Digital ink for simple cognitively effective recorded lectures: Making way for student centred engineering classrooms

New Search | Print Abstract | E-mail Abstract | Full Text | Save to My Collections | Export Citation | Related Papers

Gibson, B., Friend, J. & Yeo, L. (2008). Digital ink for simple cognitively effective recorded lectures: Making way for student centred engineering classrooms. In *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2008* (pp. 4102-4107). Chesapeake, VA: AACE.

Conference Information

ED-MEDIA World Conference on Educational Multimedia, Hypermedia & Telecommunications

World Conference on Educational Multimedia, Hypermedia and Telecommunications (EDMEDIA) 2008
Vienna, Austria June 30, 2008
AACE

Table of Contents

Authors

Bernard Gibson, James Friend, Leslie Yeo, Monash University, Australia

Abstract

This study employed tablet PCs to simplify the production of recorded multimedia lectures to facilitate transition to student-centred learning in class. In 2006 a course in micro and nano fluid and solid mechanics was delivered to fourth year engineering students using a traditional lecture-based format. In 2007 the same course was delivered using multimedia lectures whereby students were asked to watch lectures prior to coming to class and class-time was used for discussion and problem-solving activities. Students achieved significantly higher grades under the new course format than those in the control group and expressed strong subjective approval for the new format. Students also reported that tablet PC annotations helped them to understand the material better, to focus more on what was being said and to navigate presentations visually.

Tags

multimedia students
Add tag

Keywords

- Students
- Multimedia

Paper Discussion

DIGITAL INK FOR SIMPLE COGNITIVELY EFFECTIVE RECORDED LECTURES: MAKING WAY FOR STUDENT-CENTRED ENGINEERING CLASSROOMS.

Bernard Gibson, Assoc. Prof. James Friend, Dr Leslie Yeo

Abstract

This study employed tablet PCs to simplify the production of recorded multimedia lectures to facilitate transition to student-centred learning in class. In 2006 a course in micro and nano fluid and solid mechanics was delivered to fourth year engineering students using a traditional lecture-based format. In 2007 the same course was delivered using multimedia lectures whereby students were asked to watch lectures prior to coming to class and class-time was used for discussion and problem-solving activities. Students achieved significantly higher grades under the new course format than those in the control group and expressed strong subjective approval for the new format. Students also reported that tablet PC annotations helped them to understand the material better, to focus more on what was being said and to navigate presentations visually.

Introduction

Digital multimedia recording is finding wide application in higher education for the capture and online delivery of live lectures. A further but largely untapped potential lies in the ability of this technology to alleviate the need of delivering large quantities of technical material to live audiences in the traditional lecture format. By having students watch pre-recorded lectures before coming to class and using class time for other activities, significant improvements in academic performance and attitudes have been observed (Day et al. 2006), (Foertsch et al. 2002), (Moses et al. 2005). However, strategies for recording lectures have traditionally been either prohibitively complex and expensive, involving cameras, video mixers, tracking devices, etc (Erol et al. 2005) or, in the case of narrated screen capture, simple but lacking the visual signals needed to highlight and direct audience attention.

The degree to which engineering students have the opportunity to personally engage in the process of learning is of major importance. Astin (1993) showed that *interaction among* students and *between* students and faculty far outweighed all other factors, including curriculum and pedagogy, as predictors of positive change in college students' academic development, personal development and satisfaction. As well as increasing opportunities for interaction, the implementation of research-based active-learning pedagogies is of key importance to both the retention of students (Fortenberry et al. 2007) and to the development of graduates better prepared for professional practice (Smith et al. 2005).

A major difficulty for engineering educators lies in the need to present a course of structured technical lessons while still having time to implement effective, student-centred strategies in class (Mills et al. 2003). To prepare students conceptually for the real goal of instruction—which is generally to perform some practical task—has traditionally been the role of the lecture. However lectures are inherently teacher-centred, non-interactive events—events well suited to recorded delivery.

In the past two decades research in cognitive multimedia learning has begun to offer an insight into the specific factors contributing to the success or otherwise of multimedia presentations (Mayer 2005). Three factors in particular have implications for multimedia lecture capture strategies. These can be summarised as follows:

1. Cognitive effectiveness is improved when visual attention is presented with a *singular* point of focus (Mayer et al. 2003).
2. Cognitive effectiveness is improved when audience attention is regularly *directed* to specific relevant parts of the visual field (Mayer and Moreno 2003).
3. Cognitive effectiveness is improved when extraneous visual information is minimised (Mayer and Moreno 2003).

Previous studies have employed a combination of video footage with live screen capture as a means to capturing both the physical aspects of the presenter's expression and a clear representation of presentation slides (Day and Foley 2006), (Foertsch et al. 2002), (Moses and Litzkow 2005). In context of the aforementioned factors, this method falls short of cognitive research recommendations in three important ways:

1. By simultaneously presenting slide content and vision of the speaker, the presentation divides audience attention between spatially separated focal points.
2. By presenting static slides, visual attention is not being directed to relevant parts as they are discussed. Slide transitions can be used for this purpose, however their versatility is limited and significant extra preparation implied.
3. Video footage of the speaker, at least in the context of technical engineering courses, is largely extraneous to learning goals.

Digital ink refers to a group of computer technologies that allow presenters to interact directly with the contents of a computer screen using a stylus (or 'digital pen'). Presenters can highlight, annotate and illustrate relevant aspects of the topic being discussed. With real-time annotations within the field of the computer screen, digital ink enables the elimination of video footage from recordings by embedding the essential communicative features of technical presentations within the contents of a live screen capture.

It has been shown that markings and annotations made with digital ink are often analogous to the actual physical gestures of the presenter (Anderson et al. 2004). In light of cognitive learning research this suggests that digital ink offers an avenue of expression and a means of directing attention that neither divides audience focus nor imposes extraneous visual information. At the time of writing the authors are unaware of any empirical research specifically assessing the cognitive impact of digital annotation on learning outcomes.

Aside from the cognitive advantages of animated, digital ink screen capture, and the simplification of the recording process, the elimination of video footage greatly reduces file sizes. Even using low resolutions and frame rates, files incorporating video footage are an order of magnitude larger than those containing animated screen capture only.

This study proposes the use of digital ink enhanced animated screen capture as a means to dramatically simplifying the creation of recorded lectures while achieving a level of cognitive effectiveness equal to or even surpassing that of the more complex and expensive traditional approaches. With an efficient strategy for recording and delivery, a major obstacle to implementing pedagogies that make better use of face-to-face time with students is overcome. More opportunities for students to interact and engage in the learning process can be achieved with minimal additional cost and effort, and without neglecting the preparatory conceptual requirements of the domain.

Method

Course description

The micro/nano solid and fluid mechanics course offered at Monash University was taught for the first time in 2006. The course is divided into two concurrently running streams each taught by separate instructors. The first stream focuses on principles of movement and manipulation of fluids at small scales and the second deals with principles, current technologies and practices relating to manufacture at small scales. Content relating to basic principles tends to be mathematically intensive and requires calculus, including differential equations and vector calculus, as prerequisites, whereas content relating to current technologies and practices calls for more qualitative understanding of underlying scientific and engineering principles. No standard textbook is used for the course and the bulk of the core textual material is the work of the instructors themselves.

New approach to course delivery

In 2006 the course was taught in a typical classroom, using a computer projector with the standard in-class lecture style and a two hour practical session for working on problems. Students were assessed by weekly problem-solving assignments, an essay describing a particular aspect of small-scale research and a final exam. In 2007 a new approach was taken. Recordings of lecture presentations were made available to students prior to what would previously have been timetabled as a lecture. Lecture time was then used for practical demonstrations of small scale principles, class discussion, review of key concepts and work on problem-solving activities. The course content was the same for both years. Assessment tasks were also the same except for a slight change in criteria for the essay assignment—in 2007 students were asked to use one paper only as a basis for an essay whereas in 2006 they were encouraged to use several papers. The likely effect of this change was a slight decrease in the overall workload for the course. The goal of the reform was to assess the feasibility of using online lecture delivery in the form of animated digital ink screen capture in order to simplify the recording process, improve cognitive effectiveness and ultimately make more time for student-centred activity in the classroom.

Classroom activities

Class-time was used differently by the two instructors however the general structure of the time spent in each of the streams was similar. In both cases class-time started with an overview of the lecture material that had been presented in the recordings for that week. During this time students regularly took the opportunity to ask questions. In the fluids stream this overview was then followed by a presentation of solutions to selected problems from the previous weeks' assignment. In the manufacturing stream the overview was often followed by a practical demonstration of some aspect of small scale material behaviour. Finally a majority of the scheduled time in class for both streams was made available for working on assessable problem-solving exercises. Time spent on problem-solving was informal and tended to involve a significant amount of interaction between students and also between students and instructors (a second tutor was available for help with problem-solving in each of the streams). Another difference between the two streams was in the amount of time that was devoted to the lecture overview. In the fluids stream these lasted from 20 to 30 minutes whereas in the manufacturing stream they lasted from 10 to 15 minutes.

Preparation of lecture recordings

Lecture recordings were made using the Techsmith Camtasia Studio 3.0 software package and delivered in Flash file format for the fluids stream and in Quicktime format for the manufacturing stream. Accessibility for most students was not found to be a problem however in some cases it was necessary to download player updates and to ensure students were extracting files from .zip archives before attempting to play them. Automated contents menus were produced for some presentations.

Evaluation

The impact of the revised course format and lecture recordings on students' attitudes and experiences was evaluated using two different questionnaires: The standard Monash University unit evaluation survey; and a questionnaire specifically designed to assess attitudes to the new presentation style. All surveys were administered in the second last week of semester in 2006 and 2007.

Questionnaires and analysis of responses

The unit evaluation survey—a survey administered for all Monash University units at or near the end of each semester—was used for comparison of attitudes to the old and new formats. The survey comprised questions of a general nature relating to overall quality and satisfaction, achievement of learning objectives, presentation and organisation, opportunities for interaction, the utility of lectures, practical sessions and resources and overall workload. In 2006, 31 students were enrolled and twenty-four surveys returned. In 2007, 23 students were enrolled and 18 surveys returned. The second survey was specifically designed to assess attitudes to the new format. Questions related to students' attitudes to classroom activities, web lectures and to their general experience with the course. The same survey was used to assess each stream independently so that comparisons could be made. Seventeen surveys were returned for each stream. Both surveys employed five-point Likert Scale questions and open ended questions. For analysis of Likert scale responses each of the five options was assigned a numerical value ranging, for example, from 1 ("strongly disagree") to 5 ("strongly agree"). A mean value for responses to each question and p-values were calculated using two-tailed t-tests and alpha = 0.5.

Results and discussion

Educational outcomes

Students' grades were significantly higher under the new format than those of the control group (2006 mean 71.4 ±3.94, 2007 mean 80.0 ±4.45). These results are similar to those reported by Day, et al.

Attitudes to the new format

Students were asked to rate their attitudes to the new course format in general (from 5 – "Very positive" to 1 – "Very negative). Figure 1 shows that 87% of respondents reported positive attitudes (including 21% very positive)(mean 4.03 ±0.29).

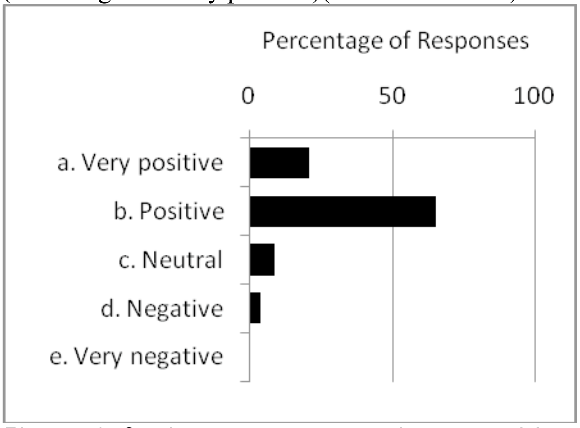

Figure 1 Student responses to the proposition: **"My attitude to the new course format is..."**

Students were also asked to rate their attitudes to the new format in comparison with traditional course formats (from 5 – "Much better" to 1 – "Much worse"). Sixty percent of respondents felt that the new format was better than traditional formats (including 10% who felt it was much better) No negative responses were returned (mean 3.7 ±0.22, $p<0.05$). Both results align with previous studies [1, 5 & 6 which have reported positive general attitudes to similar course formats.

Students reported they felt they had learned more in this course compared with other courses. Figure 2 shows that 65% of respondents felt they had learned more (including 10% who felt they had learned much more) and none felt they had learned less (mean 3.75 ±0.24, $p<0.05$).

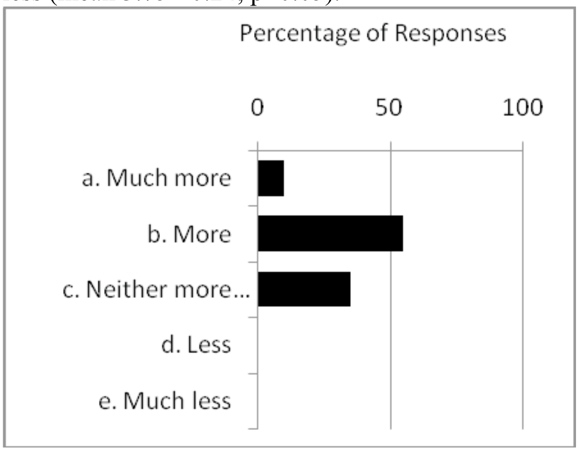

Figure 2 **Student responses to the proposition: "In** this course compared with other courses I have **learned..."**

Day, et al. (2006) also reported that students felt they had learned more under a similar course format than in traditional courses however in that study comparison with a control group showed the effect was not significant.

Attitudes to recorded lectures

The experimental group was asked to what extent they felt that the online lectures were a useful resource for their learning. Ninety-one percent of respondents felt that they were (including 29% strongly) and only 3% did not (mean 4.18 ±0.20, $p<0.05$). Figure 3 shows the breakdown of responses.

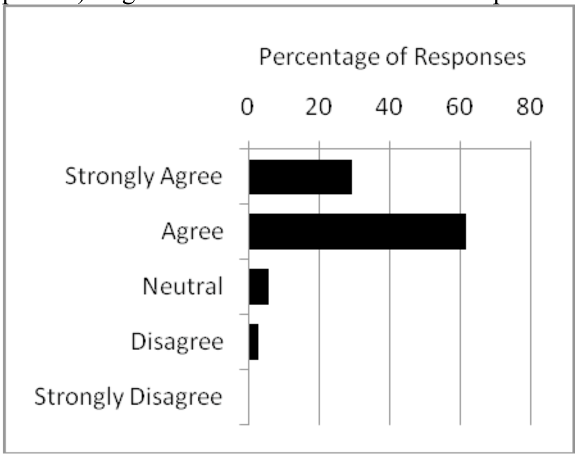

Figure 3 Student responses to the proposition: "The lectures were a useful resource for my learning"

The data showed virtually no difference in students' rating of lectures as a resource for learning between the control group in 2006 (mean 4.29 ±0.27, $p<0.05$) and the experimental group in 2007 (mean 4.22 ±0.36, $p<0.05$) despite the fact that they were delivered live in 2006 and online in 2007. This result aligns with previous research which has shown that the medium employed for delivery does not significantly affect the effectiveness of the presentation (Erol and Li 2005)

Levels of interest and attention during recorded lectures were assessed and 51% of respondents agreed that their attention or interest was maintained during recorded lectures (including 12% strongly) and 22% did not (mean 3.40 ±0.40, $p<0.05$).

Attitudes to the tablet PC format for recordings

To assess attitudes to the tablet PC format for recorded lectures students were asked about the usefulness of markings and annotations made in presentations. Ninety-one percent of respondents agreed (including 44% strongly) that the markings and annotations helped them to understand the material and none disagreed (mean 4.35 ±0.26, $p<0.05$). Figure 4 shows a breakdown of the responses.

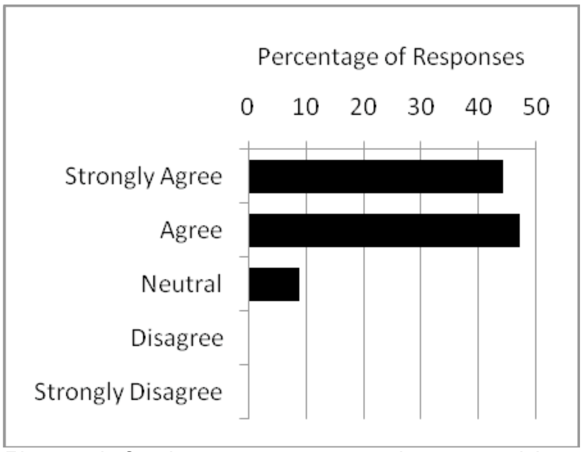

Figure 4 Student responses to the proposition: "The markings and annotations made in the presentations helped me to understand the material

In relation to whether or not the markings and annotations helped the students to *focus* on the material 76% of respondents agreed (including 33% strongly) that they were helpful, 21% were neutral and 3% did not (mean 4.06 ±0.26, $p<0.05$).

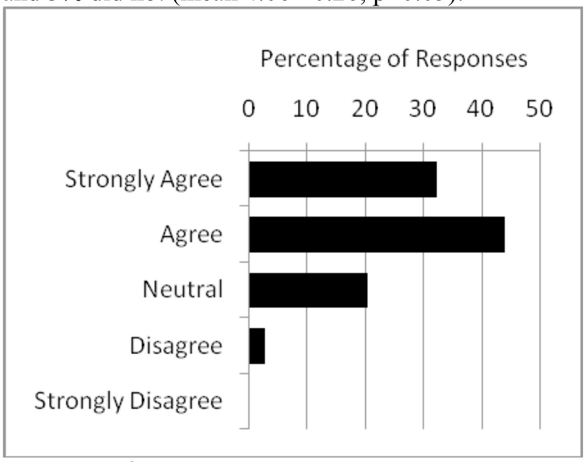

Figure 5 Student responses to the propostion: "The markings and annotations made during the presentations helped me to focus on the material

Students' attitudes to the annotations correlated strongly with their rating of the usefulness of the recordings (Pearson's $r = 0.50$). Attitudes to annotations also correlated strongly with reported levels of interest or attention (Pearson's $r = 0.46$).

Students commented that tablet annotations were sometimes used to excess. These comments generally referred to difficulties associated with presentation material being obscured and instructors were able to moderate their use of annotations in response to student feedback.

Navigation and control of recorded presentations

The media player used to view recordings gave students the opportunity to pause and restart presentations and to navigate through them using a slider. Students were asked whether the ability to pause presentations helped them to better understand the material. Sixty percent of respondents agreed that it did (including 25% strongly) and 10% felt that it did not help (mean 3.75 ±0.34, $p<0.05$). Figure 6 shows a breakdown of responses.

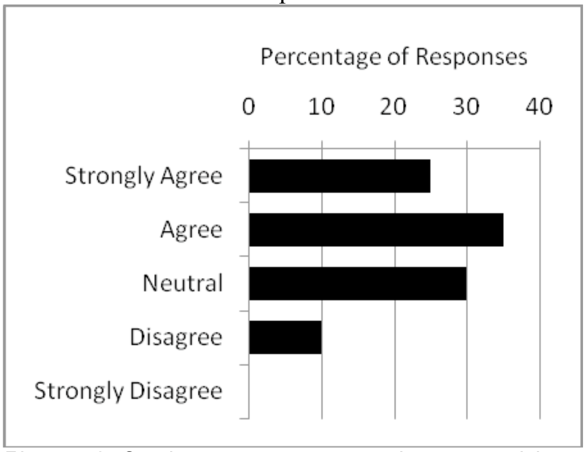

Figure 6 Student responses to the proposition: "The ability to stop the lectures helped me to understand the material better

This result aligns qualitatively with previous research which has shown that students tend to learn more when given the opportunity to control the pace of a presentation (Mayer 2005). Some students commented that rather than stopping the lectures they sometimes skipped through them using the navigation slider, listening only to parts they considered important. The ability to visually assess what is being covered while fast-forwarding is an advantage afforded by tablet annotations—they make it possible to *see* where the presenter is, allowing students to view presentations summarily and to navigate directly to specific parts.

The utility of contents menus was assessed by asking students if the menus were a useful tool for navigating presentations. Thirty-eight percent of respondents agreed (including 10% strongly) that they were useful, 52% were neutral and 10% felt that they were not (mean 3.28 ±0.52, $p<0.05$). Figure 7 shows the breakdown of responses to this question.

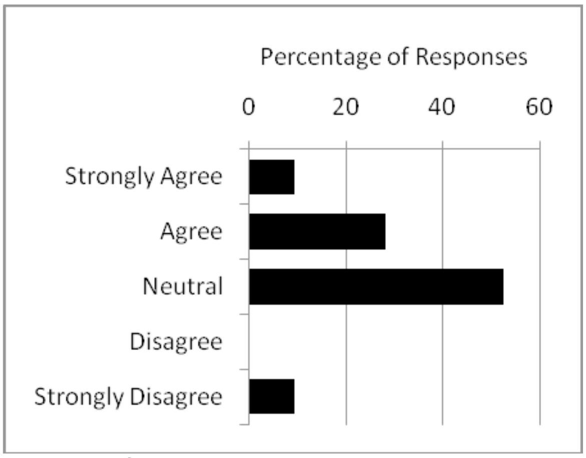

Figure 7 Student responses to the proposition: Contents menus were a useful tool for navigating presentations

The relative neutrality of attitudes to contents menus suggests they are not essential to the utility of recordings. Despite their creation being automated, contents menus proved time consuming to implement in practice. A tendency for the instructors to jump between slides caused unwanted menu entries which had to be manually deleted before publishing.

Conclusions

This study has shown that using tablet PCs to simplify online lecture delivery in order to use class-time for student-centred learning activities can work with minimal additional work on the part of instructors. Grades were significantly higher under the new course format and students expressed strong subjective approval for the new course format. Students also reported that the tablet PC's facility for visually annotating presentations as they were delivered helped them to understand the material better, to focus more on what was being said and to navigate presentations visually.

This study was limited to a small class at the senior end of an engineering degree. How this format would apply to much larger classes or more junior levels remains to be seen.

Results from this study are in general alignment with previous research, however this study has demonstrated the utility of tablet PCs for simplifying the production process and creating presentations which align more closely with findings from cognitive multimedia learning research. It is evident that, even without significant structuring of classroom activities or redesign of lecture presentations, a course presented using the new format can be as or more satisfying for students and as or more educationally enabling when compared to a traditional course structure. For engineering—and other hierarchically structured knowledge domains—a simple approach to recording presentations may be key to the feasibility of implementing active and interactive pedagogies in engineering classrooms.

Maybe mention levels of interest and attention in relation to "Using web-based lecture technologies-advice from students"

Acknowledgements

This study was funded by the Micro/Nano Research Laboratory, Monash University, Melbourne, Australia and supported by the Monash University Faculty of Engineering. Special thanks to Assoc. Prof. James Friend and Dr Leslie Yeo for their support throughout.

References

Anderson, R. J., Hoyer, C., Wolfman, S. A. and Anderson, R. (2004). A Study of Digital Ink in Lecture Presentation. SIGCHI conference on Human factors in computing Systems, ACM Press.

Astin, A. W. (1993). What Matters in College: Four Critical Years Revisited. San Francisco, Jossy-Bass.

Day, J. A. and Foley, J. D. (2006). "Evaluating a Web Lecture Intervention in a Human-Computer Interaction Course." IEEE Transactions on Education 49(4).

Erol, B. and Li, Y. (2005). An overview of technologies for e-meeting and e-lecture. IEEE Int. Conf. on Multimedia and Expo (ICME), Amsterdam.

Foertsch, J., Moses, G., Strikwerda, J. and Litzkow, M. (2002). "Reversing the lecture/homework paradigm using eTEACH Web-based streaming video software." Journal of Engineering Education 91(3): 267.

Fortenberry, N. L., Sullivan, J. F., Jordan, P. N. and Knight, D. W. (2007). "Engineering Education Research Aids Instruction." Science 317(5842): 1175-1176.

Mayer, R. and Moreno, R. (2003). "Nine ways to reduce cognitive load in multimedia learning." Educational Psychologist 38(1): 43-52.

Mayer, R. E., Ed. (2005). The Cambridge Handbook of Multimedia Learning, Cambridge University Press.

Mills, J. E. and Treagust, D. F. (2003). "Engineering Education - Is Problem Based or Project Based Learning the Answer?" Australasian Journal of Engineering Education.

Moses, G. and Litzkow, M. (2005). In-class Active Learning and Frequent Assessment Reform of Nuclear Reactor Theory Course. Frontiers in Education, 35th Annual Conference.

Smith, K. A., Sheppard, S. D., Johnson, D. W. and Johnson, R. T. (2005). "Pedagogies of Engagement: Classroom Based Practices." Journal of Engineering Education 94(1).