Uniform Instruction Using Web-Based, Asynchronous Technology in a Geographically Distributed Clinical Clerkship: Analysis of Osteopathic Medical Student Participation and Satisfaction

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Context: As medical schools in the United States increase their class sizes, many institutions are forced to extend their teaching affiliations outside of their immediate communities. Geographic distribution threatens the ability to provide the uniform learning opportunities that students need and accrediting bodies require.

Objective: To determine if a Web-based, asynchronous learning module can provide an effective, uniform learning opportunity for osteopathic medical students enrolled in clinical clerkship.

Methods: Third-year osteopathic medical students enrolled in an 8-week core clinical clerkship in surgery were required to participate in a Web-based, asynchronous, interactive instructional module designed to provide opportunities for higher-order thinking through analysis, synthesis, and reflective learning. The quantity and content of students’ online course interactions were analyzed to determine quantitative and qualitative features of their course participation. At the completion of the clerkship, students completed a 10-item Likert-type survey of their experience to determine the most helpful attributes of the Web-based learning module. Responses were assigned numerical values from 1 (strongly disagree) to 5 (strongly agree) to obtain a mean score for each question.

Results: Sixty-three students completed the Web-based module. The content of their discussions, as determined by message coding, identified the critical thinking needed to acquire abstract conceptualization of the problems presented in a typical surgery clerkship. Students found the content of the module relevant to the clerkship (mean score, 4.18) and valued facilitator feedback (4.00). Although they did not prefer Web-based instruction of classroom lecture (2.66), students indicated that the Web-based module enhanced their overall learning experience in the clerkship (3.30).

Conclusion: Web-based technology in the clinical education of third-year osteopathic medical students appears to afford an acceptable teaching alternative when face-to-face instruction cannot be provided. Further study of the impact of instructional design on the quality of higher-order thinking in this domain is needed, as is an appreciation for the dynamics of group learning in a virtual environment.

As class size at the University of North Texas Health Science Center—Texas College of Osteopathic Medicine (UNTHSC/TCOM) in Fort Worth has increased, the college has faced a shortage of clinical teaching facilities available in convenient proximity to its campus. As a result, the institution distributes students to multiple communities to assure all students access to adequate clinical experience. The college relies on faculty at each of these sites to provide instruction that will enable students to meet the prescribed objectives of the curriculum. However, it is unlikely that such instruction will be uniform, and any variance from the published curriculum may be a cause for concern to an accrediting body. An approach to the clinical curriculum is needed that will enable medical schools to provide nearly equivalent instruction for all students during this critical phase of their education.

Web-Based Instruction

One potential solution to ensuring consistent curricula is the use of Web-based instruction provided by the faculty of the parent institution. Assessment of student participation and feedback are critical to ensuring a quality online instruction tool.

Online Instructional Design

As with a face-to-face curriculum, a sound instructional design that incorporates effective learning strategies is essential for Web-based instruction. Critical elements within the technical architecture of Web-based teaching platforms are opportuni-
ties for instructor facilitation, synchronous and asynchronous interaction, and reflective and collaborative activities.3

**Facilitation**—The presence of an instructor is essential to encouraging critical thinking among students.4,5 The instructor as a facilitator is responsible for establishing the environment in which learning takes place. He or she maintains the structure of the dialogue and promotes organized thinking to achieve understanding and high levels of learning.4 Without such guidance, student interactions are not likely to impart meaningful concepts or knowledge constructs.6 The facilitator also sustains the community of inquiry without displacing the centrality of the learner in the process.

**Interaction**—Interaction engages learners with the course content, the instructor, and their peers. It also allows ideas and experiences to be shared and enlists principles of reciprocal learning.4,7,8 As with face-to-face instruction, interaction in a Web-based environment generates critical and reflective thinking. Such activity may be further advanced by the predilection for asynchronous discourse as learners can step away from the dialogue to fully conceptualize the issues at hand and then rejoin and seek feedback from the community.4,9

**Collaboration**—Members of a group construct knowledge through cooperative activities that improve learners’ motivation and self-confidence.10,11 Structured group projects designed by the facilitator can encourage individual expression toward a common goal and in a manner that may otherwise be intimidating in the larger community.8,9 Although group participation has been shown to advance individual critical thinking, some group members will not engage in true dialogue, while others will be just passive observers and make no contribution.5,6 Nevertheless, collaboration provides for cooperative learning through mutual expression in a social context that, as it relates to the clinical curriculum, is in concert with the current and future healthcare environment.9,12

In order to acquire knowledge and meaning from the online experience, the instructional design must incorporate both structure and leadership.4 Elements that require discovery, interaction, and collaboration under careful mentorship that promotes reflection and provides feedback can, in turn, foster learning.13 As is true of all other educational methods, the potential of distance learning can only be realized by well-designed instructional models.2,13

**Student Participation**

Whether measured in formal academic settings or during Web-based instruction, the frequency of interaction is not a reliable indicator of the depth of critical thinking.4 Knowledge acquisition is more seen as a function of the quality of the interactive dialogue that emerges from each online encounter. Passive participants may themselves have a cognitive presence that is otherwise immeasurable.4 Web-based, asynchronous, interactive strategies, however, can raise the likelihood that students will engage in active learning.

Accessing the online learning site merely reflects interaction with the technology. The actions of readership, commentary, response, dialogue initiation, and constructive feedback suggest increasing levels of critical thinking within the spectrum of that interactivity. Several authors have described coding scales that are intended to reflect the depth of critical thinking suggested in student messages posted in online courses.14 All messages other than those that appear to represent purely social interaction are seen as related to learning, thereby suggesting that each message holds some cognitive value for its author.14 Whatever the expression and however measured, active learning features embedded within Web-based curricular design will likely be “pedagogically advantageous” to learners.15

**Student Satisfaction**

Instructional methods that enhance student satisfaction may well raise achievement by boosting motivation.16 Web-based programs have several attributes that students find desirable. Asynchronous accessibility enables students to create knowledge on their own time. In addition to being flexible with respect to students’ daily activities, online education is portable—instruction can be engaged wherever a computer is available with Internet connectivity.8,17

Technology alone, however, is insufficient to garner positive tribute from online participants. Learners may sense greater efficacy from their online experience when the course design is challenging, interesting, and interactive.17 Perhaps application of the technology without close attention to a carefully assembled instructional design can explain reports that only 50% of learners believed their Web-based experience enhanced their learning.15 A lack of sufficient rigor may also explain why Web-based programs were not found to be superior to traditional methods with regard to student satisfaction.2,15 Overall, however, a greater frequency of interaction with peers and mentors through Web-based instruction than in face-to-face settings has positively influenced student satisfaction with this technology.5,8

Although there is no convincing evidence to suggest a Web-based curriculum is superior to conventional face-to-face methods, the preponderance of the current literature supports its application in those instances in which face-to-face instruction cannot be provided. In our review of the opinions of several authors during the preparation and design of the present study, we found little direct evidence to support the application of Web-based instruction to clinical clerkships in undergraduate medical education. We believe that the data reported herein provides that evidence.
Objectives
The purpose of the present study was to determine the efficacy—as measured by students’ participation and satisfaction—of adopting an instructor-facilitated, interactive, Web-based learning module for osteopathic medical students in geographically distributed clinical clerkships. Our research questions were as follows:

1a. Will third-year osteopathic medical students actively participate in Web-based instruction?
1b. To what extent will these students engage in the activities of an online program?
1c. What is the quality of their participation, as determined by the content of their interaction?
2a. Will third-year osteopathic medical students find value in Web-based instruction?
2b. Which elements of the instruction will they find most helpful to their learning?
2c. Which elements of instruction will be less helpful?

Methods
Participants in the present study were 63 third-year undergraduate osteopathic medical students from UNTHSC/TCOM and were participating in a required 8-week clinical clerkship in surgery. The study cohort included all students taking their surgery clerkships during the three periods that occur in the fall semester. This sample of students represented approximately one-half of the total third-year class. Students were randomly assigned selection positions to determine the sequence of their clerkship courses for the entire year. Participating students in the present study were those selecting their surgery clerkship to occur within one of three 8-week periods in the fall semester and were unaware of the clerkship curriculum or the elements that comprised the present study when selections were made.

While true randomization to assure a representative sample of the class with regard to prior academic achievement or other traits was not performed, the absence of identifiable bias in the selection process supports the generalizability of the outcomes measured.

Surgery Clerkship Protocol
The surgery clerkship was composed of 4 weeks of general surgery, 2 weeks of orthopedic surgery, and a 2-week block of specialty surgery in a discipline of each student’s choosing. Students selected one of several training sites in either Fort Worth or Corpus Christi, Texas. The curriculum for the clerkship specified a list of recommended learning objectives and associated readings. Although each site provided students with bedside teaching and formal lectures, the conduct and content of those lectures were not identical. Ample time was made available daily for self-study by limiting allowed work hours.

The WebCT Platform
In addition to face-to-face instruction, students were required to use a Web-based syllabus housed on the WebCT Vista 3 online teaching platform. WebCT is an Internet-based instructional tool that allows asynchronous communication between students and faculty. Access to each course’s WebCT site is allowed only to students currently enrolled in that particular course. Once enrolled, the students may be identified on the course Web site by other users. The instructor is given special access to course construction and management tools. This feature allows the instructor to pre-populate the site with assignments, discussion boards, and resource materials that can be downloaded by enrolled students.

The WebCT program includes utilities that allow the assignment of students to individual groups and the scheduled release of assignments and discussion boards for online communication between students. The instructor can choose to grade various elements of participation as determined by the curricular design. Access to a course’s WebCT site can be obtained from any computer with Internet connectivity and a compatible Internet browser.

Instructions for accessing the WebCT site were included in the clerkship syllabus distributed to all students. Students in Fort Worth received a brief orientation to the program on the first day of the clerkship. Students in Corpus Christi included 2 groups: (1) those assigned to the site for the entire third year of school received a single group orientation at the beginning of the year, though their individual scheduled rotations in surgery occurred at any time during the year; and (2) an additional group of students completed their rotation in surgery at Corpus Christi but was otherwise not on site for the entire year. Those students became familiar with WebCT by reading the orientation materials included in the course syllabus and engaging in trial activity that occurred during the first week of the clerkship. University technology support was available by e-mail to answer any questions or handle access problems. Performance on the Web-based portion of the curriculum comprised 10% of each student’s numeric grade for the clerkship. The numeric grade was used to determine class rank, but the final transcript grade for the clerkship was recorded as pass or fail.

Web-Based Curriculum
The Web-based syllabus was divided into 8 weekly segments to correspond to the duration of the students’ clerkship. The first author of the present report (D.N.P.) served as instructor/facilitator for all modules in the study. During the first week, each student was asked to access the course’s WebCT site to become familiar with the navigation and communication tools. This activity also assured that passwords had been set and were working correctly before gradable class work began in week 2. Each group comprised 3 to 5 students, depending on the number of students enrolled during the clerkship period.
Each group included students from both training sites so as to encourage the use of the WebCT platform for all group communication.

During weeks 2 through 5, students were required to participate in group assignments. All group assignments were similarly constructed with a common stem, but each group addressed different specific problems (Figure 1). Students were required to draft a response to the problem as a group using a discussion board reserved for their group and visible only to their group members and the instructor. The instructor followed the interaction of each group and responded to students’ inquiries without participating directly in students’ discussions. The lack of instructor intervention at this point allowed each group to complete its own discovery and apply collective logic and experience to the assigned problem.

After group discussions, all groups were required to post a draft response to a general discussion board that was visible to all student groups. On this general discussion board, the instructor provided a critique of each group’s draft response, questioned the rationale of certain management or treatment strategies, and suggested other additions to or exclusions from each group’s final plan. Each student was required to post a constructive comment, suggestion, or question to at least 2 other groups’ responses, as well as respond to other group members’ inquiries into their own group’s draft response. This practice was intended to foster familiarity with several diverse problems that are common in surgical practice. At the end of the week, each group was required to reassess its draft response to the problem, consider pertinent suggestions from their colleagues, and post a final report for grading. The assignments during weeks 3 through 5 were similarly structured, with increasing diagnostic and management complexity.

Week 6 followed a plan of activities similar to that of weeks 2 through 5, but students worked individually and were required to provide discussion of a surgical case from their own experience. Weeks 7 and 8 were used for structured review.

In week 8, students were required to complete an online evaluation of each of their group members as well as an online evaluation (attitude survey) of the WebCT module. The attitude survey (Table 1) was composed of 10 statements for which a 5-point (1, strongly disagree; 5, strongly agree) Likert-type response scale was provided. Content and face validity of the instrument were determined by obtaining opinions from two reviewers who were experts in the preparation of such documents.20

Data Collection and Analyses
WebCT contemporaneously records data that reflect student access to the course Web site and subsequent interactions (eg, discussion board messages) that occur while the student is online.

Using these records, the data collected for each student included the number of times the student accessed the WebCT site, their total online time throughout the 8-week curriculum, the number of messages posted for group projects during weeks 2 through 5, the content of each message posted, and the discussion board each message was posted to. This selection of data enabled us to determine both the quantity and quality of interactions as measures of the module’s efficacy as a learning tool for this population sample. Qualitative data were obtained from the content of the messages posted to the WebCT site and students’ responses to the attitude survey.

To answer research questions 1a and 1b, Microsoft Office Excel 2003 (Microsoft Corporation, Redmond, Washington) was used to analyze the quantity of students’ site visits, cumu-

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**Table 1**

<table>
<thead>
<tr>
<th>Group 1</th>
<th>A 68-year-old female with cholelithiasis for elective cholecystectomy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 2</td>
<td>A 72-year-old male with colon cancer for left hemicolectomy.</td>
</tr>
<tr>
<td>Group 3</td>
<td>A 35-year-old male with a right inguinal hernia for laparoscopic herniorrhaphy.</td>
</tr>
<tr>
<td>Group 4</td>
<td>A 40-year-old female with a thyroid nodule for thyroidectomy.</td>
</tr>
<tr>
<td>Group 5</td>
<td>A 52-year-old female with breast cancer for lumpectomy and sentinel node biopsy.</td>
</tr>
</tbody>
</table>

**Figure 1.** Sample group assignment as it appeared to students for week 2 of the surgery clinical clerkship described in the present study. Web-based group assignments during weeks 2 through 5 required students to draft responses to typical surgical episodes, similar to those shown here.
Type descriptions were determined by the first coder (D.N.P.). The second coder (Albert H. O-Yurvati, DO) manually assigned codes to each message using the type scheme and identified any messages that were unassignable to one of the four types. If a message met the description of more than one message type (eg, class I and II), the “higher” type (eg, class I) was assigned to that message.

When the two coders disagreed about how to code a particular message, a third coder (Michael Budd, PhD) determined the appropriate code. The third coder, who holds a PhD in education, was blinded to the opinions of the first two coders. If he agreed with one of the first two coders, his opinion resulted in a tie-break. If he did not agree with either of the assignments made by the first two coders, the message was not included in the data analysis.

Mean scores were obtained for responses to the student attitude survey. While there was similarity between some of the survey’s 10 attitude statements, each item was determined to assess a unique construct. With regard to the research questions, survey items 3 and 10 (Table 1) were deemed to provide insight into the students’ perception of the value of the Web-based instruction overall. Items 1, 2, 5, 7, and 8 identified value of specific elements in the instructional design.

Missing data, corrupt data, or data judged otherwise unreliable for any reason was identified as such and omitted from analysis. Alpha was set at .05.

**Results**

**Quantity and Content of WebCT Usage**

This study received exemption from the Institutional Review Board of the UNTHSC. Data were initially obtained for 64 students enrolled in one of three consecutive 8-week clerkships. This population comprised all students enrolled in the surgery clerkship during the fall semester. All were required to participate in the Web-based module.

One student was removed from the assigned clerkship for reasons unrelated to the present study, leaving 63 students for whom analysis was completed. The study sample was composed of 32 men and 31 women with a median age of 26 years (range, 23-36 years). Eight students requested assistance in securing access to the online course site the first time because of password issues, and 1 student lost access during the clerkship and required password re-registration. All students retained full access to the WebCT site during weeks 2 through 5 of the course.

To answer research question 1a, we assessed the mean number of times each student accessed the WebCT course site. Students across the three clerkship periods averaged 38.14 site visits during the 8-week curriculum (SD, 22.20; range, 9-138). The mean (SD) number of visits per student for each of the three courses were 44.61 (25.42), 38.33 (21.91), and 30.10 (15.90). Analysis of variance (ANOVA) revealed no statistically significant difference in means observed ($F_{2,60}=2.3159$, $P=.1074$). The median time spent on the WebCT site during the 8-week course was 587 minutes (range, 233-2242 minutes) per student.

Students submitted a total of 1214 messages to the various discussion boards during weeks 2 through 5. The mean (SD)
number of messages per student was 19.13 (7.90) (range, 7-51) for these 4 weeks of the course. To answer research question 1c, the first and second coders agreed on the codes assigned to 867 (71%) of the total 1214 messages, with the remaining messages adjudicated by the third coder. Thirty-three messages were analyzed. The distribution of messages by code arose were readily corrected, affording every student convenient and unlimited opportunities for participation.

Discussion

The present study was designed to assess one method for addressing the challenges of geographic distribution in clinical clerkships and the inaccessibility to central facilities for many medical students. The results of the current study generally support the use of an Internet-based, asynchronous learning experience for third-year medical students in a surgical clerkship. Few students had difficulty gaining initial access and the few problems that

Student Participation

Sixty-one students completed the attitude survey distributed at the conclusion of the 8-week course. Two students failed to submit the survey after 2 requests sent electronically by the course facilitator. Responses to the survey items were used to derive answers to research questions 2a, 2b, and 2c. Mean attitude scores for each question are provided in Table 1.

The mean scores of survey items 3 (3.93) and 10 (3.30) reveal that students find value in Web-based instruction. The mean scores for items 1 (4.18), 2 (4.52), 5 (3.26), 7 (4.00) and 8 (3.43) demonstrate the relative value to the students of each of these design elements.

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### Table 1

<table>
<thead>
<tr>
<th>Message Type</th>
<th>Message Descriptor</th>
<th>Sample Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Contribution to the body of knowledge</td>
<td>“Sorry this took so long. I was having a little trouble getting on. The patient should be nothing by mouth before surgery so we need to establish an IV; peripheral should work fine. Place the patient on a 125 mL/hr D5 drip or 1/2 normal saline. If the procedure is emergent, then we will also need to control pain: 2 mg IV morphine q3h as needed for pain, increased to 4 mg if the pain is unresponsive.”</td>
</tr>
<tr>
<td>Type II</td>
<td>Secondary commentary, clarification, inquiry, or response</td>
<td>“Great job on physical examination (PE) assessment for thyroid nodule. My question is about PE findings for other diseases that may have perioperative risks. Will you examine cardiovascular and pulmonary systems for evidence of any disease, for example?”</td>
</tr>
<tr>
<td>Type III</td>
<td>Organizational communication</td>
<td>“I don’t mind taking the position of group leader this week. Our case is: A 68-year-old female with cholelithiasis for elective cholecystectomy. We can divide up the work like this: (1) History, (2) Physical Exam, (3) Orders, (4) Informed Consent. Because there are only 4 topics, the 5th person can answer the questions of the other groups. I’ll do the history. Just post what you want to do in this group discussion section so we don’t overlap work. Get your part to me by Wednesday and then I’ll post it all together on Thursday.”</td>
</tr>
<tr>
<td>Type IV</td>
<td>Social interaction or unrelated exchange</td>
<td>“You guys did a great job on this assignment. I wish I could add something to its content, but it already seems quite comprehensive and complete. Let me know if there is anything I can do to help.”</td>
</tr>
</tbody>
</table>
It remains unclear what content characteristics are needed to determine the level of critical thinking that has actually occurred in an online course, and it should be assumed that some cognitive processing does occur even when it is not clearly reflected in students’ online discourse.

A difference in the students’ pattern of discussion was observed when comparing small-group activities to interactions in the larger WebCT community. This variance of messages by type was not unexpected, because students were clearly directed to provide relevant commentary on the work of others for their assignments. Their responses and inquiries regarding the subject matter are reflected in the relatively high percentage of Type II messages. Type I messages were either postings of group work as required by the syllabus or expansive commentary that added substantially to the body of knowledge.

The quantity of messages that were solely produced to direct the order of activities is noteworthy. However, the disparate percentage of Type I messages as compared to Type II in the group project discussions implies little critique or reinforcement of each other’s work within the group. When message content was scrutinized beyond categorization, it becomes apparent that each member of the group was contributing to the final project. Those contributions were then collated by a team leader who posted the final report to the larger community for discussion. Appraisal of each individual’s contribution to the group work before collation and final posting was infrequent and was reflected in the low percentage of Type II messages. This finding may be unique to this study, unique to online learning, or characteristic of group learning in general. If so, a question must be raised regarding how knowledge is co-constructed in group activities, if at all.

### Student Satisfaction

The value that students find in learning opportunities may inevitably determine the enthusiasm and quality of their participation. Factors such as students’ perceptions of the relevance of the course content and the instructional design are critical to all teaching efforts. The importance of instructor accessibility and guidance, and technical management of the course, may be unique to Web-based instruction.

Students in the present study found the course content valuable and relevant to the overall objectives of the clerkship. Students appeared to recognize their obligation to the course, may be unique to Web-based instruction. Students in the present study found the course content valuable and relevant to the overall objectives of the clerkship. Students appeared to recognize their obligation to the course, may be unique to Web-based instruction.

Table 2

<table>
<thead>
<tr>
<th>Message Type, Clerkship Period*</th>
<th>Messages Posted, No.</th>
<th>All Group Discussion Boards</th>
<th>General Discussion Board</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 1</td>
<td>94</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td>90</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Period 3</td>
<td>48</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>232</td>
<td>143</td>
<td></td>
</tr>
<tr>
<td><strong>Type II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 1</td>
<td>33</td>
<td>143</td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td>24</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td>Period 3</td>
<td>7</td>
<td>142</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>64</td>
<td>490</td>
<td></td>
</tr>
<tr>
<td><strong>Type III</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 1</td>
<td>74</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td>43</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Period 3</td>
<td>35</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>152</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td><strong>Type IV</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 1</td>
<td>27</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td>18</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Period 3</td>
<td>9</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>54</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td><strong>Total, No. (%)</strong></td>
<td></td>
<td>502 (43)</td>
<td>679 (57)</td>
</tr>
</tbody>
</table>

* All clerkship periods were 8-weeks long and occurred during the fall semester. For clerkship period 1, n=23. For clerkship period 2, n=21. For clerkship period 3, n=19.
online instruction is the opportunity for group learning. Students’ attitude scores revealed that face-to-face learning, where possible, remains the students’ instructional method of choice over Web-based learning. Overall, however, students did find their learning experience in the clerkship was enhanced by the Web-based activities.

Conclusion
The data obtained in this study enable several conclusions in response to the research questions. With regard to participation, third-year osteopathic medical students in geographically distributed clerkships were able to coordinate their activities online and devote the time needed to engage in Web-based learning. In seeking solutions to clinical problems posed online, they demonstrated higher-order thinking that included both analysis and synthesis as required by the instructional design. They readily engaged in collaborative learning with peers as directed but found it of moderate value. However, students placed greater value on the participation of a knowledgeable facilitator in the online environment to achieve their learning objectives.

In summary, while students had little difficulty in adopting interactive online technology as a learning tool, they expressed a preference for the classroom environment over Web-based instruction. Nevertheless, the results of the present study support Web-based applications to afford uniform learning experiences when face-to-face instruction cannot be provided. This efficacy study sought to identify the likelihood that Web-based instruction could be adopted for general and effective use in the identified population. Further study is needed to fully understand the dynamics of group learning in the virtual classroom and the extent to which knowledge can be co-constructed. Experimentation with various instructional design models suited for online learning is encouraged. Future studies should seek to identify those that will provide the best outcomes as well as correlate the measurable parameters of student participation with performance on standardized assessments.

Acknowledgments
We thank Michael Budd, PhD; Albert H. O-Yurvati, DO; and Jerry Alexander, PhD, for their assistance with message coding and preparation of the attitude survey.

References