrams, etc. were essential.
- Of those electronic presentations that were disliked, the main reasons were: hard copies of the notes were not provided, the presentation contained too much material, the presentation contained particularly complicated diagrams or seemingly irrelevant images, and the lectures were delivered too quickly.
- Electronic presentations avoided the issues of poor handwriting, seen with TOHP or chalk and talk methods, and the perennial issue of dirty blackboards impairing legibility of material, especially if several lectures have used the blackboards that day.
- Lectures with a heavy mathematical bias were universally not popular when presented using only electronic media. However, students did find that good visual displays that augmented mathematical material were very beneficial, especially where it was interactive and allowed the students to explore concepts off-line for revision purposes.
- Several lecturers felt that using PowerPoint or html forced them to think very carefully about the material they presented and the way they presented it. Lecturers who never used electronic media found this medium inflexible. Many said that they wanted to have the ability to respond to the audience, and when they felt that a particular diagram or point required amplification it was very hard to do this with a 'rigid' electronic presentation format. Equally, those lecturers who only used electronic media said that the major advantage was the way that complex diagrams could be built up piece by piece. In the past they had used overlaid transparencies, which had been unsatisfactory. In particular, being able to visualise and manipulate 3D structures was seen as a real advantage in chemistry.

Of course it is now possible to annotate electronic presentations through interactive whiteboards and related devices, and some lecturers have been piloting these in tutorials. Such an extension would go some way to providing the flexibility sought by lecturers in category 3.

Having observed some lectures from all categories, we noted greater confidence shown by lecturers in category 3 over category 1. This derives in the main from the fact that no matter how much preparation one does, under the current set-up at Bristol, there is usually only a maximum of 10 minutes between lectures to 'fire up' a presentation and to make sure all the links work as intended on the day on that machine. There was also a tendency for the pace of a lecture in category 1 to be 'flat' and to have no breaks, intended or otherwise. Lectures in the other categories were varied in pace and had natural breaks (cleaning the blackboard, moving around the lecture theatre etc.). Chemistry lectures will, by their nature, contain a lot of symbols, and in some cases mathematical material; this will be discussed further in the next section. Taking questionnaire and interview material together it would

seem that there are indeed some differences between lecture categories, but that their impact is slight.

Table 2. Average questionnaire scores for lecturers in the three categories of preferred presentation medium, split into the three overarching teaching strands.

Physical

Questionnaire Scores %	1	2	3	4	5
Category 1	6	59	35	0	0
Category 2	11	61	28	0	0
Category 3	14	76	10	0	0

Inorganic

Questionnaire Scores %	1	2	3	4	5
Category 1	7	61	32	0	0
Category 2	15	75	10	0	0
Category 3	12	75	13	0	0

Organic

Questionnaire Scores %	1	2	3	4	5
Category 1	6	48	43	3	0
Category 2	6	58	35	1	0
Category 3	10	71	19	0	0

Comparisons across lecture groupings

In Table 2 the effect of the subject area of lecture material is presented, and again any differences are small, with a slight bias towards Physical and Inorganic over Organic in all categories. The feedback from students emphasised three important points regarding differences in subject area.

- Lectures covering organic and biological chemistry tend to involve writing structures of compounds, with an emphasis on synthetic pathways. In general, students found this material harder to write down or annotate, regardless of lecture method used, especially when stereochemistry is important.
- When synthetic pathways were explained in organic and biological chemistry lectures, students preferred those that used TOHP or chalk and talk, because the material was presented at a slower pace, allowing students to follow the material. Those organic and biological chemistry lectures using PowerPoint or other electronic media that were perceived as being 'weaker' were reported to contain too much material and were presented too quickly. In year 1 in particular, students reported that they were unfamiliar with writing structures, and found it hard to follow pathways.
- A major concern of students in Physical and Theoretical lectures was the need for consistency of symbols used across courses, and it was observed that some electronic presentations suffered from not being able to write symbols in a font that was consistent with other lectures.

Cannon (1988) has set out characteristics that appear to be related to effective lecturing, notably preparation (Falk and Dow, 1971; Brown, 1978), presentation (Brown, 1978; Brown and Atkins, 1988) and evaluation. Under presentation, Brown (1978) and Brown and Atkins (1988) describe in detail the perceived process by which students learn from lectures. The

lecturer sends a message, which may be verbal, non-verbal, a gesture, or some other medium. Messages that are received by the students are filtered and stored temporarily in the short-term memory. If these messages cannot be rehearsed or cannot be transferred to the long-term memory after about thirty seconds, they are forgotten. In addition, attention will inevitably fluctuate throughout a fifty-minute lecture. After twenty minutes there is a marked decline in attention, followed by a peak just before the lecture ends (e.g. Johnstone and Percival, 1976). Of the lectures observed in each category, there were fewer deliberate or forced breaks in the presentation in category 1, and in the most extreme case there was a solid 50 minutes of information presented.

The work of Lowry (1999) focused on a first year environmental science course, and gave several possible reasons why there may be a marked improvement in student performance after the introduction of PowerPoint, but the most striking was the fact that the style of workshops were changed, and that these may have led to the improvement in cognition. Lowry made some excellent points concerning the use of electronic media and these have already been commented upon in this paper, yet there is no strong evidence from this study based on questionnaires, interviews and examination results, to support the assertion that electronic presentations produce deeper level learning than non-electronic ones. Indeed, if the very small differences between scores from the three categories are taken at face value they suggest the opposite is more likely to be true.

A secondary school perspective

It is useful to have a secondary school perspective on styles of teaching and to know what students of the future will have experienced. In the early days of IT in schools it was rare for teachers to make regular use of the technology in class teaching because of a lack of training and equipment. New Opportunities Fund (NOF) Training (1999-2003) with the aim of increasing the IT expertise of serving teachers (and librarians) to that of newly qualified teachers in 1999, has been successful in up-skilling most teachers (Preston, 2004). Electronic media in laboratories, classrooms and computer suites is increasingly available in schools and is being used in science lessons by “*teachers who are confident in the classroom use of modern technology*” (Ofsted, 2002).

It is now common for teachers at school to use PowerPoint and other packages to deliver lessons, particularly during practical science classes. Students are therefore very familiar with this format, however, the dominant form of delivery is still a chalk and talk approach.

Concluding remarks

There are clearly some essential characteristics for effective lecturing. Good preparation, from planning the course structure to being able to work the lights in the lecture theatre, is vital. Good presentation skills are important; students must be able to see and hear the relevant information. Ideally, the course must motivate and enthuse the students without overloading them. Ausubel (1968) has claimed that “*The most important single factor influencing learning is what the learner already knows. Ascertain this and teach them accordingly*”, although the student’s own motivation will also play a role.

Having analysed questionnaires, carried out interviews and also inspected examination results, we conclude that the method of delivery has no significant impact on learning outcomes. Questionnaires and interviews with students establish that the most important aspect of the lecture is clarity; there are good examples of clear lectures using each category of delivery inspected. In addition, there is a strong positive correlation between examination

result and questionnaire score, where interviews suggest that the reason for poor examination results is that material has been hard to understand.

Brown (1978) argues that it does not matter whether copious handouts and examples, or just a few are given out; the important aspect is quality of example and handout. It does not matter whether lecturers prefer the 'classic' or the 'thesis,' or the 'comparative' or the 'sequential' or even the 'problem-centred' (Brown, 1978) style to lecturing; the important aspect is choosing a style that is appropriate for the particular course. It would appear that the effective lecturers are those who start at a point where the learners can comprehend and lead them step-by-step through the new material, and that that is far more important than the medium used. There are always improvements one can make to style and delivery of presentation, and any slight differences observed in this study between electronic and non-electronic presentations are most likely due to lecturers learning how to use the new tools effectively. However, the conclusion of this study is that the mode of presentation is not the key difference in learning outcomes.

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