2006-123: ASSESSING AN INSTRUCTIONAL TECHNOLOGY SCAFFOLD FOR REINFORCING LEARNING OF PROBABILITY AND STATISTICS

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Assessing an Instructional Technology Scaffold for Reinforcing Learning of Probability and Statistics

Abstract

In order to facilitate active learning (*i.e.*, student interactions) and emphasize real-world applications in an introductory undergraduate biomedical engineering course on probability and statistics, we have developed a scaffold of multiple instructional technologies. These technologies include the course management system, BlackBoard®, non-linear (hyperlinked) PowerPoint® notes, Classroom Performance System (CPS) technology, and "real-world" MATLAB®-intensive problems. Based on three semesters of student data, we revised the scaffold model and assessed the impact of the component instructional technologies in reinforcing student learning and critical thinking.

1. Introduction

For three semesters we gathered pre- and post-class student survey data, observational data, technology usage data, and classroom performance results in BME 335 (Introduction to Probability, Random Processes, and Statistics.) Students solve homework assignments using the assessment tools within BlackBoard® in addition to using this course management tool for obtaining course notes and announcements. The class structure provides lectures using non-linear (hyperlinked) PowerPoint®, interspersed with active learning activities via Classroom Performance System (CPS). The CPS technology consists of remote controls for each student and a receiver that records student answers to questions posed by the instructor. In smaller groups, students work on "real-world" MATLAB® problems in a computer lab section. In this paper, we will provide assessment results on how these instructional technologies influence students in developing basic content understanding and also in the development of critical thinking and reasoning skills.

Our initial scaffold of instructional technologies was presented at ASEE 2005 [1]. Based on two additional semesters of experience and data, we have revised the scaffold (Figure 1). We experimented with running the computer lab section in both a traditional dedicated classroom and by using a laptop cart system (mobile classroom technology) in a regular classroom. In our experience, the differences between these two formats did not appear to significantly impact student learning. Thus, we revised our conceptual scaffold to eliminate any apparent dependency on the particular computer arrangement used for solving the "real-world" MATLAB® problems. With the assistance of the UT Center for Instructional Technologies, we developed a set of interconnected non-linear PowerPoint® presentations to encourage a flexible lecture style that is responsive to students' learning needs, help students see the connections between topics, and provide a learner-driven resource for self-study and review. Our first version of the non-linear presentations was developed in spring 2005 through the support of a UT Austin Faculty And Student Teams for Technology (~FAST Tex) grant and deployed for the first time in fall 2005. The hyperlinks were used extensively during the lecture and self-report surveys indicated that students also navigated the course notes using the hyperlinks when reviewing the material outside of class time [2]. Also, surveys from fall 2004 indicated that students did not make a significant distinction between PowerPoint®, which was used to present questions, and the CPS technology, which was used to collect student responses. Consequently, in the 2005 surveys, short definitions of the various instructional technologies were provided (please refer to the Appendix). Thus, the scaffold was revised to emphasize the pedagogical role of PowerPoint® in this teaching approach.

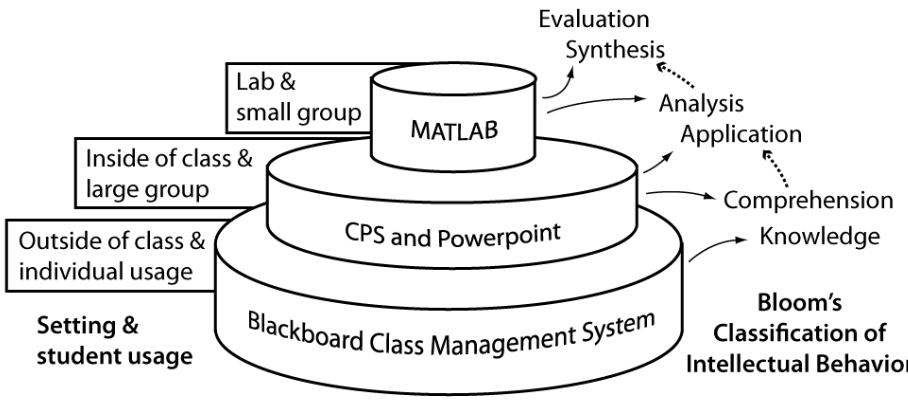

Figure 1. Instructional technology scaffold.

2. Methods

IRB approval was obtained for this study and efforts were made to protect the students' interests. For example, the instructor did not have access to any study data not regularly used for instructional purposes until the final course grades were submitted and only had access to anonymized data (names removed). The methods used to probe students' learning and use of instructional technology were previously described in detail [1].

In this analysis, we focused on surveys regarding instructional technologies that were conducted at the beginning and the end of course. The surveys are reproduced in the Appendix for the reader's reference. The enrollments for fall 2004 (N = 17) and summer 2005 (N = 13) were unusually low for this course, so the statistical analyses presented in this paper are based on the data from fall 2005 (N = 60).

Since all of the variables under study are ordinal in nature (*e.g.*, ratings on a 5-point scale) and were collected in a pairwise manner (*i.e.*, the same student answered the same questions at the beginning and end of the course), a Wilcoxon Signed Rank test was employed to statistically analyze the data. The null hypothesis is that the median of the difference in the rating between the two time points is zero; the alternative hypothesis is that the median of the differences is not zero. Two-sided p-values were computed since we had no reason to presuppose that the ratings would necessarily be higher/lower at the end of the course. For ease of language, in the text we simply say that there was or was not a difference between the beginning and ending survey results. For the variables with "N/A" as an option, it was encoded as "0" when selected by a student. If a student did not answer a question either the beginning or ending surveys, that student was dropped from the analysis of that particular question. The calculations were performed using the “signrank” function of the statistics toolbox in MATLAB®.

3. Results and Discussion

3.1. Frequency of Use

Students reported that they used BlackBoard® frequently both during and outside of class times and no difference was observed between the frequency of use recalled for previous courses on the beginning survey and for the frequency of use reported for BME 335 on the ending survey. Likewise, students had substantial prior exposure to PowerPoint® in their coursework. As expected, students reported that in prior courses they had used CPS technology more frequently during class time than outside of class time and no change was observed for CPS use outside of class time during BME 335. By comparison, students reported an increase from “sometimes” to “frequent” use of CPS during class time for BME 335 relative to their previous courses ($p < 0.01$). This result is consistent with the use of CPS in almost every class session in BME 335. Most students entered BME 335 with little previous experience with MATLAB®; the median response on beginning survey was “never” for MATLAB® use both during and outside of class time. As expected from the fact that students were required to attend weekly lab sessions using MATLAB® and complete substantial lab reports outside of class, the reported frequency of use of MATLAB® significantly increased to “sometimes” for both during ($p < 0.01$) and outside ($p < 0.01$) of class time activities.

3.2. Comfort in use

In keeping with the fact that they had frequently used BlackBoard® and PowerPoint®, students indicated that they were very comfortable using those technologies. No change in the students’ comfort level with these tools was observed. A trend of increasing comfort from “moderate” to “strong” was observed for CPS usage, but the change was not statistically significant ($p = 0.10$). A substantial change in students’ reported comfort with MATLAB® was seen ($p < 0.01$). Coming into the course, students typically indicated that they were very uncomfortable with MATLAB®, but when they finished the course they were “moderately” comfortable with the technology. While many students were initially reluctant to use MATLAB® and were concerned about the programming element of BME 335, over the course of the semester they became more comfortable as they were repeatedly exposed to the tool.

3.3. Communication with instructors

Upon entering the course, students were “moderately positive” about the role of BlackBoard® in aiding communication with instructors based on their previous experiences. There was a trend of increasingly positive feelings about BlackBoard® for this purpose over the course of BME 335, but the change was not statistically significant ($p = 0.06$). Students were “neutral” regarding the influence of PowerPoint® and CPS on communication with the instructor on both the beginning and ending surveys. There was a trend of increasingly positive feelings about MATLAB® with regard to communication with instructors over the course of BME 335, but the change was not statistically significant ($p = 0.09$). Overall, students reported "strong" to "moderate" negative opinions about the influence of MATLAB® on communication with instructors, which is not surprising since that is not the intended function of the technology.

3.4. Communication with peers

Students reported a decrease from "neutral" to "moderately negative" ($p = 0.02$) for the role of BlackBoard® in supporting communication with the peers in BME 335 relative to that in their previous courses. Most likely this indicates a failure to effectively use student communication tools such as the Discussion Board in this course. In future offerings of BME 335 the instructors will try to make better use of this aspect of the technology. Likewise, a significant decrease from "neutral" to "moderately negative" ($p < 0.01$) was observed for the influence of PowerPoint® on peer communications. It is not clear to us how PowerPoint® may have been used differently in other courses that would explain this observation. It may be valuable to ask open-ended questions geared towards this observation in future studies. The trend was toward a "neutral" role of CPS in peer communication in this course relative to a "moderate negative" influence in previous courses, but this change was not statistically significant ($p = 0.14$). There was an increase from a typically "strong negative" to typically "moderate negative" ($p = 0.02$) assessment of the influence of MATLAB® on peer communications. However, when students who indicated "N/A" on the beginning survey because they had not used MATLAB® were excluded, the change in the peer communication dimension was not statistically significant.

3.5. Knowledge of course deadlines and requirements

Students reported that BlackBoard® was very valuable in helping them be aware of course deadlines and requirements and this did not change over the semester. This is encouraging since efficient distribution of this kind of information is one of our primary goals in using BlackBoard®. On the beginning of the semester survey, PowerPoint® was rated as "neutral" influence in knowledge of course deadlines and the rating decreased to "moderately negative" on the end of the semester survey ($p < 0.01$). It is not clear to us how PowerPoint® may have been used differently in other courses that would explain this observation. It may be valuable to ask open-ended questions geared towards this observation in future studies. As expected, CPS and MATLAB® were not considered helpful in gaining knowledge of course deadlines and this did not change over the semester.

3.6. Reviewing course material outside of class

BlackBoard® was considered to be very valuable for supporting review of course material outside of class and this did not change over the course of the semester. The value of PowerPoint® for self-study was higher ("strong positive") for BME 335 as compared with that reported for previous courses ("moderate positive", $p < 0.01$). This likely reflects the merits of the “non-linear” organization of the PowerPoint® notes with numerous hyperlinks among course topics. CPS was reported to have a “moderate negative” role in reviewing course material outside of class for both previous courses and BME 335. This is consistent with our observation that our current implementation does not entice students to review their responses after class to questions posed using CPS during class. The surveys indicated that the perception of the role of MATLAB® in supporting review increased from “strong negative” to “moderate positive” on average from the beginning to the end of the semester ($p < 0.01$). As with some of the other dimensions discussed, this trend was not statistically significant if the students without previous MATLAB® experience were excluded ($p = 0.11$).

3.7. On-going feedback about [your] progress in the course

The survey results indicated an increase from a “neutral” to “moderate positive” influence of BlackBoard® on on-going feedback on a student’s progress in BME 335 relative to what they had experienced in previous courses ($p < 0.01$). Most likely this reflects the fact that we routinely used the gradebook feature such that students could check their scores on assessments and regular homeworks were assigned that were automatically scored by BlackBoard® such that immediate feedback was provided. PowerPoint® was viewed as playing a “moderately negative” role in providing on-going feedback and no change in this was observed over the course. This is to be expected since no particular effort was made to use PowerPoint® for this purpose. There was an increase from approximately “neutral” to approximately “moderate positive” for the rating of the influence of CPS on on-going course feedback ($p < 0.01$). This result is gratifying since this is precisely the goal in using CPS in BME 335. The survey results indicated MATLAB® had a “moderately negative” to “neutral” role in providing on-going feedback. The change over the course of BME 335 was significant if students who had not previously used MATLAB® ($p < 0.01$) were included, but not significant ($p = 0.09$) if they were excluded from the analysis.

3.8. Problem-solving practice

The surveys indicated that students rating of the role of BlackBoard® in supporting problem-solving practice was increased in BME 335 (“moderate positive”) relative to how it was used in their previous courses (“neutral”, $p < 0.01$). This most likely this reflects the fact that we routinely used the assessment features of BlackBoard® to automatically score simple homeworks such that immediate feedback was provided. Similarly, there was a significant increase over the semester from “neutral” to “moderate positive” for the perception of PowerPoint® ($p < 0.01$) and CPS ($p < 0.01$) in supporting problem-solving practice. This is presumably due to the fact that problems (and their solutions) which were discussed in class with the aid of CPS were distributed as part of the PowerPoint® notes. The students indicated more appreciation of MATLAB® for supporting problem-solving practice at the end of the course (“moderate positive”) than they had at the beginning (“neutral”, $p < 0.01$). Moreover, this trend was still statistically significant when the students who reported no previous MATLAB® experience were excluded ($p < 0.01$). Thus, these results suggest that the instructional technology scaffold we have developed is effectively supporting students in gaining the problem-solving practice that they need to learn probability and statistics.

3.9. Understanding of "real-world" value of course material

Students reported that the BlackBoard® and PowerPoint® both had "neutral" influence on their understanding of the "real-world" value of the course material and this assessment was stable from the start to the end of the semester. These results are not surprising since these technologies provide a way to present and organize content without regard to whether the professor has selected materials that demonstrate the "real-world" value of the course. The surveys indicated an increase over the semester from approximately "moderate negative" to "neutral" for the students' opinion of the role of CPS in supporting understanding of the "real-world" value of the course material. This may indicate that the kinds of questions posed using CPS in BME 335 were of a more practical nature than students had typically experienced with CPS in previous courses. A large increase in the perceived value of MATLAB® in understanding the "real-world" value of the course was observed from the beginning ("moderate negative") to the ending surveys ("strong positive", $p < 0.01$). Moreover, this difference was still significant when students who had never previously used MATLAB® were excluded from the analysis ($p < 0.01$). These data support our contention that MATLAB® labs can play an important role in aiding biomedical engineering students in recognizing the applications of probability and statistics in the profession, even if they are initially very uncomfortable with the technology due to lack of previous experience with it.

4. Conclusions

In order to facilitate active learning (*i.e.*, student interactions) and emphasize real-world applications in an introductory undergraduate biomedical engineering course on probability and statistics, we have developed a scaffold of multiple instructional technologies (Figure 1). In this paper we present an analysis of student surveys collected during a recent offering of the course employing the instructional technology scaffold. The results suggest that the instructional technology components are supporting student learning in the intended ways. BlackBoard® was rated as valuable for supporting communication, distributing information regarding course deadlines, supporting students in reviewing course materials outside of class, and providing on-going feedback and problem-solving practice. PowerPoint® positively influenced students' learning by aiding in review outside of class through use of the non-linear (hyperlinked) PowerPoint® course notes. In combination with CPS, PowerPoint® enabled problem-solving practice. The use of CPS also aided student learning by providing on-going feedback. MATLAB® had some value in reviewing material outside of class time, but was especially influential on student learning by providing problem-solving practice in a way that emphasize the real-world value of the course material. The strong relationship we observed between students' comfort with an instructional technology and the frequency of its use is intuitive, but worthy of emphasis. Students are typically nervous about the introduction of unfamiliar technologies such as the MATLAB® programming language, but exposure to such ubiquitous engineering tools is valuable to understanding the real-world applications of the course topics. Our experience indicates that a combination of instructional technologies targeted to support different aspects of student learning can facilitate learning of probability and statistics when care is taken to acclimate students to tools that are new to them.

5. Appendix A: Survey on instructional technologies conducted at beginning of course

Pre-Survey Instructions:

The purpose of this survey is to collect data to help us better understand how student's experiences with technologies interact with teaching approaches so that we can continue to improve this course in future semesters. Your UTEID is needed to match up the results of this survey with others used in the course, but will then be removed from the record. The professor and teaching assistants will not have access to any survey data with UTEID attached and will not have access until after the final course grades are assigned. You may choose to not answer any questions.

The data gathered in this study will be reviewed by Kathy Schmidt, Director of the College's Faculty Innovation Center. The purpose of this study is to look at which technologies facilitate active learning and emphasize real-world applications in this BME statistics course. You will never be identified and all responses will not be seen by the instructor until after the semester has ended and grades are finalized. Should you have concerns please contact the Office of Research Support and Compliance at 471-8871.

UTEID ___________________

Here are some definitions of instructional technologies used here on campus. Keep these definitions in mind as you answer the questions on the following pages.

- **Blackboard** – a Web-based course management system used at UT Austin that is available for any course.
- **Classroom Performance System -** consists of student-operated remote controls and a receiver that records responses to multiple-choice questions posed by the instructor.
- **PowerPoint –** a presentation software package that comes with MicroSoft Office.
- **MATLAB** - is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical computation.

Please indicate on scale of 1 to 3 the extent to which you have used the following instructional technologies in previous courses at UT Austin *during in-class sessions* where: 1: never, 2: sometimes, 3: frequently. Please indicate N/A if you haven't used the instructional technology before.

		Never	Sometimes	Frequently
BlackBoard				
	N/A	1	2	3
Classroom Performance System				
	N/A	1	2	3
PowerPoint				
	N/A	1	2	3
MATLAB				

N/A	1	2	3

Please indicate on scale of 1 to 3 the extent to which you have used the following instructional technologies in previous courses at UT Austin *outside of in-class sessions* where: 1: never, 2: sometimes, 3: frequently. Please indicate N/A if you haven't used the instructional technology before.

		Never	Sometimes	Frequently
BlackBoard	N/A	1	2	3
Classroom Performance System	N/A	1	2	3
PowerPoint	N/A	1	2	3
MATLAB	N/A	1	2	3

Please indicate on scale of 1 to 5 the extent to which you are comfortable with the following instructional technologies, where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology before.

		Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
BlackBoard	N/A	1	2	3	4	5
Classroom Performance System	N/A	1	2	3	4	5
PowerPoint	N/A	1	2	3	4	5
MATLAB	N/A	1	2	3	4	5

Comments:

Please indicate on scale of 1 to 5 the extent to which **BlackBoard** influenced the listed aspects of your learning as used in previous courses at UT Austin, where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology before.

		Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
Communication with instructors						
	N/A	1	2	3	4	5
Communication with peers						
	N/A	1	2	3	4	5
On-going feedback about your progress in the course						
	N/A	1	2	3	4	5
Reviewing course material outside of class						
	N/A	1	2	3	4	5
Understanding of "real-world" value of course material						
	N/A	1	2	3	4	5
Problem-solving practice						
	N/A	1	2	3	4	5
Knowledge of course deadlines and requirements						
	N/A	1	2	3	4	5

Comments:

Please indicate on scale of 1 to 5 the extent to which **Classroom Performance System** influenced the listed aspects of your learning as used in previous courses at UT Austin where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology before.

	Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
Communication with instructors					
N/A	1	2	3	4	5
Communication with peers					
N/A	1	2	3	4	5
On-going feedback about your progress in the course					
N/A	1	2	3	4	5
Reviewing course material outside of class					
N/A	1	2	3	4	5
Understanding of "real-world" value of course material					
N/A	1	2	3	4	5
Problem-solving practice					
N/A	1	2	3	4	5
Knowledge of course deadlines and requirements					
N/A	1	2	3	4	5

Comments:

Please indicate on scale of 1 to 5 the extent to which **PowerPoint** influenced the listed aspects of your learning as used in previous courses at UT Austin, where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology before.

	Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
Communication with instructors					
N/A	1	2	3	4	5
Communication with peers					
N/A	1	2	3	4	5
On-going feedback about your progress in the course					
N/A	1	2	3	4	5
Reviewing course material outside of class					
N/A	1	2	3	4	5
Understanding of "real-world" value of course material					
N/A	1	2	3	4	5
Problem-solving practice					
N/A	1	2	3	4	5
Knowledge of course deadlines and requirements					
N/A	1	2	3	4	5

Comments:

Please indicate on scale of 1 to 5 the extent to which **MATLAB** influenced the listed aspects of your learning as used in previous courses at UT Austin, where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology before.

	Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
Communication with instructors					
N/A	1	2	3	4	5
Communication with peers					
N/A	1	2	3	4	5
On-going feedback about your progress in the course					
N/A	1	2	3	4	5
Reviewing course material outside of class					
N/A	1	2	3	4	5
Understanding of "real-world" value of course material					
N/A	1	2	3	4	5
Problem-solving practice					
N/A	1	2	3	4	5
Knowledge of course deadlines and requirements					
N/A	1	2	3	4	5

Comments:

6. Appendix B: Survey on instructional technologies conducted at beginning of course

Instructions:

The purpose of this survey is to collect data to help us better understand how student's experiences with technologies interact with teaching approaches so that we can continue to improve this course in future semesters. Your UTEID is needed to match up the results of this survey with others used in the course, but will then be removed from the record. The professor and teaching assistants will not have access to any survey data with UTEID attached and will not have access until after the final course grades are assigned. You may choose to not answer any questions.

The data gathered in this study will be reviewed by Kathy Schmidt, Director of the College's Faculty Innovation Center. The purpose of this study is to look at which technologies facilitate active learning and emphasize real-world applications in this BME statistics course. You will never be identified and all responses will not be seen by the instructor until after the semester has ended and grades are finalized. Should you have concerns please contact the Office of Research Support and Compliance at 471-8871.

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- **Classroom Performance System -** consists of student-operated remote controls and a receiver that records responses to multiple-choice questions posed by the instructor.
- **PowerPoint –** a presentation software package that comes with Microsoft Office.
- **MATLAB** - is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical computation.

Please indicate on scale of 1 to 3 the extent to which you have used the following instructional technologies in BME 335 at UT Austin *during in-class sessions* where: 1: never, 2: sometimes, 3: frequently. Please indicate N/A if you haven't used the instructional technology in BME 335.

		Never	Sometimes	Frequently
BlackBoard				
	N/A	1	2	3
Classroom Performance System				
	N/A	1	2	3
PowerPoint				
	N/A	1	2	3
MATLAB				
	N/A	1	2	3

Please indicate on scale of 1 to 3 the extent to which you have used the following instructional technologies in BME 335 at UT Austin *outside of in-class sessions* where: 1: never, 2: sometimes, 3: frequently. Please indicate N/A if you haven't used the instructional technology in BME 335.

		Never	Sometimes	Frequently
BlackBoard				
	N/A	1	2	3
Classroom Performance System				
	N/A	1	2	3
PowerPoint				
	N/A	1	2	3
MATLAB				
	N/A	1	2	3

Please indicate on scale of 1 to 5 the extent to which you are comfortable with the following instructional technologies, where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology before.

		Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
BlackBoard						
	N/A	1	2	3	4	5
Classroom Performance System						
	N/A	1	2	3	4	5
PowerPoint						
	N/A	1	2	3	4	5
MATLAB						
	N/A	1	2	3	4	5

Comments:

Please indicate on scale of 1 to 5 the extent to which **BlackBoard** influenced the listed aspects of your learning as used in BME 335 at UT Austin, where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology in BME 335.

		Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
Communication with instructors						
	N/A	1	2	3	4	5
Communication with peers						
	N/A	1	2	3	4	5
On-going feedback about your progress in the course						
	N/A	1	2	3	4	5
Reviewing course material outside of class						
	N/A	1	2	3	4	5
Understanding of "real-world" value of course material						
	N/A	1	2	3	4	5
Problem-solving practice						
	N/A	1	2	3	4	5
Knowledge of course deadlines and requirements						
	N/A	1	2	3	4	5

Comments:

Please indicate on scale of 1 to 5 the extent to which **Classroom Performance System** influenced the listed aspects of your learning as used in BME 335 at UT Austin where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology in BME 335.

		Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
Communication with instructors						
	N/A	1	2	3	4	5
Communication with peers						
	N/A	1	2	3	4	5
On-going feedback about your progress in the course						
	N/A	1	2	3	4	5
Reviewing course material outside of class						
	N/A	1	2	3	4	5
Understanding of "real-world" value of course material						
	N/A	1	2	3	4	5
Problem-solving practice						
	N/A	1	2	3	4	5
Knowledge of course deadlines and requirements						
	N/A	1	2	3	4	5

Comments:

Please indicate on scale of 1 to 5 the extent to which **PowerPoint** influenced the listed aspects of your learning as used in BME 335 at UT Austin, where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology in BME 335.

		Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
Communication with instructors						
	N/A	1	2	3	4	5
Communication with peers						
	N/A	1	2	3	4	5
On-going feedback about your progress in the course						
	N/A	1	2	3	4	5
Reviewing course material outside of class						
	N/A	1	2	3	4	5
Understanding of "real-world" value of course material						
	N/A	1	2	3	4	5
Problem-solving practice						
	N/A	1	2	3	4	5
Knowledge of course deadlines and requirements						
	N/A	1	2	3	4	5

Comments:

Please indicate on scale of 1 to 5 the extent to which **MATLAB** influenced the listed aspects of your learning as used in BME 335 at UT Austin, where: 1: strong negative, 2: moderate negative, 3: neutral, 4: moderate positive, 5: strong positive. Please indicate N/A if you haven't used the instructional technology in BME 335.

	Strong Negative	Moderate Negative	Negative	Moderate Positive	Strong Positive
Communication with instructors					
N/A	1	2	3	4	5
Communication with peers					
N/A	1	2	3	4	5
On-going feedback about your progress in the course					
N/A	1	2	3	4	5
Reviewing course material outside of class					
N/A	1	2	3	4	5
Understanding of "real-world" value of course material					
N/A	1	2	3	4	5
Problem-solving practice					
N/A	1	2	3	4	5
Knowledge of course deadlines and requirements					
N/A	1	2	3	4	5

Comments:

7. Biographies

MIA K. MARKEY is an Assistant Professor in Biomedical Engineering at The University of Texas at Austin. The mission of her Biomedical Informatics Lab is to design cost effective computational medical decision aids that will help physicians better diagnose, treat, and manage cancer. Her primary interest in improving engineering education is the identification of effective strategies for coordinating instructional technologies to reinforce learning.

KATHY J. SCHMIDT is the director of the Faculty Innovation Center for the College of Engineering at the University of Texas at Austin. In this position, she promotes the College of Engineering's commitment to finding ways to enrich teaching and learning. She works in all aspects of education including design and development, faculty training, learner support, and evaluation.

8. Acknowledgements

Many, many thanks are due to Vicente Colunga for data entry and also to Zack Mahdavi for setting up the database for this study.

9. References

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