Medical Students’ Opinion of a Web-based Module to Teach Clinical Reasoning and Knowledge

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Background: Japanese medical student education lacks emphasis on teaching clinical reasoning skills. To partially remedy this situation, we developed a prototypic web-based module for tutors to teach clinical reasoning. We report the medical students’ opinions of this module.

Methods: Twenty-four students from two Japanese medical universities were randomly assigned to the two tutored virtual classrooms, each classroom with six students, or to the self-study group, 12 students, after taking the Internet-based Sequential Question and Answer pretest. After four weeks, each of the 24 students took the Sequential Question and Answer posttest. The entire 24 students answered a questionnaire about the Sequential Question and Answer tests; all 12 tutored students answered a questionnaire about the web-based tutored module.

Results: Although both tutored and self-study Sequential Question and Answer posttest scores increased, the increases of the tutored group’s posttest compared to the self-study posttest group were not statistically significant (p = 0.066).

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Ninety-two percent of the students rated the Sequential Question and Answer tests as an improved way to learn case presentation and clinical reasoning. Moreover, 79% of students felt that the Sequential Question and Answer tests were an effective way to learn clinical information. The tutored students rated the web-based tutored seminars as an ‘excellent to fair’ method to learn clinical reasoning using a five-point ‘excellent to poor’ scale.

**Conclusions:** We developed a prototypic web-based module for tutors to teach clinical reasoning to medical students. The students’ opinion supported the modular components of the web-based seminar format, Sequential Question and Answer test, and the tutoring syllabus as an effective way to improve learning clinical reasoning, case presentation, and medical information. Students also suggested refinements of the prototypic module.

**Keywords:** clinical reasoning, medical students’ opinions, web-based seminar (webinar)

**Introduction**

Teaching clinical reasoning to medical students (MS) is formidable, even more so in Japanese medical universities where instruction is primarily via lectures. Japanese medical educators have struggled to address these deficiencies. For example, a group of investigators using a Bayesian-type measurement, showed the lack of improved Japanese MS clinical thinking after a short clinical course. Farrell et al integrated MS into patient-care teams during clinical clerkships; the MS responses to their questionnaire were very favorable for these mostly observational experiences. Matsushita et al reported MS favored problem-based learning (PBL) tutorials during their clinical clerkships to improve their patient understanding. Kita et al showed improved clinical reasoning using many structured formulas. Rao & Rao describe the difficulties reforming the Japanese medical university curriculum and suggested a total re-organization of the educational programs.

In this lecture-focused environment, where communication skills are attenuated, there is little opportunity for MS discussion, verbal analysis, or feedback, important components of learning. Akashi reported increased MS classroom verbal participation using a reward system in a large class. Tsukamoto et al recognized the importance of training MS to use the medical history for clinical reasoning. However, their use of simulated cases lacked MS verbal communication. Mukohara et al showed that an intensive small group seminar could impact specific communication skills for improved patient understanding. Nonethe-
each of the two universities, were randomized to the self-study comparison group. Randomization details have been published.\textsuperscript{14}

All 24 randomized students were administered the Japanese language online pretest called the Sequential Question and Answer (SQA) test. These 24 students were further randomized to either a tutored group (TG) or a self-study group (SG), with 12 students in each of the two groups. The two TG of six students met weekly for four sessions, in a virtual ‘classroom.’ Each session lasted 1.5 hours, and was led by a clinical tutor previously trained in a United States general internal medicine residency program. The Internet ‘classroom’ permitted the six students and their tutor to see and hear each other in real time simultaneously for Japanese language discussions. The tutors were encouraged to follow the provided Japanese language slideshow syllabus which was designed to promote clinical discussions rather than lecture. All 24 students were told once the clinical topics, namely fever, introduction to infectious diseases and clinical aspects of pneumonia, and encouraged to study these topics on their own. The entire 24 students were subsequently administered the online SQA posttest at the conclusion of the month long fourth tutored sessions.

The SQA tests
The SQA tests comprised two clinical scenarios, the pre- and the posttest. Each of the Internet-based tests contained eight sequential patient information and questions from a common pneumonia case in the traditional clinical narrative format of medical history, physical examination, preliminary differential diagnosis, laboratory and imaging studies, and final differential diagnosis. The text-based scenarios simulated a physician-patient encounter as might occur in a clinic. As the clinical narrative with patient’s information was revealed in sequential panels, a question was posed. The MS typed brief answers using their own computer’s word processor (Japanese language Hiragana to Kanji and Katakana), and ‘saved’ the answer panel. Instantly the same panel lengthened to show the clinical information, the posed question, its correct answers, and the MS’s saved answers as immediate feedback. During the 30-minute timed test, the MS was permitted to scroll up or down to review all prior clinical data, the correct answers with additional data, the MS’s answers, and new questions. Further SQA technical details can be found in our recent publication.\textsuperscript{15}

All data was captured on a downloadable secured spreadsheet for analysis; MS and medical university confidentiality consisted of unique encoding. The answers were scored manually based on a weighted scoring system with more points assigned for medical history and differential diagnosis. We defined ‘clinical reasoning’ as the weighted scores of the two questions requiring the students to list their differential diagnosis.\textsuperscript{16}

The Syllabus
The Japanese language slideshow syllabus was a standardized visible script for the two tutors to lead the webinar with their respective virtual Internet classrooms, and for the MS to follow the visual presentation. The syllabus consisted of four sessions: 1\textsuperscript{st} session was an introduction to fever and infection; the 2\textsuperscript{nd} session was an introduction to clinical aspects of pneumonia; the 3\textsuperscript{rd} and 4\textsuperscript{th} sessions were a patient with pneumonia, basically in the same clinical narrative format as the SQA tests with medical history, physical examination, laboratory and imaging data and differential diagnosis, illustrating the exact use of the problem list for practical and complete differential diagnosis. The syllabus contained animations in the form of questions for the tutor to lead discussions followed by the correct answers.

Module
The module consisted of four Japanese language components, 1) the SQA tests, 2) the syllabus, 3) the virtual Internet ‘classroom’ for discussions (webinars) and 4) the students’ questionnaire.

Students’ Questionnaire
The printed paper questionnaire consisted of four sections: 1) a general information section, 2) six questions about the SQA tests asking for two-point answers (yes or no); 3) 10 five-point Likert item questions (Excellent, Good, Fair, Inadequate, and Poor).
about the webinar sessions; and 4) five free text comment questions.

**Statistical Analysis**
All statistical analysis used Stata version 16 (Stata Corp., College Station, Texas, USA) for chi-squared test for difference of proportions, and Fisher’s exact test. Two-tailed p-value less than 0.05 was considered statistically significant.

**Ethical Approval**
Ethical approval for this project was obtained from the medical universities’ ethics committees, in conformity with the international Declaration of Helsinki standards. All of the 24 final randomized MS signed an approved informed consent form describing the project, that their identity would be disclosed, that their sessions would be recorded for analysis, and that they could withdraw at any time.

**Results**
The randomization process resulted in the selection of the 24 MS. Their age range was 24–27 years old. Nine participants (38%) were female students. The two groups’ ages and sexes were matched by the randomization without intention and were representative of their classes. No student withdrew.

**Questionnaire about SQA Tests**
The printed paper questionnaire was immediately administered to the 24 MS after completion of the SQA posttests. All 24 MS completed the questionnaire. For the 12 TG students, of whom eight were men and four were women, their questions focused on their opinions of both the SQA tests and the tutored sessions; the SG questions only focused on the SQA test. For the technical aspects of the SQA test, 92% of the students found the Website easy to use; 88% found the 30-minute time limit was sufficient to complete the test. However, only 58% scored typing the answers in Japanese easy (Table 1). For the cognitive aspects of the SQA, 92% of the students rated the SQA as an improved way to learn case presentation and to learn clinical reasoning. Additionally, 79% of the students felt that the SQA was an effective way to learn clinical information. There was no statistical difference in the responses between the tutored and the self-study students except for the clinical information question where 100% of the tutored students scored the SQA effective compared to 58% of the self-tutored students; this difference was statistically significant at a p = 0.037 (Table 2).

<table>
<thead>
<tr>
<th>Table 1. Responses to SQA questionnaire for tutored and self-study students.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For the SQA pre- &amp; post-tests, please answer the following by circling your answer:</td>
</tr>
<tr>
<td>a. Is the Website easy to use including login?</td>
</tr>
<tr>
<td>b. Do you have adequate time to complete your answers?</td>
</tr>
<tr>
<td>c. Is it easy to type text (Hiragana to Kanji)?</td>
</tr>
<tr>
<td>2. Overall,</td>
</tr>
<tr>
<td>a. Do you think these tests are an improved way to learn case presentation?</td>
</tr>
<tr>
<td>b. An improved way to learn clinical reasoning?</td>
</tr>
<tr>
<td>c. Did you learn clinical information from taking the tests?</td>
</tr>
</tbody>
</table>

**SQA MS positive comments**
I realized that I was missing the most likely cause about clinical problems.
I can acquire the way to diagnosis from limited information and clues without lab data.
Typing answers rather than selecting multiple choices is more like real doctors.

**SQA MS negative comments**
I think the tests were difficult.

**Questionnaire about webinar tutored students**
Using a five-point ‘excellent to poor’ scale, students rated a score of excellent, good, or fair for the
following questions: usefulness of the Webinar technology, improvements in clinical reasoning, usefulness of the tutored sessions, and the effectiveness of the tutors. They rated a score of excellent, good, fair or inadequate for the following questions: knowledge gained, the effectiveness of the slideshow syllabus, and the likelihood of recommending this webinar program to classmates.

Other Results
The tutored and self-study groups had similar pretest scores of about 40 weighted points, which were not statistically different ($p = 0.640$). The tutored MS group gained 47% ($p = 0.003$) in the posttest scores compared to an increase of 30% ($p = 0.021$) for the self-study group. These increases of the tutored group’s posttest compared to the self-study posttest group were not statistically significant ($p = 0.066$) (Table 3).

Table 2. Responses to SQA questionnaire between tutored students and self-study students.

<table>
<thead>
<tr>
<th>1. For the SQA pre- and post-tests, please answer the following by circling your answer:</th>
<th>Tutored</th>
<th>Self-study</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Is the Website easy to use including login?</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>b. Do you have adequate time to complete your answers?</td>
<td>9</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>c. Is it easy to type text (Hiragana to Kanji)?</td>
<td>5</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>2. Overall:</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>a. Do you think these tests are an improved way to learn case presentation?</td>
<td>12</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>b. An improved way to learn clinical reasoning?</td>
<td>11</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>c. Did you learn clinical information from taking the tests?</td>
<td>12</td>
<td>0</td>
<td>7</td>
</tr>
</tbody>
</table>

*Based on Fisher’s exact test. **Statistically significant

Webinar students’ response times
As previously reported, the combined tutored students’ verbal response rate, as a measure of their participation during an attempt to encourage discussions, was a mean time of 13% for the four webinar sessions.17

Discussion
We developed a prototypic webinar module for tutors to teach clinical reasoning to fifth grade Japanese medical students. In this report, we documented the MS overwhelming approval of the module’s four components, 1) the SQA pre- and posttests, 2) the syllabus including clinical information and a realistic clinical case for the students to learn the proper order of the patient’s narrative, apply the data to make a practical differential diagnosis as an introduction to clinical reasoning with the guidance of the tutors, 3) the medical student questionnaire, and 4) the technical Internet real-time virtual classroom.

The MS responses to the questionnaire were too subjective to be decisive in supporting their opinion about improving clinical reasoning. However, the tutored MS stated the SQA tests did add to their acquisition of clinical information at a statistically significant level.

Surprisingly for many participating MS, this was their first stated exposure to the international order of the clinical narrative from medical history, physical examination, laboratory and imaging studies, and their first exposure to make a practical differential diagnosis.

Table 3. Tutored and self-study medical students’ (MS) average weighted percent correct points for the SQA pre- and posttests.

<table>
<thead>
<tr>
<th>Average Points</th>
<th>Pretest</th>
<th>Posttest</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutored MS (n = 12)</td>
<td>42</td>
<td>62</td>
<td>47%</td>
</tr>
<tr>
<td>Average Points Self Study MS (n = 12)</td>
<td>40</td>
<td>52</td>
<td>30%</td>
</tr>
</tbody>
</table>
based on the clinical narrative.

The fact that the majority of MS expressed the need for improving their clinical reasoning reinforces the paucity of adequate clinical training for MS and first grade residents in their medical universities, a deficiency previously described by others.\textsuperscript{18,19}

The overall improvements in the posttest SQA scores for both TG and SG groups highlighted the success of the short text answers as a process to increase clinical reasoning. Although the posttest SQA scores increased more in the TG than the SG, the difference was not statistically significant. The SQA innovations were its demonstration of the clinical narrative order, introduction of medical information, measurement and teaching clinical reasoning, and providing instant correct answer feedback; the concepts of test-enhanced learning have been recently described.\textsuperscript{20}

**Limitations**

There were several limitations of the project. Firstly, neither validity nor reliability data of the MS questionnaire, the SQA tests or the syllabus were obtained because this was a feasibility study; future studies may address these needs with increased number of participants. Further analysis and discussion of the modest TG SQA higher scores have been cited elsewhere.\textsuperscript{14} Although students expressed difficulty using their word processor in Japanese, a few students mentioned the benefit of writing text answers as a way to improve individual reasoning. Our module only focused on one common respiratory and infectious disease, specifically pneumonia. All specialties and subspecialties topics may be written into our module to teach clinical reasoning in every medical discipline, whether organ specific or by symptoms.

This module was a prototype, which will require improvements for future studies. For the SQA, having the participants make a dynamic problem list is an important needed addition.\textsuperscript{21} The term 'dynamic' denotes a problem list that is increased as new clinical data is presented from physical examination, laboratory and imaging data, etc. Also ancillary data including ECG, and radiography should be included in revised editions. Future SQA improvements will address the MS's relatively low questionnaire score regarding learning clinical information. We simplified the different types of PBL, such as case-based Learning (CBL), to emphasize clinical reasoning in our modular components, the SQA and this syllabus.\textsuperscript{22}

The role of the tutors was not a prominent feature in the project’s outcome because we had not anticipated their dedication to the lecturing mode. Future changes for the tutors should include the use of an improved syllabus with greater prompts to increase student participation and to reduce lecturing.\textsuperscript{17} Feedback from experienced PBL faculty to the tutors is needed to limit their speaking. Frequent praise to MS to positively reinforce engagement to improve MS learning and decreased boredom is also required.\textsuperscript{23}

Although not documented in this report, the use of social media data as a forum for MS to freely express their opinions about tutors, professors and courses may be a good source for future medical university’s curriculum reforms.\textsuperscript{24}

**Conclusion**

We developed a prototypic webinar module for tutors to teach clinical reasoning to medical students. The students’ opinion supported the modular components of the web-based seminar (webinar) format, the SQA, and the tutoring syllabus as effective ways to improve learning clinical reasoning, case presentation, and medical information. Students suggested refinements of the module may be a stimulus for medical universities to instigate significant clinical training improvements.\textsuperscript{25}

**Conflict of interest**

The authors declare that they have no conflict of interests.

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References