Evaluation of Different Forms of Interactivity in Distance Learning

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Abstract

**Introduction.** A series of experiments involving 3 dental schools has shown that distance learning can be acceptable to residents and effective in teaching concepts that are fundamental to orthodontic practice. **Methods.** Residents in each dental school participated in seminars, clinical conferences and clinical seminars via high-speed Internet connections. The acceptability of this form of instruction was judged from evaluation forms completed by the residents. In addition, its effectiveness in producing learning gains was judged from pre- and post-tests on the seminar topics. **Results.** The improvement from pre- to post-test scores after observing a sequence of distance seminars was similar to direct instruction. Orthodontic residents rated the educational experiences very positively. While live participation in seminars via video conferencing was preferred to live observation without real-time interaction and to later observation of a recording, each approach provided similar improvement in test scores. **Conclusions.** The acceptability of the distance seminars appeared to be influenced by the instructor’s personality and teaching style in facilitating interaction, the seminar subject, the residents’ comfort level in dealing with this technology, and the sequence for interaction vs observation. Further development of recorded seminars with live follow-up discussions has the potential to supplement distance learning instruction in a cost-effective manner.
Evaluation of Different Forms of Interactivity in Distance Learning

As a result of four primary drives, interest in distance learning has accelerated in post-secondary education. These primary drivers are: the potential for (1) improved instruction that incorporates elements unavailable locally, (2) greater educational cost-effectiveness by making resources more widely available, (3) better utilization of faculty in highly specialized areas, and (4) ability of educational institutions to offer courses in areas for which they do not have faculty with appropriate backgrounds and training. Increasing interest in the application of distance learning is occurring in all areas of education. The major technical obstacles to distance learning that have hindered it in the past have been largely overcome with the availability of high-speed Internet-2 connections among major universities, and the development of dual-streaming equipment so that images and data can be transmitted simultaneously. Considerable prior research has demonstrated that distance learning is an effective alternative to traditional classroom instruction. Measures of learning achievement as well as student satisfaction typically show very small, if any, differences between distance learning and traditional instruction. When differences are detected, often these favor distance learning. Emphasis has now shifted from comparing distance learning with traditional instruction to comparisons of different ways or modes of using distance learning. Among others, Clark has argued that media in itself does not produce learning effects. Hannum indicated that what matters when learning through technology is the pedagogy, not the technology. Thus we echo the call from others to focus research on comparing different pedagogical approaches within distance learning rather than comparisons of distance learning with face-to-face instruction. We argue this for two reasons: (1) considerable media comparison studies have been done and typical to show any significant differences, and (2) from a policy perspective these comparisons are moot since educational institutions often use
distance learning in those situations where they are unable to offer the course in any other manner primarily due to lack of faculty with appropriate background for the course. The choice is not whether to offer it as a face-to-face or distance learning course, but rather how to make the distance learning course effective. This argues for comparisons of different pedagogical techniques within distance learning courses, not comparisons with traditional, face-to-face courses.

Interactive seminars are often conceded to be the most effective method for education at graduate and post-professional levels where the focus is on evaluating uncertainty and making decisions in spite of incomplete information. Teaching by discussion can be an extremely effective means of helping students apply abstract ideas and think critically about what they are learning. Johnson et al concluded that when the purpose of a class is to develop problem-solving skills and abilities, the least efficient discussion is superior to most lectures. However, fostering effective discussion is difficult, even for experienced faculty, and especially difficult as class size gets large. Class size can have an impact on the type of learning that takes place, with smaller class sizes being related to higher levels of learning. Through a series of experiments this study evaluated the acceptability (to both dental school residents and faculty) and effectiveness in terms of learning gains of several modes of instruction, using a distant instructor and high-speed Internet links to participating resident groups at three major universities in the United States.

Methods

1. Research Design

The experiments involved three types of seminars that represent three common teaching methods for residents in dental schools: (1) concept seminars presenting didactic instruction of basic concepts and clinical application of underlying principles, (2) clinical conferences to evaluate patients and develop treatment plans, and (3) clinical seminars to develop a theme and
discuss treatment of a type of problem using case reports. For all three types of seminars, both data and video images of presenters and participants were exchanged via Internet-2 connections. The dental school residents participated and interacted in various ways and degrees with the seminar leader. In addition, internal clinical conferences with a distant part-time faculty member were evaluated. The research design is outlined in Figure 1.

2. Concept Seminars

Three seminar sequences were developed to cover aspects of three important topics in orthodontics (tooth eruption and its control, equilibrium theory, biomechanics). Each seminar sequence consisted of three individual seminars related to the topic for a total of nine seminars. Each of these seminars were led by the same instructor, who was an experienced dental school faculty member. Prior to each seminar, residents were given an outline of the seminar objectives and assignments to read journal articles or view material on a web site. A total of 21 second-year residents at the three universities participated in the concept seminars. All residents were at a distance from the instructor and were connected via dual-streaming high-speed video and data links. Three different instructional approaches to distance learning were used in this study. One group was interacting with the instructor and each other in real-time with two-way video conferencing, i.e. the instructor as well as students at other sites could see and hear the students in this condition. A second group of students observed the seminar in real-time as it occurred without being able to interact, i.e. they could not be seen or heard by the instructor or students at the other universities. However they were given an opportunity for further discussion with the instructor at the conclusion of the seminar. The third group watched a DVD recording of the seminar at a later point in time and could discuss it with their own faculty, but did not interact with the other resident groups. The research design was counterbalanced to allow each student group to experience each of the three teaching modes for one of the seminar sequences to control
for any possible student effects. Any possible faculty effects were controlled for by having the same instructor in each condition.

To compare the educational effectiveness of the different instructional approaches, residents took a pre-test before and post-test immediately after each sequence of 3 seminars. To evaluate the acceptability of the seminars and the overall approach, residents completed three types of evaluation forms, one following each individual seminar, another following each seminar sequence of three seminars, and a third overall evaluation after the final seminar was completed. Evaluation forms contained a set of statements that were rated on a 7-point Likert scale. The final overall evaluation contained a similar set of statements evaluated on a Likert scale, and also open-ended questions for residents to answer.

3. Clinical Conferences

Clinical conferences were evaluated in two settings. First, we used the typical pre-conference (a preliminary discussion of surgical-orthodontic treatment plans between residents and a faculty member) at one university to see whether residents reported any differences in perceived effectiveness or acceptability with the instructor physically present in the seminar room or connected from a distant location by telephone and computer. The faculty member was with the residents for 8 consecutive sessions, then conducted 8 sessions from a distant location using a VPN computer connection (Virtual Private Network) and telephone. The telephone connection allowed the teacher and students to communicate and interact, and the VPN allowed the faculty member and residents to simultaneously see the same diagnostic records on the faculty member’s office computer and projected in the residents’ seminar room. Six second-year residents at this university completed three evaluations: one following the 8 sessions with the faculty physically present, a second following the 8 sessions with the faculty member participating at a distance, and a third overall evaluation at the conclusion of the 16 sessions. For the overall evaluation, a 7-point Likert scale was used.
Second, the three schools participated in a series of 6 clinical conferences in which residents from each school used dual data and video streaming to present surgical-orthodontic cases for discussion among the other groups. At each school, residents participated twice in each of three participation groups: one group was in their seminar room during a case presentation by a classmate, the second group was live and interactive from a distant classroom, and the third group observed the conference and had an opportunity to interact with the other residents following the conference. Approximately 20 second- and third-year residents and 7 faculty participated in these conferences. Residents and faculty completed evaluation forms at the conclusion of each clinical conference, and an overall evaluation followed the last of the 6 clinical conferences. All evaluation forms contained a set of statements that were rated on a 7-point Likert scale, and the final overall evaluation also contained open-ended questions for residents to answer.

4. Clinical Seminars

A series of 6 clinical seminars, 2 from each school, was conducted quite similarly to the clinical conferences, with two differences: the presentation was by a faculty member rather than by the residents, and the observation group could ask questions or offer comments during the presentation by e-mail. The instructor could respond to the questions and comments in real-time during the seminar in a similar fashion as if the question was asked by one of the residents interacting with the instructor. Approximately 18 first-year residents and 4 faculty participated in the conferences. Residents and faculty completed evaluation forms at the conclusion of each clinical conference, and an overall evaluation followed the last of the 6 clinical conferences. All evaluation forms contained a set of statements that were rated on a 7-point Likert scale, and the final overall evaluation also contained open-ended questions for residents to answer.

5. Statistical procedures
Pre-test and post-test data from the concept seminars were evaluated using a linear model for the post-test score, with the pre-test scores as a baseline evaluation. This model included the main effects of sequence and participation group. The effects of school and students nested within school were modeled by incorporating random effects. These linear models were fit using PROC MIXED with the RANDOM and REPEATED statements in SAS release 9.1.

The interaction effect between the sequence and condition was not statistically significant in the model added to the main effects model (F= 0.86, df= (4, 33), and p= .5003). This indicated that the effect of sequence of a seminar on the post-test score was not significantly dependent on the condition.

Acceptability data (from evaluation forms) for concept seminars, clinical conferences and clinical seminars were examined by constructing and comparing tables of means and standard deviations.

**Results**

1. **Basic concept seminars**

   **a. Effectiveness.** Changes in pre- to post-test scores for residents at each school are shown in Table 1. There was a statistically significant increase in test scores for participants in all groups. The greatest improvements for each school occurred while in the interacting group. Overall, when controlling for sequence of participation and participation group there was significantly more improvement in the interacting group than both observing groups (live and later). There was no statistical difference between the groups who observed the seminar live or later, but both were below the interacting group. There were some differences in achievement noted by school. The university that had the lowest mean pre-test scores had the greatest improvement. The two other universities showed similar improvement, but one of these universities had higher pre- and post-test scores.
\textbf{b. Acceptability.} Questions and responses from the concept seminar evaluations are displayed graphically in Figure 2. Overall, there was high acceptability in all three groups. Residents judged interacting to be better than observing regardless of whether the observation was live or later. It is interesting to note that they rated observing live slightly less positively than observing a recording later, although this difference was not considerable. Residents at two universities rated each of the three participation groups highly positive, over 6 on the 7-point scale. Residents at the third university who participated in the interactive group first were equally positive about that, but were less positive about the subsequent observation groups, both live and later.

Responses to the open-ended questions also were quite positive (Table 2), and revealed differences and similarities between residents’ experiences in each of the participation groups. Residents felt interacting live was advantageous because they had the ability to interact with the professor and were more attentive and involved due to that interaction; however, they felt that technical difficulties were a limitation of this type of instruction. Residents felt observing live (watching the seminar then having a brief opportunity to interact with the instructor) was positive because it eliminated the stress of having to actively participate during the seminar while still providing the opportunity to ask questions and get clarification at the conclusion of a seminar; however, they also felt the lack of interaction was a limitation of learning in this way. Residents felt observing later (watching a recorded DVD of the seminar) allowed them to watch and learn at their own convenience and to watch again at a later time; however, the lack of interaction was seen as a limitation of learning in this way. One common response about all three learning methods was that each can provide opportunities they may not otherwise have to learn from experts in the field. Responses were quite positive about the experience; only two participants reported that in the future they would not like to learn using any of the distance education approaches evaluated.
2. Clinical conferences

   a. Audio vs live contact. The evaluation scores for the series of conferences with a faculty member present at the conference, versus those with the same faculty member distant and in audio and computer contact, are shown in Table 3. For all attributes, the ratings were higher with the faculty member present, and it is clear that the residents preferred this, but the ratings for the faculty member at a distance were still positive.

   b. Video conferencing: interactive vs observing. Data for the 3-school clinical conferences are shown in Table 4. At all 3 schools, residents commented that they enjoyed seeing how the other schools evaluated patients. It is interesting to note that the overall evaluation scores for all the participating groups were almost identical – there was very little differentiation for the residents between their experience as interacting or observing. The overall score for observing live was lower than for the interacting groups, but only very slightly. Responses to many individual questions reflected this same tendency for the experience in all groups to be rated similarly. Residents at the origination site did report that technology was less of a distraction than those at interacting and observing at distant sites.

   There were differences among the three universities in their ratings, with ratings from one university being substantially lower than the other two. At all 3 universities, the faculty were even more positive about the conference sessions than the residents.

3. Clinical seminars

   The 6 clinical seminars differed from the clinical conferences in two ways: faculty rather than residents presented the seminars, and the observation group had e-mail interaction with the instructor. Acceptability scores are shown in Table 4. Note that the overall evaluation scores for all the interacting groups, both at the originating site and at a distance, were almost exactly the same, while the overall score for observing live was substantially lower. Responses to many individual questions also reflected this same tendency. Several residents commented about how
some faculty didn’t check their email during the seminar, thereby eliminating the possibility of any connection or interaction by the observing group. As with the clinical conferences, faculty were as positive or more positive, than the residents.

**Discussion**

1. Influences on Outcomes

   *a. Concept seminars.* Overall, the concept seminars were judged by residents to be very acceptable. Residents found all three instructional approaches used to be effective as a teaching technique. Residents reported that discussion was helpful, and that they were more actively engaged in learning while in the interactive group. They agreed they were able to learn as well as they would have in a traditional classroom although not better. Technology was not generally noted to be a distraction, and there were no differences in the technical distractions reported at the three schools.

   It is interesting that there appeared to be a relationship between acceptance of the distance learning method and improvement in test scores. The residents at one university gave the concept seminars the most favorable rating regardless of their type of interaction and also showed the most improvement between pre- and post-test scores (Figure 5). It has been noted many times that student performance is affected by whether they have a positive or negative attitude toward the way they are being taught. That is likely to be as true, perhaps even more true, for distance learning.

   It is quite possible that having one instructor for the 9 concept seminars, all dealing with clinical application of basic concepts, contributed to the relatively higher ratings for these sessions. While it is quite apparent that the use of videoconferencing equipment will not magically transform a poor teacher into a great teacher, we did find that teaching and learning in this way can be effective as well as acceptable. The same principles used in developing
successful seminars that are led and conducted in person seem to apply to seminars taught at a
distance, and are likely to be the main determinants of whether a seminar will be successful and
well received.

For all 3 types of seminars, the “sequence effect” may have influenced scores for
acceptability. The residents who started with direct interaction were less positive about
observation than those who started in another condition. Since direct interaction was always
perceived as better, perhaps those students who started with direct interaction rated the other
conditions lower that students who started with those other conditions because after having first
experienced what everybody rated as the best form of distance learning instruction the other
conditions seemed less good then if they had started with the other conditions. Still all three
conditions of interaction within distance learning were rated highly.

b. Clinical conferences. One possible influence on the clinical conference scores was
resident burnout. The majority of the residents saw participating in the concept seminars and
doing the evaluations as positive and beneficial, but toward the end of the experiments a few did
not. It appeared that as the series of experimental sessions continued that their novelty wore off
and a few residents became more critical. This has been noted before in research on technology-
based instruction. The same groups of residents that participated in the 9 concept seminars also
participated in the 6 clinical conferences, so their responses for the clinical conferences may
have been biased somewhat by their experience in the previous concept seminars. The residents
at one university were less positive about the experience than residents at the other two schools
during the concept seminars. At the other two universities, the seminars were held in the dental
school, while residents at the university that rated them lower had to finish early in clinic and
walk across campus (several times in bad weather) to the room where their seminars were held.
From their comments, this was a negative factor and may have contributed to their lower ratings.
Another potential factor that might influence acceptance and ratings is the residents’ perception
of faculty support for distance learning in general and for this project in specific. While we don’t have specific data, it was our observation that faculty at two universities were more enthusiastic about distance learning than the faculty at the third university.

In the clinical conferences residents found it interesting and informative to see how patients were worked up and presented at the other schools and to see how their counterparts elsewhere handled the presentations. For the conferences, the groups were larger because residents from other years and several faculty were usually present. Faculty could and did participate in the discussion, which increased learning opportunities but decreased the amount of participation by individual residents. There was less differentiation between groups for the clinical conferences. Those interacting at the origination site and at a distant location rated the experience almost equally, only the observing group rated that experience slightly lower.

c. Clinical seminars. In contrast to the conferences the clinical seminars could be, and sometimes were, more like lectures, which probably affected students’ perception of involvement and participation. Observing a seminar with email interaction may have potential as an acceptable way to learn, although this type of interaction was not rated highly in our study. Such an approach requires a willingness by observers to send questions, but more importantly requires an instructor that is able to respond to email questions in a timely manner as part of the seminar. Since this was new for most of the faculty members, there was a steep learning curve in incorporating email questions from students who were not visible nor audible to the instructor that may have impacted the quality with which this mode of interaction was implemented.

d. Overall. In the ratings of acceptability, a common trend was seen for all three types of seminars: being live and interactive at a distance was judged almost as good as being face-to-face, while just observing was not. A number of variables could have influenced perceptions of acceptability as well as effectiveness of these experimental seminars. These include the instructor’s personality and teaching style especially as this relates to encouraging interaction
with students, the seminar subject, the comfort level in dealing with distance learning technology, the sequence for interaction vs observation, and possibly other unidentified factors as well. It is possible that some residents found the use of technology somewhat distracting because this was their first experience learning in this way. Compared to traditional face-to-face interaction, any use of technology would likely be seen as more distracting.

2. Applications to Future Distance Learning

While distance learning cannot be expected to completely replace traditional classroom instruction, these experiments confirm that it can be a useful supplement, and in some cases a replacement, at least in graduate dental education. The data indicate that it is at least as good as the traditional approach. It appears to be particularly useful in teaching the basic concepts that underlie clinical practice and also can be useful in a more clinical setting. There are two benefits from using distance learning. It can enhance the experience of dental residents by exposing them to a variety of different thoughts, ideas and other dental residents and instructors, and it can alleviate problems associated with decreasing numbers of experienced full-time faculty. It seems highly likely that these benefits would be realized in other areas of graduate education, and in post-graduate professional training more broadly.

For clinical faculty, videoconferencing technology has made it now fairly easy to originate seminars from locations outside of academic institutions. Part-time clinical faculty can conduct interactive seminars from a computer at their private practice or homes, which would mean that their time while physically in the dental school could focus more completely on treating patients there. The result could be more productive use of clinical time by faculty and residents.

A greater need in most dental schools as well as in other departments of today’s universities is faculty who can provide direct support to students helping them learn how to solve problems and apply knowledge they are acquiring in class. For this type of instruction, it is
particularly interesting that after appropriate preparation, viewing a recorded seminar later is educationally effective and generally acceptable. It appears that if recorded seminars were combined with live discussion afterward, a useful supplement to existing courses could be developed.

We call for additional research exploring techniques for offering distance learning courses rather than research that compares distance learning with face-to-face instruction. We encourage measurement of both learning gains and student perceptions of acceptance and quality within distance learning courses. Distance learning has been demonstrated by this series of experiments to be a successful means of teaching that can be expanded without fear of loss in learning achievement or its application by students or faculty.

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## Research Design Summary

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### Concept Seminars (9 total)

(3 Sequences of 3 Seminars)

1 Seminar Sequence in Each Participation Group

- Seminar Sequence Pre-Test
- Seminar Sequence Post-Test
- Individual Seminar Evaluations
- Sequence Evaluations
- Overall Evaluation

### Clinical Conferences (6 total)

2 Clinical Conferences in Each Participation Group

- Individual Conference Evaluations
- Overall Evaluation

### Clinical Seminars (6 total)

2 Clinical Seminars in Each Participation Group

- Individual Seminar Evaluations
- Overall Evaluation

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Figure 1. Summary of the research design, showing the different seminar settings and the types of interaction.
Figure 2. Comparison of mean pre- and post-test scores during the concept seminars by participation group and school.
Figure 3. Overall acceptability of concept seminars and responses to selected questions from different evaluations.
Figure 4. Overall acceptability of clinical conferences and responses to selected questions.
Figure 5. Clinical seminar data for selected questions.


Johnson, DW; Johnson, RT; Smith, KA. (1991) *Active Learning: Cooperation in the College Classroom;* Interaction Book Co.: Edina, MN.