

# Student Teachers: Medical Students Developing Content for their own Website-Supported, Self-Assessment Question Database

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### Abstract

**Background:** The Student Teacher Program is a student driven project designed by educators, student teachers (medical students), and technology experts in the Faculty of Medicine at the University of Toronto. The program involves the collaboration of students and faculty, and combines peer teaching with self-directed student learning to form an online course-specific question and answer resource.

**Objective:** To determine the perceived usefulness of the resource, student willingness to contribute to the program, its perceived educational value, and the barriers to its use.

**Methods:** The first-year medical class used the prototype during their Metabolism and Nutrition course block (September 2002), and their experience was assessed through a survey.

**Results:** 48.5% of the respondents used the website and 74.5% rated it useful for self-assessing conceptual understanding. The barriers to its use appeared to be concerns of the users, rather than the predictors of reasons keeping non-users away.

**Conclusions:** This work shows that the program is seen as a valuable complement to pre-clinical lecture-based medical curriculum, and lays a foundation for future research into usage trends and objective educational value.

### Introduction

Learning medicine is a continual process of acquiring, assimilating, and assessing knowledge. Any useful educational initiative should look to aid this process by accelerating how quickly the appropriate information can be accessed, increasing the efficiency by which this new information is understood by the learner, and fortifying the retention of new knowledge. With this in mind, the education team at the University of Toronto, comprised of medical educators, medical students, and technology experts, created the Student Teacher Program (STP) in early May 2002.

The education team designed the STP as an adjunct to the traditional lecture-based, pre-clinical curriculum at the

University of Toronto. The STP is a novel initiative that uses an information technology framework to incorporate aspects of peer teaching, student/faculty collaboration, and self-directed learning into one educational resource. The concept is quite simple: each Student Teacher (medical student) would 1) create several question and answer sets based on their current lecture series, 2) meet with or e-mail faculty to correct these sets, and 3) submit these questions to the course's specific Student Teacher website for the rest of the class to view. For the pilot program, 15 Student Teacher volunteers contributed questions to the Metabolism and Nutrition STP website. Over the eight-week period between February 3 and March 28, 2003, 47 questions were submitted to the site.

This study measured only the perceived usefulness of the site and the willingness of students to contribute to similar resources if incorporated as a standard part of the medical curriculum. It was the intention of the education team to establish a foundation for future work by gauging end-user acceptance and areas required for improvement prior to a full-scale introduction. Once introduced to multiple curricula, future research will undoubtedly correlate users' subjective experiences with usage information and measure objective indices to determine educational value. In this paper, the education team will also address the intended benefits of this program with support from current literature. This discussion is divided according to the role of technology in medical education, the contribution of self-assessment tools, and the value of peer teaching systems.

### Why Information Technology?

Developing tools to assist medical education today is a complex process that can be facilitated by using information technology (IT). Many educators hope that IT can help improve current educational content and the manner in which it is conveyed<sup>1</sup> as well as harness a vehicle (i.e. digital technology) that today's students are familiar with in most other aspects of their lives.<sup>2,12</sup>

The education group intended to create a dynamic resource with the capacity to evolve easily over time. Using technology, and a website in particular, for the STP initiative was imperative because of the need to centralize the process of creating, storing, and viewing content. During the design process, some of the issues the education team encountered included protecting the site so only authorized students

could submit questions, making the submission process comprehensive but simple enough for students to use, and designing an appealing and user-friendly interface. Website revisions focused especially on visual design, streamlining the content submission process, and adding features such as “print questions” options and displaying author (faculty & student) and date information.

Once content delivery and access issues were addressed, a number of other benefits of using information technology for this program became clear. Table 1 Part A summarizes these benefits.

### Practice Makes Perfect

The process of learning requires ongoing practice and repetition in order to assess comprehension. In clinical educational environments, however, where live patients are the source of ‘practice,’ there is little control over case types, and the standardization of clinical experiences and repetition can be difficult to create.<sup>2</sup> Similarly, a pre-clinical environment can present with limited opportunity to practise basic scientific and medical concepts. While students may have access to a small number of sample questions or ‘old tests,’ these seldom include full explanations of the underlying concept or significance of the specific problem. As a result, many students will struggle with the same concepts, but lack ways to test their comprehension or document their concerns for future learners.

The STP was created to address this problem and function as an adjunct to complement course lectures. By employing a question-and-answer-based self-assessment format, the education team hoped to enhance practice and repetition in the medical curriculum.

There is already some evidence that question and problem-based educational websites can promote the learning process. Kronz et al. showed that “a Web-based tutorial improved Gleason grading accuracy by pathology residents to an equal extent regardless of their year in training,” while also demonstrating areas needing further teaching efforts.<sup>3</sup> Roubidoux et al. created an interactive computer game whereby students test their knowledge of breast imaging against each other in a competitive environment. Among their main findings, the authors concluded that the website was more interesting to students than an information handout, and that it provided additional reinforcement of learning beyond a handout or lecture.<sup>4</sup>

In a similar initiative to the STP, Hammoud et al. used Test Pilot™ software to house a database of 500 self-assessment questions for an obstetrics and gynecology clerkship. Although the content was derived from faculty, the authors reported student satisfaction with the web-based format.<sup>5</sup> Relan et al. have employed a similar tool for self-assessment and argue the resource “has served to convert a passive practice exam into a cognitively meaningful teaching tool emphasizing metacognition.”<sup>6</sup>

Based on the current literature reviewed, appropriately developed self-assessment resources appear to improve the learning experience of students as well as their learning outcomes. In the present case, the STP provides a self-assessment resource whose question content is drawn by students directly from the specific course and lectures being taught. With

direct faculty input, these questions are most likely to be focused and relevant. By regularly assigning students specific lectures, there will quickly be enough questions to provide adequate practice for current students and review for students at more advanced stages of training. Table 1 Part B summarizes the benefits of using a self-assessment tool to enhance medical education.

### Value of Peer Teaching

An apprenticeship approach to teaching is still widely used in medicine and describes how physicians learn information and then pass this information on to train colleagues.<sup>2</sup> Likewise, modern pre-clinical education has begun to incorporate group work and problem-based learning into the curriculum. These environments encourage students to research questions, learn information, and discuss learning issues based on the supposition that understanding can be enhanced through peer teaching.<sup>14</sup>

Research indicates that peer teaching already has widespread application. Crowley et al. designed an electronic database to house a series of posed clinical questions. During medicine ward rotations, residents answered these questions with validated reference links and article summaries for other staff to use in patient care. The authors concluded that residents benefited from questions previously researched by other residents because it allowed them to address a wider spectrum of issues, which ultimately influenced almost half of their patient care decisions.<sup>7</sup> Shanks et al. discuss their institution’s Knowledge Co-op program administered by second-year health science students for first-year health science students. This successful peer-teaching program serves as an additional educational resource that incorporates large group reviews, small group tutoring, one-on-one tutoring, and practice laboratory practicals.<sup>8</sup>

Using the same principle, Riza et al. implemented a program in which medical students work full-time for the school’s educational development multimedia team for eight weeks after their first year. These authors argue that “students are in a unique position in the curriculum to identify problem areas and most effectively apply technology to create resources that are inevitably learner centered.” Combined with the financial savings of employing students to create educational resources, it allows “students to review the core curriculum, to apply a learner’s perspective directly to course material, and to facilitate collegial relations between students and faculty.”<sup>9</sup> These same benefits are hypothesized to be true of the Student Teacher initiative, and are summarized in Table 1 Part C.

### Materials and Methods

The STP website was programmed between May and August 2002 (including performance testing), and post-pilot revisions were made in August 2003. It was designed to allow information to be stored in a database so that the content (i.e. question and answer sets) could be continuously added. Students were able to submit approved questions (with full answers) through a password protected link on the website that was connected to the database itself. This website was also used to view submitted questions.

The website was created using server side VBScripts on

ASP pages that were connected to an Access database. The website had three links: a) a question link, b) a submission link, and c) a contact link. The question link was subcategorized by week according to the organization of the course block in which it was introduced.

**Part A: Proposed design benefits of using technology to support the STP**

- Students can use resource on their own time, at their own pace
- The "print questions" function on the website allows them the flexibility of text-based learning and the ability to add specific questions and answers to their own study notes
- Resources can be gathered over years and can be accessed by students in all years of study and practice
- Various forms of media (e.g., pictures, videos, animations) can be included with question and answer sets to better illustrate learning objectives
- Resource can be easily applied to most other courses simply by creating a new database

**Part B: Proposed educational benefits of using the STP self-assessment tool**

- Students actively test their knowledge of information relevant to their own curriculum
- May not empirically improve grades or performance, but may simplify and expedite the process of learning by creating a centralized resource for self-assessment with clear and complete explanations<sup>10</sup>
- As an adjunct to lectures, the site can provide an additional tool for reinforcing concepts

**Part C: Proposed educational benefits of using a peer teaching system for the STP**

- Students are well equipped to identify and target information relevant to or problematic in the course they are taking
- Students are required to understand a concept in order to create a question
- Faculty review of questions can a) identify weaknesses in a particular student's understanding of the material, and b) adopt a different approach for future lectures to explain a particular concept that is difficult to grasp
- Students are motivated to create questions by altruism, leading to the opportunity to interact with faculty, and the desire to contribute to a teaching and learning system that will provide reciprocal benefit
- By using students, the resource is more cost effective to produce

Table 1. Proposed benefits of the STP.

In February 2003, the bare (i.e. without any questions) STP website was introduced to first-year students in the Faculty of Medicine of the University of Toronto at the beginning of their eight-week Metabolism and Nutrition course. The course covers gastrointestinal, renal, and endocrine physiology, as well as lipid and carbohydrate metabolism. The purpose and function of the program as well as website navigation were explained to the class, and interested students were asked to volunteer for the program.

Each week of lectures (approximately 10-15 lectures) was assigned to two Student Teacher volunteers. Student Teachers were asked to create 2-4 questions of any format (e.g., short answer, multiple choice), accompanied by full answers and explanations. Each volunteer verified the questions with the appropriate lecturer, and e-mailed the final approved copy to the course representative, who used the website submission page to upload the questions for public use.

Given the intensity of the development process, no information has yet been collected about use and "surfing" behaviour. Preliminary program evaluation concentrated on students' subjective experience with the website and their will-

ingness to contribute to the program in order to aid in future site development. This formative assessment was done by questionnaire and undertaken during the course evaluation in March 2003. The sample was approximately 200 first-year medical students at the University of Toronto taking the mandatory Metabolism and Nutrition course block. Survey questions were designed to determine how often the site was used, how it affected the learning experience, what barriers were faced, a student's desire to contribute to future Student Teacher initiatives, and the potential applications to other courses.

Results of the questionnaire were analyzed using SAS version eight statistical software. The analysis provided descriptive statistics of self-reported website use and student willingness to participate in a future Student Teacher Program. For the chi-squared analysis using Fisher's Exact Test, the group was divided into students that used the site (users) and those who did not (non-users), to determine significant differences in website usefulness, website barriers, and desire to apply the program to other course blocks. The measure of statistical significance was adjusted from 0.05 according to the number of questions in each measure in order to account for confounding factors.

**Results**

The results from the evaluation of the Student Teacher initiative will be presented for discussion purposes according to general program statistics, resource usage, learning benefits, barriers, and applicability. Of the 200 distributed, 97 mostly complete surveys were returned, and 3 surveys were rejected as incomplete (47% response rate). This rate is reflective of the student response for other course evaluations.

**Resource Usage**

Based on questionnaire results, 51.5% of respondents never used the program website, 12.4% used the website once a week, and 36.1% of students used the resource only around exam time (there were two exams in the course).

**Learning Benefits**

Learning benefits were assessed by asking students to identify how the website was useful, and 74.5% of students who used the site found it useful in testing their understanding of concepts. Half of the users (51.1%) also believed that it showed them deficiencies in their knowledge. Only 14.9% of users learned new information, and 21.3% went to the website to clarify concepts they did not understand from lecture. As expected, there is a statistically significant difference between users and non-users in cited website usefulness and educational value (non-users did not use the resource). Please see Table 2 for a summary of student reported educational benefits of the website resource.

Learning Benefit	Users n= 47	
	Yes (%)	No (%)
Learned new information	14.9	85.1
Tested my understanding of concepts	74.5	25.5
Clarified concepts	21.3	78.7
Helped reinforce concepts	38.3	61.7
Revealed deficiencies in my knowledge	51.1	48.9

Table 2. Student-reported benefits of website's educational value given in percentages.

Student Teachers

Barrier	Users n= 47		Non-users n=50		p-value
	Yes (%)	No (%)	Yes (%)	No (%)	
Did not know about the website	2.1	97.9	4.0	96.0	0.39
Lack of internet access	8.5	91.5	2.0	98.0	0.14
Did not know the link (web address/URL)	4.3	95.7	10.0	90.0	0.18
Difficult to navigate	0	100	0	100	
Do not like using computers to learn	6.4	93.6	14.0	86.0	0.13
Not enough questions to be worthwhile	25.5	74.5	12.0	86.0	0.075
Worry about the accuracy of the content	25.5	74.5	16.0	84.0	0.10
Questions were not relevant to metabolism and nutrition course	4.3	95.7	0	00	0.23

Table 3. Student report of website's barriers given in percentages.

Course	Users n= 47		Non-users n=50		p-value
	Yes (%)	No (%)	Yes (%)	No (%)	
Gross Anatomy	66.0	34.0	20.0	80.0	5.2X10 <sup>-6</sup>
Cardiology	83.0	17.0	26.0	74.0	1.7X10 <sup>-8</sup>
Respirology	74.5	25.5	24.0	76.0	7.4X10 <sup>-7</sup>
Brain & Behaviour	80.9	17.0	24.0	76.0	6.4X10 <sup>-8</sup>
Pathobiology of Disease	80.9	19.1	20.0	80.0	2.3X10 <sup>-7</sup>

Table 4. Student reported desire to apply Student Teacher program to other preclinical courses given in percentages.

	Users n=46	Non-Users n=34	Total n=80	Total n=97 (assuming n=17 were "not willing")	Missing n=17	
					Users (%)	Non-Users (%)
Not Willing (%)	2.2	11.8	6.2	22.7		
Would Rather Not (%)	13.0	23.5	17.5	14.4		
Neutral (%)	34.8	26.5	31.2	25.8	5.9	94.1
Willing (%)	32.6	32.3	32.5	26.8		
Very Willing (%)	17.4	5.9	12.5	10.3		

Table 5. Student reported willingness to contribute as a Student Teacher one time (i.e., one week of lectures) during their first two years of medical school given in percentages.

Barriers

Barriers to use were assessed by asking students to identify factors impacting on their use of the website. Surprisingly, no statistically significant differences existed between users and non-users in perceived barriers to website use. Although not statistically significant ( $p < 0.05$ ), the trend showed that non-users were less likely to know about the website, the link to the website, or enjoy using computers to learn when compared to users. These differences, however, were small, and unlikely to fully explain why half of the respondents did not use the website.

One quarter of the users (25.5%) felt that there were insufficient questions in the database and worried about the accuracy of the content. Non-users also cited the same two major concerns, but not to the same extent.

Historical barriers to use of electronic resources do not appear to make a major impact.

The great majority of students appear to have internet access, feel comfortable navigating through simple websites,

and enjoy using computers to learn. Table 3 summarizes the results of student reported barriers to website use.

Applicability

The educational team also wished to assess students' desire to expand this program to other pre-clinical courses. At the time of the survey, students had not yet taken Brain and Behavior, or Pathobiology of Disease. There is a significant difference between users and non-users in their desire to apply the program to other courses. Table 4 presents data illustrating that most users of the website were in favour of extending the program to other subject areas.

In order to investigate extending the STP to other courses, student willingness to contribute to question content was assessed (Table 5). A disproportionate number of non-users did not answer this question (i.e., sixteen); therefore, in order to make conservative estimates, we have assumed that all missing values were from students unwilling to contribute content (Table 5,  $n=97$ ). Of the total, only a small proportion of students, (22.8%) were "not willing" to contribute content,

whereas 37% of students were either willing or very willing to create questions, and 26% were neutral to the idea.

### Discussion

As predicted, users found the question/answer website most useful because it allowed them to self-assess their understanding of concepts, which is consistent with the program's main goal of practice and repetition for learning. Most students did not learn new information nor use the website for clarification. This also supports the other goal to use the resource as an adjunct to a traditional lecture-based curriculum.

It was also surprising that barriers to use appeared to be a concern for users of the website, and not predictive of reasons that kept students (i.e. non-users) away. Based on these results, the education team realized the importance of 1) building the confidence of existing users by making modifications to address their concerns and 2) determining how new users can be encouraged to use the resource.

In response to this feedback, the educational team has updated the website design. The amount of content on the website will be addressed over time if a) students are assigned lecture weeks for which to create questions and if b) faculty suggest clarification questions that can be added by students to the course website.

To address the other main concern of question accuracy, the website will now contain a section that describes the program and development process. Each question submitted will also display the name of the student submitting the question, the faculty member who approved it, and the posting date so that students can judge the relevance of the question to their particular course. In addition, to increase the resource flexibility, the website has now been designed to allow students to print questions and answers.

The above changes may also address some of the barriers that kept non-users from using the site. In addition, the education team will also encourage non-users by formalizing the STP into individual courses. The program can be included in information sessions given by course directors, documented in course manuals, and advertised as one of the resources available to students on Faculty websites and information packages. This barrier could therefore be removed with concerted and regular marketing of the benefits of the resource in order to reassure slow-adopting students that the resource is a necessary part of the curriculum, not simply additional work. Through past experience, the thorough integration of new electronic resources within the daily classroom culture and content often proves critical to the ultimate success of the technology.

It is also believed that faculty perception will be a foreseeable barrier to the adoption of the STP, but this has not yet been studied. It was the experience of the education team that resistant faculty quickly realized that vetting questions took only a limited time, submitted questions were of good quality, the redundancy of discussing similar concerns with multiple students was reduced, and interactions with Student Teachers could be incorporated into lectures. Future work can assess these findings further.

Based on the usage statistics, approximately half the respondents used the website resource; an encouraging trend

given that this was a novel, non-traditional resource that employed a website that was not fully populated with questions. For the half of the respondents that did not use the resource, the education team considered a few hypotheses to explain their non-usage. During development, the education team postulated certain technical or social barriers (e.g., not enjoying computers to learn or concerns over content) would account for usage disparities between users and non-users. As this was not the case, it is possible that other barriers that we did not consider were at play. A second, more likely explanation is that such a resource simply does not appeal to a portion of the class. This can be supported by the fact that most of the non-user group would prefer not to have a similar resource for other pre-clinical courses. We, therefore, believe users either had a propensity for using such a resource in the first place, or simply found it useful to their education after having used it. Still as the resource is set up as one tool of many available to students, we understand it may not appeal to students with certain learning and studying styles.

The educational team believes, however, that there are still some non-users who may use these resources if they became a standard part of course curriculum, especially as the database becomes more populated with useful content and student awareness of its attributes grows. In this study, 65% of non-user respondents reported being neutral, willing, or very willing to contribute to the resource. We, therefore, believe these students would choose to use the resource if they in fact contributed to it.

There are several limitations to this type of study. First, this is not a census, but a sample. Although the responses of the selected students are ideally intended to draw conclusions about the entire medical student population, one can only place confidence limits on where the true response rates fall. The response rate of 47% was reflective of the response for the concurrent course evaluation. It is believed that this is sufficient for this preliminary study to determine whether or not to move forward with the program. Second, this can be a difficult population to survey, and regardless of the number of contacts and the types of incentives that may be offered, many students simply fail to respond. Third, the results are based on self-reports and are influenced by the recollections, perceptions, and honesty of the students. Future studies can compare website usage data with survey results in order to corroborate conclusions.<sup>11</sup>

Furthermore the nature of the study's design only permits conclusions to be made about student perceptions of educational value, and not empirical measures of the teaching benefits of this site. Although measuring teaching outcomes can be extremely difficult given the number of confounding factors, this study's results give support to other studies investigating the effect, if any, of the Student Teacher Program on learning milestones.

In conclusion, this paper presents a dynamic, on-line educational resource for medical students that incorporates peer teaching, faculty-student collaboration, and self-directed learning into its development. The resulting website facilitates interactions between medical students, the faculty, and the curriculum. Results indicate that despite limited marketing, the resource was utilized by almost 50% of respondents. A majority of users believed the website allowed them to test

their understanding of concepts, and showed deficiencies in their knowledge. There was also a general willingness to contribute to the resource, if lectures were to be pre-assigned to all members of the course group. There already exists a body of literature that supports the educational value of peer teaching as well as self-assessment through practice and repetition. By combining these concepts into one dynamic and readily updatable website resource, the Student Teacher Program is perceived by students to be a valuable educational adjunct to a lecture-based curriculum. This study of resource development and evaluation will be a foundation for further qualitative and quantitative investigations into determining whether the tool increases the efficiency by which new information is understood by students and fortifies the retention of new knowledge.

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