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ARTICLE

Assessing small-scale interventions in large-scale teaching

A general methodology and preliminary data

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ABSTRACT The use of lectures is ubiquitous in higher-education institutions, but also heavily criticized from an andragogical viewpoint. A current challenge for lecturers is to provide opportunities for active learning during these sessions and to evaluate their impact on student experience. Three one-minute interventions based on the lecture materials (write down one thing you have already learnt, one question you would like answering, and take a break) were introduced approximately 20, 30 and 40 minutes into the lecture and assessed with respect to engagement over a five-week period on a final-year psychology option. Students were invited to record their current level of lecture engagement every 5 minutes. Both between-and within-subject analyses revealed a significant increase in lecture engagement for the first intervention during the first intervention week relative to baseline weeks. The data show an enhancement of student engagement with certain small-scale interventions during large-scale teaching.

KEYWORDS: *active learning, large-scale teaching, lecture engagement, one-minute paper, pause procedure, small-scale interventions*

Introduction

Lectures continue to serve as a primary delivery method for large-scale teaching in higher-education institutions (Biggs, 2003; Ruhl and Suritsky, 2006). However, this does not appear to be related to strong andragogical evidence supporting their effectiveness but rather reflects 'the formidable forces of economic efficiency, institutional inertia and personal habit' (Huxham, 2005: 18). Indeed, lectures are quite unsympathetically defined by Habeshaw et al. (1992) as '50–55 minutes of largely uninterrupted

discourse from a teacher with no discussion between students and no student activity other than listening and note-taking' (p. xi). Moreover, there is empirical evidence to support the notion that lectures are actually quite ineffective (Knight and Wood, 2005). Lloyd (1968) discusses the consistent deterioration in levels of attention as a function of lecture time for both student and lecturer, with only a slight reprieve in student attention at the end of the lecture. Further critique of the lecture format is provided by Caldwell (2007), who reflects on 'the passive, one-way communication inherent in lecturing and the difficulty students experience in maintaining sustained concentration' (p. 11). In this respect, Caldwell (2007) is associating the lecture with a transmission model of communication (essentially originating from Shannon and Weaver (1949), although see Kolitch and Dean (1999) for a more educational perspective) in which learning is a unidirectional process in which information is transmitted from teacher to student.

There is a useful distinction that can be made here between active and passive learning, in which lectures aligned with the transmission model of teaching tend to fall into the latter category. While passive learning is characterized by the principle of knowledge transference, active learning is viewed more as a constructive process (Prosser and Trigwell, 1999) characterized by intentional engagements, purposeful observations and critical reflection (Graffam, 2007). The movement from passive to active learning also reflects a movement from teacher–student relationships to learner–learner relationships (Graffam, 2007). As an example of this, Wood (2004: 797) reflects on receiving feedback that only 48% of students were able to correctly apply a rule of genetics: 'For me, this was a moment of revelation … for the first time in over 20 years of lecturing I knew, on the spot (rather than after the next mid-term examination), that over half the class didn't "get it": had not understood either the question or my presentation of the phenomenon …' With this kind of reciprocal feedback, lecturers themselves learn about the current level of understanding of the class, and are able to adjust teaching accordingly. In this respect, the learner–learner cycle provides a more equitable framework between teacher and student and also makes transparent the importance of the student experience in higher education.

Therefore, there is scope to improve the quality of the lecture experience for both student and lecturer, and the introduction of active learning in this traditionally passive form of teaching appears to be one way to do this (Nierenberg, 1998). However, there are substantial barriers to students becoming involved in lectures, and Caldwell (2007) describes three. There is the student expectation of passive behaviour during a lecture setting (Knight and Wood, 2005) as well as fear of embarrassment and fear of peer

evaluation. Therefore, appropriate forms of active lecture intervention would appear to be those that allow the student at least some form of anonymity. One technologically sophisticated solution to this problem is the implementation of personal response systems (PRS; Beekes, 2006), also known as clickers or audience response systems (Caldwell, 2007), in which students are invited to submit electronic responses to questions and prompts during the teaching session, often acting as catalysts for break-out group discussion and other activities. In this respect, PRSs can overcome many of the problems faced with lecture intervention by allowing for anonymized input, the opportunity for engagement from all members of the class, and a break from the traditional transmission model of teaching (Caldwell, 2007).

In the absence of such technology, more low-tech solutions have been suggested that may broadly be described under the term of *interactive windows* (Huxham, 2005). Interactive windows have the general goal of increasing the level of student input during lectures, and incorporate a wide variety of interventions ranging from the provision of uncompleted handouts to buzz groups, from student reading to quiet reflection time (Gibbs et al., 1987; Habeshaw et al., 1992). One intervention that will serve as the focus for the current study is known as the *one-minute paper* (OMP; Stead, 2005). Usually administered at the end of a teaching session, the OMP invites students to privately answer on a sheet of paper two questions regarding (a) the most critical piece of information that they have learnt during the session, and (b) one question they have not had answered during the session. In this respect, the OMP shares a number of desirable qualities with the use of PRSs in that both are easy to administer and provide a relatively safe and anonymous form of active contribution for the student. The OMP is also clearly aligned with a constructivist approach to teaching in the way it encourages reflection from the student.

In contrast to these activity-based interventions such as the one-minute paper, there is also the additional notion that students might also benefit from non-activity-based interventions such as the simple act of taking a break (Beekes, 2006). For example, Bligh (1998: 59) provided a hypothetical graph depicting level of performance on the *y*-axis and period of teaching along the *x*-axis, in which the decline in level of performance as the teaching period extends is offset by the introduction of a 5-minute rest halfway through the session. A recent empirical example supporting the effectiveness of taking a break has been provided by Ruhl and Suritsky (2006) in which they discuss the *pause procedure*. Here, the free recall of lecture ideas was tested in college students with learning disabilities who were assigned to a number of conditions. In the pause procedure condition, students were allowed 2-minute breaks to be able to catch up on their

note-taking. In the outline condition, students were provided with the key points from the lecture but were not exposed to breaks during the delivery of teaching. In the combined condition, students were given both the outline and regular 2-minute breaks. The data from Ruhl and Suritsky (2006) suggest that students in the pause procedure condition performed best in terms of recalling ideas from the lecture, while the presence of an outline appeared to narrow the students' focus in terms of information acquisition. Therefore, it is likely that the simple act of taking a break will also lead to positive outcomes for the student. Consequently, the current study aims to compare the effects of small-scale activity-based interventions with non-activity-based interventions, using variations of both parts of the one-minute paper and the pause procedure.

A final component of the study concerns exactly what the effects of small-scale interventions should be measured against. Since one clear property of active learning is to make students more engaged in the material, it seems appropriate to examine variation in lecture engagement as a function of small-scale intervention. As Graffam (2007) states, 'intentional engagement and active learning pedagogies change the nature of learning, while simultaneously improving knowledge gain and recall abilities . . .' (p. 38). However, previous studies have tended to use offline lecture involvement measures such as the completion of questionnaire items after the session (Jackson and Trees, 2003), in which participants are likely to rely on reconstructive approaches regarding the measure of interest. For example, Hardy et al. (2003) defined lecture involvement with respect to two self-report items: lecture attendance (with the responses ranging from 'did not attend' to 'always attended') and note-taking (with the responses ranging from 'does not describe me at all' to 'describes me extremely well'). As a result, the current study incorporates a live measure of lecture engagement in a style similar to the early studies reviewed by Bligh (1998) via a simple pen-and-pencil scale.

In summary, the present study sought to investigate the impact of small-scale interventions on large-scale teaching by collecting from students online estimates of lecture engagement every 5 minutes. Lecture engagement was assessed during weeks in which intentional interventions were introduced into the session at various time points (experimental weeks), and also during weeks in which no intentional interventions were present (baseline weeks). Intervention effectiveness was operationalized as a positive difference in lecture engagement between the time point featuring the intervention and the time point previous to the intervention. A comparison between baseline and experimental weeks also provided an estimate of naturally occurring and intentional variation in lecture engagement, with the hypothesis that interventions would produce significantly larger (positive) changes in lecture engagement over those in naturally occurring lecture environments.

Method

Participants

In accordance with the ethical guidelines set out by the British Psychological Society (2004), it was critical that the experimental design afforded students the opportunity not to take part if they so wished. The study was also designed such that the right not to take part did not result in the compromise of teaching for non-participants. Therefore, both participating and non-participating individuals experienced the same lecture, the only difference being that those participating in the study systematically recorded their level of engagement while those not participating in the study did not. Before beginning the experiment, informed consent from 22 students out of 46 taking part in the final-year undergraduate course Art as Psychology was obtained. Of these individuals, 19 were female and the mean age within the sample was 22.09 (SD = 5.83). However, it was clear from the number of responses collected over subsequent weeks that other individuals in the class informally dropped in and out of the study, with the average number of responses collected per week approximating 19 (see Results for a more detailed breakdown of response allocation across the weeks).

Stimuli and apparatus

Participants completed an engagement rating sheet over the course of five weeks. Each sheet consisted of ten 10 cm vertical lines defining 5-minute intervals during the lecture (from 5 to 50 minutes), thereby allowing lecture engagement to be calculated on a 100-point scale using a millimetre measurement. The highest level of lecture engagement would be represented by a mark at the top of the line and the lowest lecture engagement would be represented by a mark at the bottom of the line. So that participants would be prompted to make a mark on their individual sheets every 5 minutes, a timer was controlled using a Powerbook G4 computer. Here, a 5-minute audio loop was created in SoundEdit 16 (Micromedia) comprising 4 minutes 58 seconds of silence, followed by a 2-second burst of an FM modulated tone (750 Hz with modulation frequency of 5 Hz and a deviation frequency of 40 Hz) with 10 ms linear onset and offset ramps to avoid sample click. This loop was played back over Labtec speakers at a comfortable volume at the front of the lecture venue.

Design

The experiment took place over the final six weeks (weeks 5–10) of an Art as Psychology course. Before the lecture in week 5, an email was sent out to all students enrolled in the course, alerting them to the fact that there

would be an opportunity to take part in an informal assessment of teaching practice and that informed consent for the experiment could be provided in week 5. At the end of the week 5 lecture, the procedure for recording lecture engagement data was detailed and students were invited to take part if they so wished. During weeks 6 and 10, participants completed engagement sheets during the lectures in the absence of intentional intervention so as to provide baseline measures of lecture engagement as a function of time. The collection of baseline data provided some measure of natural variation in lecture engagement and, in this way, the magnitude of the effect of intentional interventions could be compared with unintentional interventions. During weeks 7 to 9, three short one-minute interventions (write down one thing you've learnt so far [A], think of a question you haven't yet had answered [B], take a short break [C]) were initiated by the experimenter just before 20, 30 and 40 minutes into the lecture. The timing of these interventions was counter-balanced across the weeks such that the order for week 7 was ABC, the order for week 8 was BCA and the order for week 9 was CAB (see Figure 1). This design feature made it possible to assess not only which (if any) interventions led to an increase in lecture engagement, but also whether these effects were limited to specific times during the lecture.

Procedure

Throughout the five weeks in which the students were invited to record their live engagement during the lecture (weeks 6–10), data capture sheets

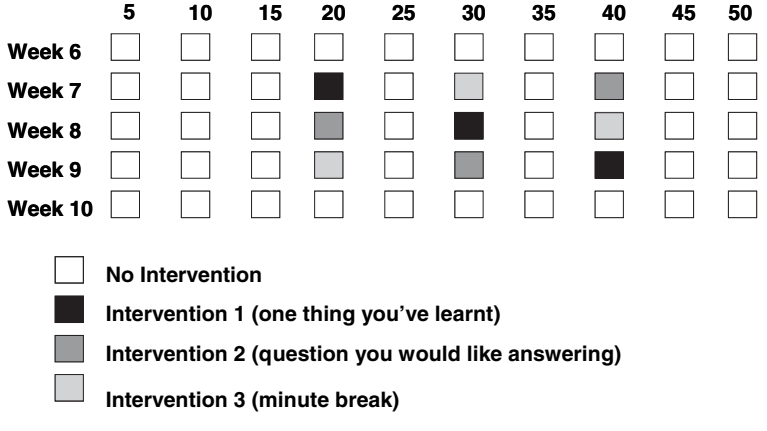

Figure 1 **Schematic representation of the experimental design. Lecture weeks are shown in rows while time points for each lecture are shown in columns. Students were invited to record their current level of lecture engagement every 5 minutes**

were provided before the lecture. Participants were also asked to write down a personal identifier (in this case, their favourite song) at the top of the sheet, thereby allowing levels of engagement to be compared within the same individual across weeks. At the beginning of the lecture, students were invited to record their first response and the timer was set in motion to act as a cue to mark subsequent estimates of lecture engagement in the appropriate column on the data capture sheet. No explicit mention of the interventions were made during the lectures themselves. At the end of the week 10 lecture, students were thanked for their input during the lecture and the rationale behind the various interventions was explained.

Results

The data were examined in three ways. First, data were collapsed across weeks to provide an overview of average student lecture engagement. Second, data from individual weeks were examined to see whether small-scale interventions had a significant impact on lecture engagement. Given the nature of lecture attendance, there was substantial variation in the quantity of student data collected on individual weeks and so a between-subjects analysis across weeks was initially conducted. Third, data were examined for a subset of students who completed a lecture engagement form every week. This allowed for a reanalysis of the data under within-subjects conditions, thereby controlling for a source of variation apparent in between-subject analysis and also providing the opportunity to collapse between weeks 6 and 10 to obtain an aggregate baseline measurement of lecture engagement.

General characteristics of lecture engagement

A total of 93 completed forms were used in an analysis of lecture engagement over an average 45-minute session. Figure 2 shows average lecture engagement collapsed across individual students and across the five weeks of data collection. The figure shows essentially an inverted-U-shaped function with moderate levels of engagement throughout the lecture (averaging approximately 70%), with lecture engagement being low at either end. The data were successfully modelled using the formula $y = -0.78x^2 + 9.80x + 49.98$, which accounted for 82% of variance in the original data. Lecture engagement appeared to be particularly low at the start of the lecture and, while possible explanations for this observation will be addressed in the general discussion, it is important to note that standard deviation for lecture engagement was significantly larger at the 5-minute mark relative to any other time point ($F[9,36] = 8.03$, $p < 0.001$; Tukey's HSD for pairwise comparisons, $p < 0.05$).

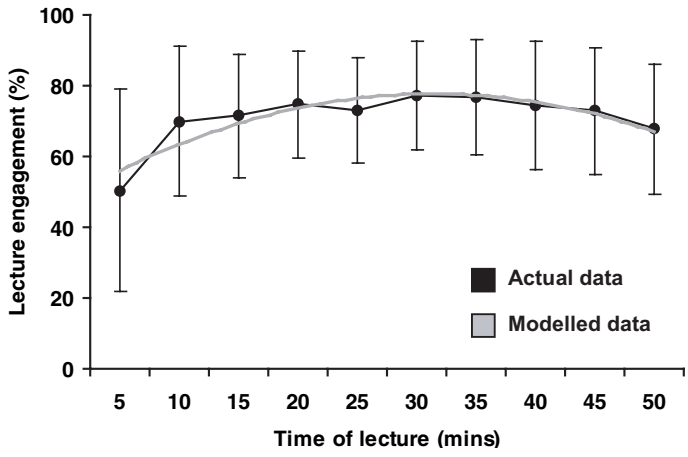

Figure 2 **Graph to show actual and modeled data of lecture engagement averaged across five weeks. Error bars represent standard deviation**

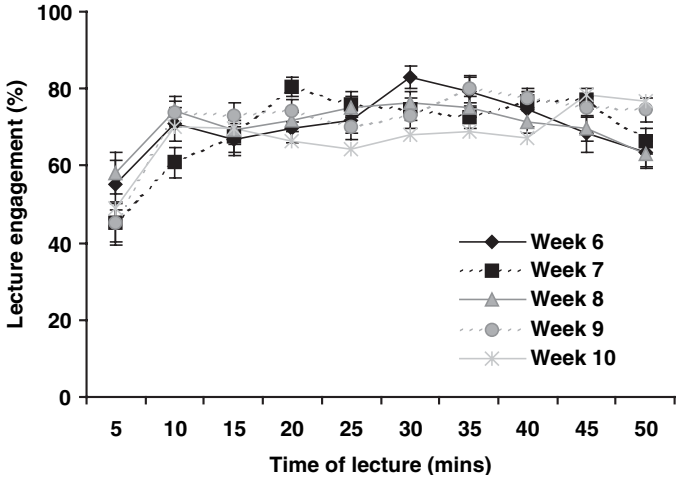

Figure 3 **Graph to show average lecture engagement as a function of time across five teaching weeks. Error bars represent standard error**

Breaking down the data from individual weeks (see Figure 3), substantial individual variation was revealed. Specifically, lecture engagement appears relatively high during week 6 and relatively low during week 10, suggesting some effects of maturation (Campbell and Stanley, 1963), although this cannot be teased apart from lecture content, which inevitably changed from week to week. In terms of the relationship between intentional intervention

and time, there is an encouraging increase in lecture engagement at 20 minutes during week 7. However, a similar positive change was also observed at 30 minutes during baseline week 6.

Between-participant analysis

A primary attempt was made to assess the success of the various small-scale interventions using week as a between-participants factor. This involved taking the level of lecture engagement after the intervention (20, 30 and 40 minutes) and subtracting the level of lecture engagement before the intervention (15, 25 and 35 minutes, respectively) for all five weeks. As no intentional interventions were employed during weeks 6 and 10, the subtraction between these points should provide an estimate of natural variation in lecture engagement, with which the magnitude of the small-scale interventions can be compared.

An initial examination of the differences in lecture engagement revealed that certain combinations of week and intervention led to violations of normality according to the Shapiro–Wilk (S–W) test (see left-hand panel of Table 1; Shapiro and Wilk, 1965). In an attempt to reestablish normality across the different samples, differences outliers were defined as any value greater than +35 or lower than −35. Although this led to a slight reduction in the number of individual recordings utilized per week, week 6 ($n = 22$), week 7 ($n = 21$), week 8 ($n = 21$), week 9 ($n = 18$) and week 10 ($n = 13$), all samples were now assumed to derive from a normal distribution according to a repeated administration of the S–W test (see right-hand panel of Table 1). This data then served in a two-way mixed ANOVA in which week (6, 7, 8, 9 and 10) served as a between-participants factor and intervention (1st, 2nd and 3rd) served as a within-participants factor, the results of which are graphically represented in Figure 4.

Table 1 **P-values for the Shapiro–Wilks test of normality across the 15 groups (5 weeks x 3 interventions) before and after lecture engagement difference outlier removal**

		Before outlier removal				*After outlier removal*		
Intervention	*n*	*1st*	*2nd*	*3rd*	*n*	*1st*	*2nd*	*3rd*
Week 6	26	= 0.942	= **0.033**	= 0.075	22	= 0.789	= 0.953	= 0.089
Week 7	24	= 0.073	< **0.001**	= 0.951	21	= 0.683	= 0.843	= 0.997
Week 8	22	= 0.331	= 0.817	< **0.001**	21	= 0.277	= 0.840	=0.177
Week 9	19	= 0.195	= 0.492	= **0.001**	18	= 0.053	= 0.450	= 0.549
Week 10	16	= 0.125	= **0.020**	= 0.122	13	= 0.635	= 0.779	= 0.242

Note: Statistically significant violations of normality in bold.

The ANOVA revealed a non-significant main effect of week ($F[4,90] = 0.94$, $p = 0.445$, observed power = 0.287), a significant main effect of intervention ($F[2,180] = 5.89$, $p = 0.003$, observed power = 0.871), and a significant interaction between week × intervention ($F[8,180] = 3.46$, $p < 0.001$, observed power = 0.977). Pairwise comparisons were further explored using Tukey's HSD test ($p < 0.05$), in which the positive effect of the 1st intervention at week 7 (+7.86) was significantly larger than the decrease in lecture engagement observed for the 3rd intervention at week 6 (-3.55), the 3rd intervention at week 9 (-3.72) and marginally significant for the 2nd intervention at week 7 (−2.67; $p = 0.054$). This suggests that at least one active intervention (that is, writing down one thing that you've learnt so far) introduced around 20 minutes into the lecture produced an increase in engagement that was *larger* than that for other active interventions (that is, think of a question you haven't yet had answered and take a one minute break) introduced at different times. However, further analyses showed additional positive effects for the 2nd intervention during baseline week 6 (+9.82). This is problematic since during baseline weeks there was no systematic attempt to involve the student with the materials and, as such, the data reflect natural variation in lecture engagement. As a

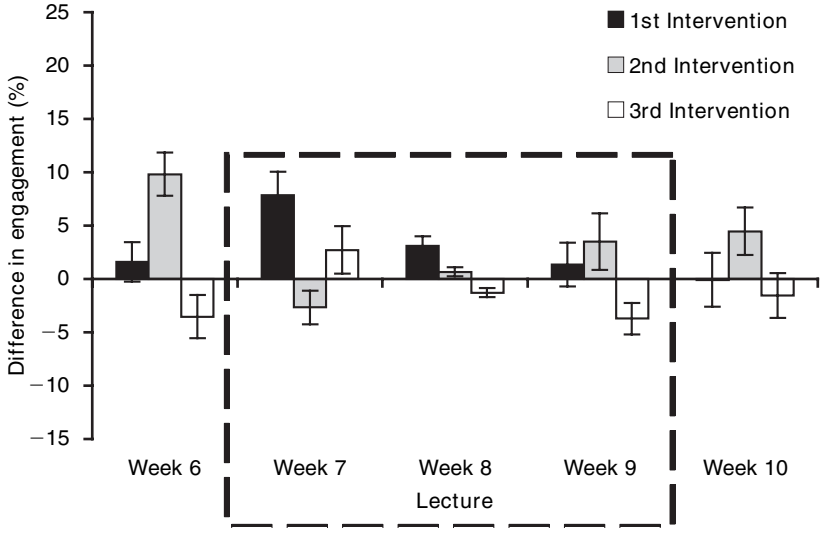

Figure 4 **Graph to show the differences in lecture engagement calculated as engagement after intervention minus engagement before intervention, across five categories of lecture (week 6, week 7, week 8, week 9 and week 10) and three different intervention times. Comparisons were between-participants and error bars represented standard error**

result, the between-participant data suggest that there was as much variation in lecture engagement during baseline weeks as there was during intervention weeks.

Within-participant analysis

As a result of using the same personal identifier across weeks, it was also possible to undertake a within-participant analysis of the data on those students who consistently attended all five lectures and completed a lecture engagement sheet, thereby controlling for the use of different students over different weeks in the previous analysis. The additional advantage of a within-participant analysis in the current instance is that engagement over baseline weeks could be collapsed into a single measure. This meant that effects of maturation could be controlled for, in that baseline measures were now an aggregate of student engagement when the procedure was at its most new (that is, week 6) and also at its most old (that is, week 10). This seemed particularly important as the within-participant analysis replicated the between-participants analysis in that the 2nd 'intervention' during baseline week 6 continued to show a positive effect (+9.2).

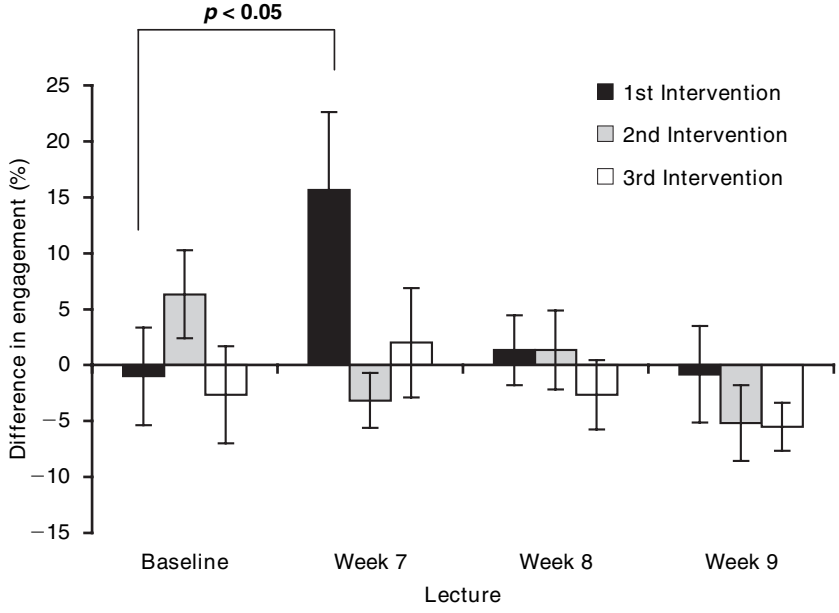

Figure 5 **Graph to show the differences in lecture engagement calculated as engagement after intervention minus engagement before intervention, across four categories of lecture (baseline, week 7, week 8, week 9) and three different intervention times. Comparisons were within-participants and error bars represented standard error**

Only six students fulfilled this criterion (with no constraints on maximum lecture engagement differences), therefore representing a small sample size with which to supplement the between-participants analysis. Nevertheless, engagement difference data were entered for the three interventions across the four categories of lecture (baseline [weeks 6 and 10 averaged], week 7, week 8 and week 9) in a two-way repeated measures ANOVA (see Figure 5 for a graphical representation of the data). The data revealed a significant main effect of week ($F[3,15] = 4.40$, $p = 0.021$, observed power = 0.768), a non-significant main effect of intervention ($F[2,10] = 0.95$, $p = 0.420$, observed power = 0.170) and a significant interaction between week × intervention ($F[6,30] = 2.90$, $p = 0.024$, observed power = 0.818). Pairwise comparisons were again further explored using Tukey's HSD test ($p < 0.05$), in which the positive effect of the 1st intervention at week 7 (+15.67) was significantly larger than the 2nd intervention at week 7 (-3.17), thereby replicating the marginal effect observed in the between-participants analysis, and all intervention differences in week 9 (-0.83, -5.17 and -5.50). As demonstrated in Figure 5 and most critically for the current study, the 1st intervention at week 7 was also significantly larger than the comparative time point during baseline lectures (-1.00).

Discussion

Lecture engagement collapsed across weeks was broadly characterized by a slow increase at the beginning of the lecture and a slow decrease towards the end of the lecture. Lecture engagement was significantly more variable at the beginning of the lecture relative to all other periods. An initial between-subjects analysis showed an effect of the first intentional intervention during the first experimental week (that is, write down one thing you have learnt so far), but similar positive effects were found for naturally occurring variation in lecture delivery during baseline weeks. A subsequent within-subjects analysis following the same individuals across all five weeks replicated the increase in lecture engagement for the first intervention during the first experimental week only, in the absence of significant increases in lecture engagement during baseline weeks. Such conclusions are tempered by the relatively small number of individuals who took part in the study, and also as a result of the self-selecting nature of the sample. However, the self-selecting nature of participants is inevitably constrained by the safeguard that students have the right not to take part in the study if they so wish (British Psychological Society, 2004), particularly when the situation is such that participants may feel an obligation to the experimenter as a result of pre-existing relations (see below).

Perhaps the first thing to note from the current data is that the engagement curves derived in the present study look radically different from the classic curves as summarized by Bligh (1998). Typically, and as described in the introduction, both student and lecturer levels of attention tend to deteriorate throughout the course of a single lecture. This highlights the potential problems associated with the use of student self-report as a dependent variable in educational contexts, and an alternative explanation of the data arises in terms of expectancy effects (Rosenthal, 1966). That is, despite any attempts at establishing an equitable community of practice under a situationalist account of teaching (Lave and Wenger, 2002) or learner–learner dynamic under the remit of a constructivist approach to teaching (Graffam, 2007), it is likely that implicit power relations continue to influence the response of some students. As Rosenthal (1966: 74) has stated 'regardless of how the experimenter derives his relative status or prestige in the eyes of his subjects, that status often affects not only whether the subject will respond …but also how he will respond'. An alternative account of the differences between previous research and the current study may simply be due to the different measures used (that is, lecture engagement vs. level of attention, in Lloyd, 1968), while a final possibility is that perhaps the very act of asking students to record current levels of engagement throughout the lecture also acted as a form of active and anonymized contribution to the learning process (Caldwell, 2007) that facilitated the relatively high average levels of lecture engagement observed.

Another issue to consider is whether the students understood what was meant by the term 'lecture engagement' itself. This question seems particularly important in light of one of the empirical findings, in that lecture engagement was significantly more variable at the first time point than at any other time point. It appears that the reason for this was that students tended to cluster into two groups: those who reported close to zero engagement and those who reported close to maximum engagement. The former group appeared to be taking a strict reading of the notion of lecture engagement, since the first response was made before the lecture began and therefore there was no actual 'lecture engagement' to speak of. The latter group appeared to be interpreting this measure in a more traditional way in line with more general measures of attention or performance that have the potential to be altered with small-scale interventions (Bligh, 1998; Gibbs et al., 1987). Future studies would do well to explicitly define subjective dependent variables such as 'lecture engagement' to the participants, or else assess each individual's understanding of the term.

While Gosling (2006) states that it is relatively impossible to hold all extraneous variables constant in assessing interventions in teaching practice,

the present study does overcome some of the specific pitfalls in conducting research on interactive windows identified by Huxham (2005). These include the possible confound of timing with intervention across the different conditions, and the likelihood that studies taking place over a number of weeks result in the use of different teachers and hence add the additional problem of different teaching styles. The use of the same lecturer across all sessions provided a safeguard against the confound of different teaching styles, although it was (inevitably) the case that different lecture materials were presented across the different weeks and this must remain a limitation of the study. The present study also overcame the confound of intervention with time as a result of counter-balancing across subsequent weeks. Consequently, it is suggested that the general design represented in Figure 1 might be used as a framework with which to investigate additional teaching and learning interventions over time. Moreover, the current approach is flexible enough that it can assess the effect of any kind of small-scale intervention against data, apart from engagement within environments other than lectures.

However, there have also been potential objections to the use of interactive windows (Morton, 2007) and these claims require some consideration. Specifically, Caldwell (2007) states that the benefit of any intervention needs to be evaluated in light of the potential costs in reducing lecture time. Huxham (2005) adds that such interactive elements reduce the total amount of lecture content and also increase the likelihood of introducing errors into students' understanding. Indeed, there is some evidence to suggest that lecture-based teaching is actually preferable to problem-based teaching with respect to pick-up of basic factual information such as, in the case of a residential course on anaesthesiology, recognizing clinical data with anaesthetic implications (Carrero et al., 2007). In light of the clear tension between the need for active student participation and the delivery of course content, the need for *small*-scale interventions appears to be paramount. As a case in point, Morton (2007) describes an *active review* process in which students work in small groups to summarize the key points of a lecture and then take part in a question-and-answer period. Like many of the suggestions for improving teaching and learning in a higher-education setting, this appears an initially attractive proposition but also has its drawbacks. Morton (2007) states that the two sections of the active review take at least 20 minutes to perform, thereby requiring a substantial time investment that could potentially detract from the content of the lecture itself if both were to be housed within a standard 50–55 minute lecture slot (Habeshaw et al., 1992). Stead (2005) emphasizes the counterpoint and states that, in the case of the OMP, even 2-minute interventions may be not long enough for the student to benefit substantially from

the intervention. This also offers a potential explanation regarding the lack of consistent effects observed in the current design, given the brief interventions used.

Some concern must also be raised as to whether changes in lecture engagement reflect any kind of meaningful end-product for the student in terms of learning. In other words, there has been an implicit assumption in the current study that lecture engagement is somehow linked more generally to student learning in terms of improved exam performance, understanding course materials, course satisfaction or some other form of higher-order variable. A cautionary piece of evidence is provided by Hardy et al. (2003) who showed that course involvement has actually very little impact on eventual exam performance. As Hardy et al. (2003: 9) themselves acknowledge this may be a result of the restricted definition of course involvement (that is, offline and subjective measurement of lecture attendance and note-taking), and they also appeal to the nature of the course as an intervening factor. Specifically, for courses in which the exam materials are closely related to the lecture materials, there is often the charge that students 'could have done well on the course exams simply by reading the textbook and obtaining lecture notes, without attending the lectures'. Therefore, it remains to be seen whether a direct link exists in the present study between increases in lecture engagement and eventual summative performance.

Taken at face value, the data specifically recommend that the only small-scale intervention showing a significant enhancement in lecture engagement is the 'write down one thing you have learnt so far' part of the one-minute paper deployed 20 minutes into the teaching session. In this respect, the current data support the usefulness of the summary component of the one-minute paper, but fail to support the effectiveness of question component of the one-minute paper, and also fail to support the pause procedure (Ruhl and Suritsky, 2006; Stead, 2005). However, some caution is warranted here since the small-scale intervention that was shown to have an effect was also the first intentional intervention of the first experimental week. Therefore, an alternative explanation is that interventions such as the one-minute paper simply do not benefit from repeated administration. This is a comment echoed by Stead: 'the OMP should not be deployed unthinkingly …it appears too monotonous to utilize an identical format in more than two or three consecutive classes, as reflected in the quickly declining student response rates over the course of two lecture series using an unchanged OMP' (2005: 129). While repeated administration of the interventions was a necessary aspect of the experimental design, perhaps a more parsimonious conclusion consistent with both the current data and the work of Stead (2005) would be that it is intervention *novelty* that is

important in terms of enhancing lecture engagement, rather than the specific nature and timing of the event itself. In other words, the introduction of 'something new' into the lecture format might accrue a benefit in terms of student engagement regardless of the nature of the intervention itself. While the current data support the use of the summary component of the OMP only, it is also clear that by introducing a variety of small-scale interventions the lecturer increases the likelihood of engaging all of the students at least some of the time. For example, in the context of medical teaching, Nierenberg (1998) describes seven andragogical principles that, collectively, show an appreciation of the wide range of active interventions that can be deployed as a way of enhancing student learning. These include encouraging students to summarize key lecture points, the provision of examples from real life and media, and the rather contentious suggestion of allowing whispering during the lecture. In short, an unpredictable variety of novel interventions may ultimately lead to a more rewarding lecture experience for both teacher and student although further research will be required to support this contention.

In conclusion, while lectures may never go away within higher-education institutions, they have the potential to become much more useful in terms of student learning and move beyond the rather uninspiring definitions provided by previous researchers (Habeshaw et al., 1992). Andragogical research provides the tools necessary to evaluate whether the intentional interventions deployed by lecturers are successful in raising the level of engagement within individual students. As Graffam (2007: 41) states, any attempt to improve the student and teacher experience during the most ubiquitous of delivery method is certainly 'worth the experiment'.

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