Perceptions of the effectiveness of lectures in improving student conceptual understanding

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Structured abstract

CONTEXT
"Developing students' conceptual understanding" was ranked highest as the 'purpose of a lecture' in a previous survey of academics from a range of disciplines at Swinburne University of Technology. Traditional transmissive lecturing remains the norm at most institutions, despite the evidence that this mode achieves little in terms of student learning. So why does this teaching mode still persist? What are the perceptions of its effectiveness, and how do these depend on academics' familiarity with education research?

PURPOSE
In this study we investigated to what extent engineering education researchers perceive that "developing students' conceptual understanding" is achieved in lectures. What evidence do they use to explain their views? And what are their perceptions of the attitudes of their colleagues?

APPROACH
An online survey was designed to rate the extent that respondents felt "developing students' conceptual understanding" was achieved in lectures, and why. They were also asked what responses they felt their colleagues (i.e. presumably those not conducting education research) would give, and to provide some demographic information. Respondents were recruited from AAEE 2012 Conference participants.

OUTCOMES
Thirty-seven conference participants responded to the survey. Although there was a wide range of responses, on average respondents felt their colleagues would rate lectures as more effective in developing students' conceptual understanding (5.9 out of 10) than the respondents did themselves (5.2). This disparity became more marked with more experienced respondents, in particular with increasing education research experience.

CONCLUSIONS
Although respondents from a previous survey identified "developing students' conceptual understanding" as the main purpose of lectures, respondents in this study did not rate lectures as being very effective at achieving this purpose. Maybe this is not surprising given the weight of evidence that transmissive teaching has little effect on student understanding. So the question remains: why do lectures continue to be so popular?

Perhaps more interestingly, with increasing education research experience, there is a perception of a growing divide between engineering education researchers and their more discipline-focused colleagues about the effectiveness of lectures. Real or not, this divide poses an obstacle to meaningful discussions about education reform and dissemination of education research.

KEYWORDS
Lecturing, perceptions, conceptual understanding

Introduction

The research presented here is one part of a larger study into why traditional lecturing remains so prevalent despite the explosion of research evidence in recent decades that it is ineffective as an education strategy.

In a previous survey by the authors (report in preparation), Swinburne University of Technology academics (N=99) were given a list of five different possible purposes of a lecture (and one "Other" purpose they could nominate) and asked to rank them in order of importance. "Developing students' conceptual understanding" was the most popular – being ranked as either most, or second most, important by 68% of respondents, whereas "motivating students to learn" was the next most popular, with 43% of respondents ranking it in the top two. Conversely, "teaching students the course content" was the least popular of the given options, being ranked in the top two by only 19% of respondents. So it seems that of the academics motivated enough to respond to a survey about their teaching practice, most see the point of lectures as not being about information transfer or content delivery, but instead as being about developing student understanding. But how effective are traditional lectures in achieving this goal?

Traditional lectures are ineffective in improving conceptual understanding

Traditional lectures in this context are defined as describing the perhaps all-too-familiar teaching scenario in which the lecturer stands out the front of the room talking at the class, often with the aid of a blackboard, whiteboard, or Powerpoint™ presentation. Students are passive, expected either to listen or take notes. To facilitate students paying attention to the lecturer, there is often tiered seating. This is how it has been done for hundreds of years (see Figure 1, a painting of an ethics lecture at the University of Bologna from the 14th century) and this mode remains the norm today, across disciplines and countries (see for example Coppola (2008); Gunzburger (1993); Nunn (1996); Paulson (1999); or Skovsmose, Valero, and Christensen (2009)).

Figure 1: Laurentius de Voltolina; Liber ethicorum des Henricus de Alemannia; 14th cent.

In his seminal study, Hake (1998) compared the learning outcomes in introductory physics in the United States between traditional instruction and what he called interactive-engagement strategies, and found that the latter were far superior in improving students' conceptual understanding. There are many such interactive-engagement strategies but in a lecture context these could be typified by Interactive Lecture Demonstrations (Sokoloff & Thornton, 1997), Peer Instruction (Mazur, 1997a), or the flipped classroom (Berrett, 2012; Wilson, 2012). Similar strategies have generally led to better student learning outcomes when adopted to other cultures (e.g. Abdul et al., 2011; Cahyadi, 2004; and Hussain, Azeem, & Shakoor, 2011) and disciplines (e.g. Ebert-May, Brewer, & Allred, 1997; FitzPatrick, Finn, & Campisi, 2011; and Masikunas, Panayiotidis, & Burke, 2007).

One compelling study comes from Deslauriers, Schelew, and Wieman (2011), who compared the learning outcomes of two large streams of an introductory physics course. One stream was taught traditionally by an experienced and highly-rated instructor, whereas the other was taught by an inexperienced instructor trained to implement best-practice from the literature. The students taught using research-based strategies by the trained but inexperienced instructor had higher attendance, higher engagement, and, on a multiple-choice conceptual test, scored more than twice as high above chance as the traditionally taught stream.

Why does traditional lecturing prevail?

In the face of this evidence, why then does traditional lecturing continue to prevail? One part of the answer is surely that academics are time-poor and that research is rewarded and respected more than teaching (Bexley, James, & Arkoudis, 2011; Probert, 2013). Another possibility that has been proposed (Mazzolini & Daniel, 2013) is that academics believe that traditional instruction is really more effective than it actually is.

There is some evidence from the literature suggesting this misplaced belief is common. Some researchers have described their incredulity in witnessing how poorly their students perform on tests, such as the seemingly simple multiple choice questions of the Force Concept Inventory (Hake, 1991; Mazur, 1997b), despite the lecturers' "beautifully clear and clever explanations" (Wieman, 2009).

More rigorously, Wieman and Perkins (2005) found that only 10% of students retained a counter-intuitive fact that had been explained 15 minutes previously in a lecture. However, when they asked teachers to predict this retention rate, overwhelmingly teachers over-estimate the number of students who answer correctly. This accords with the finding of Hrepic, Zollman, and Rebello (2007), that experts consider a lecture as much more informative than students. In their study, both staff and student participants watched a short recorded lecture and then rated it in various ways. Experts generally reported the lecture as being more informative and thorough than students did, and even when students could recall what was said in the lecture they often misconstrued it or did not make sense of it at all.

In this study we investigated how effective respondents perceive lectures to be in developing students' conceptual understanding, and what evidence they use to explain their views. Respondents were drawn from the attendees of the 2012 AAEE Conference. To get some insight into what role familiarity with education research plays in affecting these perceptions, we also asked respondents to describe their colleagues' views (who in most cases would presumably not be conducting education research).

Method

An online survey was developed in Survey Monkey along research-based survey design principles to investigate the perceived effectiveness of lectures in developing students' conceptual understanding. It was promoted to attendees of the 2012 AAEE Conference, who were presumed to have a degree of familiarity with, or interest in, the education research literature.

After an opening page in which respondents could give their informed consent, the survey had three pages of questions. To offset the fact that some respondents might drop out of the survey before completing all questions, the sections were ordered in decreasing importance.

Page 2 – Respondents' perceptions of the effectiveness of lectures in improving conceptual understanding

The respondents were asked to rate on a scale of 0-10 to what extent they felt lectures achieved the purpose of developing students' conceptual understanding.

The null response (i.e. 0 = "not at all") was listed first, to offset the biases of primacy and social desirability (Choi & Pak, 2005). The primacy bias is that which leads to respondents favouring the first response in a list (in this case, “not at all”). Whereas the social desirability (or social acquiescence) bias is where respondents tend to agree with the question as phrased or to answer as they perceive the investigator hopes (i.e. 10 = “completely”). Although these biases are real, by setting them against one another, they negate the effect of each other.

After this rating question, respondents were asked what evidence they used to decide upon their rating response.

Page 3 - Respondents’ perceptions of their colleagues’ views of the effectiveness of lectures in improving conceptual understanding

This page mirrored the previous page’s format but asked instead about the respondents’ perceptions of their academic colleagues’ views and what evidence their colleagues would use to explain their views. While asking respondents to estimate their colleagues’ perceptions is not as meaningful a measure as asking the colleagues directly, it did offer an insight into how respondents felt their familiarity with education research affected their perceptions of lecture effectiveness, and whether there is a perceived divide between more education-focused researchers and their presumably more discipline-focused colleagues.

The analysis of the explanations that respondents ascribed to their colleagues will be the subject of a subsequent paper.

Page 4 – Research and teaching experience

This page asked about how many years’ experience respondents had in academia, education research, and teaching various class sizes. To minimise respondent burden (Bradburn, 1978), a small set of only 6 response options was offered. These 6 options were of increasing size (i.e. “None”; “Less than 1 year”; “1-2 years”; “3-5 years”; “6-9 years”; “10 years or more”), to reflect the initially steep learning curve of gaining experience in each of these areas. Lastly respondents were able to add “any further comments”.

Results and Discussion

Thirty-seven academics responded to the survey. Their responses are collated and discussed in this section.

Completion

Three respondents did not answer the last demographic question (about their experience teaching classes of more than 100 students), and 1 respondent dropped out after the question about their views, for a completion rate of 92%.

Respondents’ perceptions of the effectiveness of lectures in improving conceptual understanding

On the scale of 0 to 10, the average rating on this question was 5.2 with a standard deviation of 2.1. Although we do not claim this scale is linear, we include these descriptive statistics to give some sense of the range of the responses.

Ratings of lecture effectiveness versus respondent experience

The respondents reported a wide range of experience levels along the five different experiential measures. Do the ratings of perceived lecture effectiveness differ by experience in research or teaching?

Note that because of the small sample size, in the following analysis along different demographic dimensions, in each case we simply divided the sample as evenly as possible into thirds. This allowed us to contrast the ratings of the least experienced third with the most experienced third. Note that because there were only 6 response options, the partitioning of the sample into thirds was only approximate. Where possible, the size of these partitions never exceeded one third of the total sample size.

Table 1: The effect of experience on the perceptions of lecture effectiveness

Dimension of experience	~ Least-experienced third	~ Most-experienced third
Academia	4.8 (<=5 years, N=5)	4.8 (>=10 years, N=21)
Education research	4.8 (<=2 years, N=10)	4.3 (>=10 years, N=8)
Teaching < 50 students	5.9 (<=5 years, N=9)	4.5 (>=10 years, N=20)
Teaching 50-100 students	4.8 (<=2 years, N=6)	4.5 (>=10 years, N=11)
Teaching > 100 students	5.2 (<=5 years, N=11)	4.7 (>=10 years, N=6)

There was a weak trend of respondents more experienced along the different dimensions to rate lectures as less effective at developing conceptual understanding (see Table 1 above). The highest average scores for lecture effectiveness were given by the respondents with the least experience teaching smaller classes. One possible interpretation is that perhaps their more experienced peers have had more time to realise the pedagogical advantages of teaching smaller groups, and so were more critical of the large groups typical of lectures.

Conversely the lowest average scores were given by the most experienced education researchers. Perhaps through familiarity they have internalised the findings of the research literature about the limited effectiveness of lectures. We will explore their responses more in the next section.

Justifications given for ratings of lecture effectiveness

What justification did respondents give for their views? Thirty-three respondents justified their views. These responses were classified in an iterative process into five categories (see Table 2 below). No one made explicit mention of the research literature in explaining their rating.

Table 2: Common justifications for respondents' ratings of the effectiveness of lectures

Response Category	Description of category	Example quote
Context	Respondents typically gave a neutral response and explained that the effectiveness of a lecture depends on numerous variables such as the lecturer, the strategies they use, the preparedness of the students, content, etc.	*I believe that the extent to which consolidation of conceptual understanding is achieved is highly variable - itis [sic] dependent on many factors, including the level of the students' conceptual understanding prior to the lecture, their engagement during the lecture, the skill and preparation of the lecturer.... So I chose a median score.*
Feedback	Used in either a positive or negative sense to describe the direct or indirect feedback received from students. For example, students' performance on assessment tasks, the quality of questions they ask, their responses to informal questioning, or more formally through focus groups.	*Students are often not able to answer questions that demonstrate their conceptual understanding.* [negative] *Students are able to ask intelligent questions relating to the lecture content during the class and in tutorial classes* [positive]
Outside	Learning takes place outside of the lecture, either in other teaching contexts (e.g. tutorials) or through private study. Some respondents also state that the lecture is about content delivery.	*Personal experience. Lectures always seemed to me to be a way of transferring information that would provide a framework for the development of conceptual understanding but the understanding itself tended to come during extended readings or the use of lecture information in assignments.*
Personal	The lecturers' personal experience or opinion.	*None really - This is just an opinion.*
Purpose	Lectures have some other (often unstated) purpose	*There's a lot going on in a lecture that isn't about conceptual understanding*

These categories were represented across the spectrum of responses (Table 3 below).

Table 3: Prevalence of different categories justifying different ratings of lecture effectiveness

	Category				
Ratings	**Context**	**Feedback**	**Outside**	**Personal**	**Purpose**
Low (<5) (N=12)	0	5	5	1	1
Medium (5-6) (N=12)	3	2	4	2	1
High (>6) (N=13)	2	4	3	3	0
TOTAL	**5**	**11**	**12**	**6**	**2**

The most common theme was 'Outside' – that is, that learning takes place outside the lecture. Two of the respondents who used this theme to justify their high ratings of lecture effectiveness gave their reasons as: "students need things in context. Often it needs other material such as labs, visits, etc" and "Conceptual understanding takes time, more time than 50 mins." These somewhat negative comments suggest that perhaps they interpreted the scale the other way around, and were in fact not meaning to endorse lectures as effective.

What is more interesting about the popularity of this response is that it is at odds with the majority view from our previous survey that identified "developing conceptual understanding" as the main purpose of a lecture. It suggests that some education researchers have quite different views about lectures compared to academics in general, a point we will return to in the following section.

Respondents' perceptions of their colleagues' views of the effectiveness of lectures in improving conceptual understanding

The numerical average score on this item was 5.8. However, several respondents explained that they felt unable to speak on behalf of their colleagues' perceptions or that the diversity was so great and dependent on so many factors that they could only give a median score. Setting these responses aside leaves 31 responses with an average of 5.9 and standard deviation of 2.0. There was a low positive correlation ($r = 0.21$) with the respondents' self-reported views.

The responses were also analysed along the different dimensions of the respondents' experiences. In the previous section it was observed that the more experienced respondents rated lectures as less effective. Here, the converse was observed: more experienced respondents thought their colleagues would rate lectures as *more* effective. This effect was the strongest with increasing education research experience (see Table 4 below).

Table 4: The effect of experience on the perceptions of colleagues' views

Dimension of experience	~ Least-experienced third	~ Most-experienced third
Academia	4.8 (<=5 years, N=5)	6.2 (>=10 years, N=17)
Education research	4.3 (<=2 years, N=7)	6.4 (>=10 years, N=7)
Teaching < 50 students	6.0 (<=5 years, N=8)	6.0 (>=10 years, N=17)
Teaching 50-100 students	5.6 (<=2 years, N=5)	6.0 (>=10 years, N=9)
Teaching > 100 students	5.6 (<=5 years, N=10)	6.4 (>=10 years, N=5)

The effect of experience on disparities between respondents' views and their perceptions of their colleagues' views: a growing divide

Typically, respondents thought their colleagues would rate lectures as more effective than the respondents themselves did. Moreover, this effect became stronger with experience.

In Figure 2 below, we have graphed the differences in average score between self-reported and colleagues' perceived ratings of lecture effectiveness, versus experience. (Note that the respondents least-experienced in academia had zero difference).

On every measure of experience, the less-experienced engineering education academics thought their colleagues had fairly similar views to their own. The most-experienced academics however showed a large disparity: they thought their colleagues perceived lectures as much more effective than they themselves did. This disparity was the most striking along the dimension of reported education research experience. In fact with every increment in education research experience, this gap widened (see Figure 2 below).

Although we cannot be certain of our respondents' colleagues' views and how they differ from the views of our respondents, we can be certain that the engineering education researchers who responded to our survey *perceive* a gap, a gap that only becomes wider with more experience. This hints at an 'Us–and–Them' mentality, also borne out by the large number of respondents who questioned that “developing students’ conceptual understanding” really was the main purpose of a lecture. This raises questions about how experienced engineering education researchers can bridge this gap, that they themselves perceive, to improve academic teaching practice through professional development programs with their colleagues and more generally through disseminating research findings.

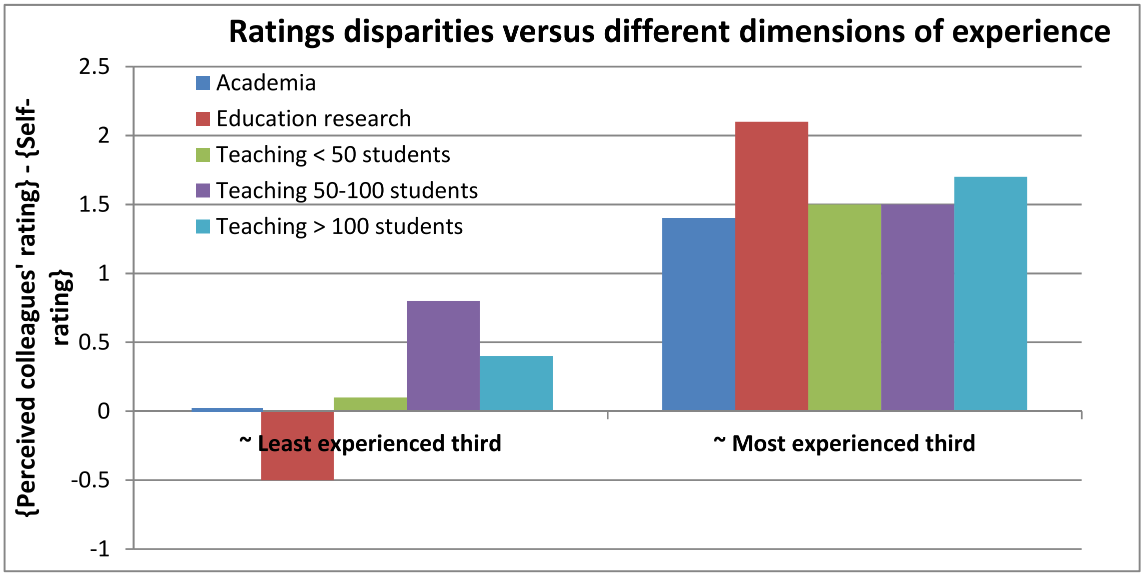

Figure 2: Growing disparities between self-reported and colleagues’ perceived ratings of lecture effectiveness along different dimensions of experience

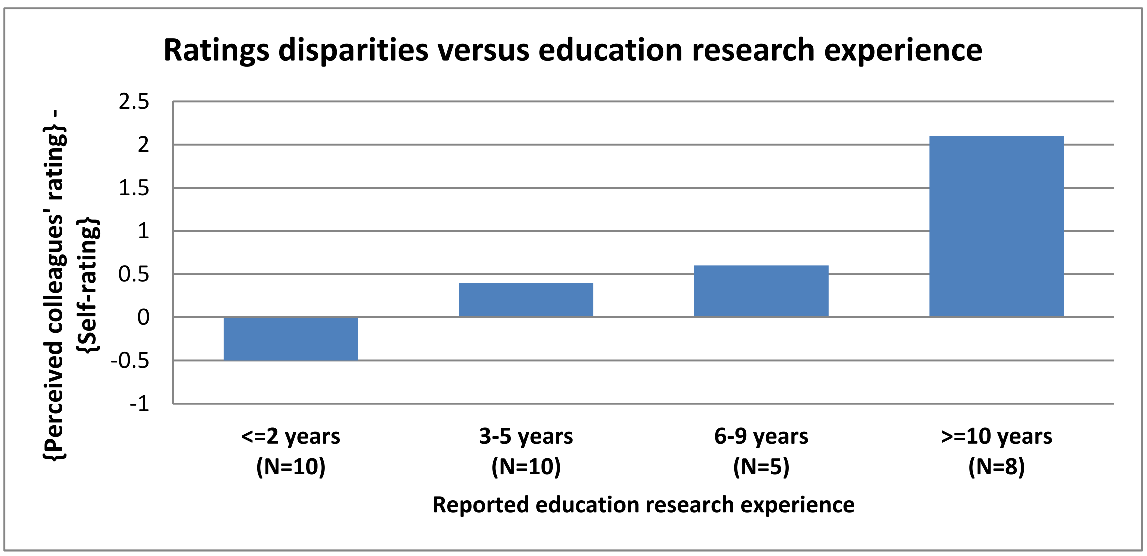

Figure 3: Growing disparities between self-reported and colleagues’ perceived ratings of lecture effectiveness with increasing education research experience

Conclusion

Survey respondents rated lectures as only moderately effective in “developing students’ conceptual understanding”. They thought their colleagues would rate lectures as somewhat more effective, and this difference was greater with the more experienced respondents. This growing disparity was most pronounced along the dimension of increasing education research experience. This raises questions about how the more-experienced education researchers can bridge this perceived gap to improve teaching and learning practice in the wider academic community.

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