Chapter 13

Using Instructional Technology to Encourage Collaborative Learning

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Instructional technology such as Tablet PCs and related educational software can provide a medium to encourage faculty-student collaboration. We describe how the Tablet PC is being used by faculty and students in the College of Engineering at Virginia Tech to cover course content in an interactive educational setting. Student and faculty data have been collected and examined to determine the extent to which instructional technology is changing the nature of the teaching and learning environment as faculty and students use other modes of communication to cover course content. Other institutions interested in using instructional technology can use these findings to consider ways in which faculty-student interaction can be encouraged through successful application.

INTRODUCTION

Faculty-student interaction can be facilitated through application of instructional technology. Exchanges between faculty and students have been identified as an important part of the learning process and are linked to several educational benefits. Students have been shown to invest more in their academics as faculty interaction increases, including working harder due to faculty feedback on course work and working to meet faculty expectations [1, 2]. Interaction can help develop students' academic self-concept and motivation, leading to greater achievement [3]. Students' critical thinking skills have been shown to benefit as students are encouraged to think through difficult questions as discourse and feedback from faculty allow students to generate their own conclusions [4]. Engineering undergraduates who interact with faculty and receive constructive feedback on their performance reported greater gains in design and professional skills [5]. Exchanges with faculty can increase students' perceptions of support, encouraging

student integration into the academic setting and ultimately student retention as students become more engaged in the learning process [6, 7].

USING THE TABLET PC TO ENCOURAGE FACULTY-STUDENT INTERACTION

Creating learning environments that foster interactions between faculty and students can be aided with effective use of instructional technology [8]. One example of instructional technology that is being employed in the engineering undergraduate learning environment is the Tablet PC. The Tablet PC is a conventional notebook, with a keyboard for typing, with the option to rotate and fold the screen so that a stylus can be used to make handwritten notes and drawings in a similar fashion to pen and paper. The design allows for students to participate in class presentations and activities by drawing responses and questions and sending them to the instructor for display and further discussion. Students can seek assistance from faculty members outside of the classroom as well. These applications are aided through DyKnow educational software. Used in conjunction with the laptop and presentation equipment, DyKnow integrates content delivery and interactive mechanisms on one system, allowing students and faculty to edit and use the laptop e-inking stylus to write on instructor provided Powerpoint slides, and offers polling features for in-class quizzes. This software also allows students to submit their work during class for instructor feedback and peer collaboration and for distribution among students so that multiple individuals can view the feedback provided.

Virginia Tech's College of Engineering (CoE) made the Tablet PC a requirement for all engineering undergraduates in the fall of 2006. The Tablet was seen as a way to have undergraduates become adept in utilizing cutting-edge technology while at the same time enhancing their learning experience through exposure to instructional technology that is theoretically linked to increases in self-regulated learning behaviors and collaborative learning [9, 10, 11]. Faculty can opt to use the DyKnow software and are provided with in-class technology support by a trained student support team.

Previous studies focusing on engineering undergraduates have shown that the capabilities associated with the Tablet can serve as a means to facilitate a variety of pedagogical approaches and invite student participation and collaboration with one another [12, 13] as well as with the instructor [14, 15]. However, these studies are focused on experiences of a limited number of students, using only one or two course sections [14, 15], and discuss the experiences of Tablet based instruction among a limited pool of undergraduates, namely first-year students [16, 17]. The degree to which this technology is being used college-wide by both faculty and students and how this use shapes perceptions of the level of faculty-student interaction from both instructor and student perspectives and the perceived value of this interaction is less known. This study was undertaken to understand these elements of the educational experience among undergraduates and the teaching experience of faculty within the Virginia Tech College of Engineering.

In 2006, at the inception of the Tablet PC requirement, baseline data were collected from faculty to assess the degree to which instructional technology was used in courses across the college. The baseline data showed the faculty relied primarily on lecture, instructional technologies were seldom used, and interaction with students was limited by large course enrolments. Four years into the Tablet PC requirement, current assessment efforts that include data collected from faculty and students show that some changes have

occurred with regard to the manner in which instructional technology is serving as a medium to encourage faculty-student interaction. When employed effectively, both groups readily identify benefits associated with the exchanges that take place through this form of instructional technology and view this interaction as a way to enhance the teaching and learning experience.

Student Experiences

Overall, quantitative and qualitative data collected from undergraduate engineering students show that when the Tablet is used in conjunction with the DyKnow software it can help facilitate faculty-student interactions. Among student participants, this instructional technology is considered most helpful for clarifying course content and engages students in the learning process in new ways, especially in large courses that rely on lecture as the primary form of pedagogy.

Quantitative data was collected through a student survey administered to all engineering undergraduates in the college (~ 6,000 undergraduates) that included Likert-scale formatted questions as well as open-ended responses. A total of 1,090 students responded to the survey. The survey gauged the degree to which students used the Tablet with the majority of respondents indicating that they either used the Tablet as their primary computer or used it for both engineering courses as well as for courses outside of engineering (refer to Table 1).

Students were also asked to report the degree to which they used many of the Tablet features in their courses. This included the e-inking features as well as other interactive modules such as polling. In most cases the type of interaction that occurred was with the e-inking features of the Tablet with the two most frequently cited being the capability to mark slides and to respond to in-class assignments that used written responses (refer to

	N	%
For all of my classes as the primary notebook	399	36.6%
For all of my engineering classes but not for other classes	47	4.3%
For some engineering courses and some other courses	286	26.2%
Only in the engineering courses that require it	358	32.8%

TABLE 1
EXTENT OF TABLET USE DURING 2009-2010 ACADEMIC YEAR (N=1090)

Table 2). However, there is only occasional use across the college of these features.

Students identified instructional technology as adding to their educational experience (N=1009). While undergraduates admitted technology was a distraction in some instances, they also felt it resulted in more rapid feedback from the instructor, aided in clarification of course content, and made class more interactive (refer to Table 3).

First-hand experiences from students were also collected through focus groups held with both first-year students and seniors. A total of 40 students participated in three different focus group sessions. Open-ended survey responses also illustrated how students used the Tablet to interact with faculty members. Following are quotations that

To what extent did you use the following Tablet PC functions this academic year? (scale: 1= Never – 4=Frequently)	M	SD
e-ink to mark slides provided by the instructor	2.39	1.17
Instructor presented using e-ink	2.30	1.08
e-ink to take notes using OneNote	2.30	1.25
e-ink to create diagrams	2.16	1.09
Imported web-based information into notes	2.00	1.1
Shared notes/slides with other students	1.94	0.98
e-ink to take notes with another program	1.93	1.06
e-ink was used to grade homework or projects	1.90	1.05
To respond to interactive class exercises using polling/voting	1.74	0.91
To respond to interactive in-class exercise using written responses	2.39	1.17

TABLE 2
FREQUENCY OF TABLET FEATURES USED DURING 2009-2010 ACADEMIC YEAR (N=1090)

In general, the use of technology in my engineering courses: (scale 1=Strongly Disagree – 5=Strongly Agree)	M	SD
Caused me to be distracted by use of internet/email	3.61	1.07
Offered me the opportunity to locate class resources online	3.48	1.02
Helped illustrate points made in class	3.31	0.95
Results in more rapid feedback from instructor	3.11	1.15
Made class more interactive	3.10	1.11
Improves how well I learn	2.94	1.08
Often did not work properly	2.94	1.13
Helps me better communicate and collaborate	2.90	1.08
Encouraged me to share notes or other materials with students	2.83	1.08
Helped me feel more alert and engaged during class	2.70	1.04

TABLE 3
STUDENT PERCEPTIONS OF THE USE OF TECHNOLOGY IN ENGINEERING COURSES (N=1090)

summarize the main themes as they relate to how faculty-student interaction is encouraged through instructional technology. When used by faculty, students identified the ability to interact with faculty through note-taking during lectures as an important aspect of using the Tablet in their courses as well as the polling feature in DyKnow. Students felt that the Tablet PC inking capabilities allowed them to interact with faculty as they were able to make notes during lectures on Powerpoint slides. One student explained, “It's best when the instructors post a notes outline which they would then annotate in class and have the outline available for students to also annotate during the

lecture." Rather than sitting passively and taking notes, students felt they were able to visually observe faculty demonstrate problems or concepts and then add that information into their notes.

Students explained how instructor use of the Tablet along with the software Dyknow proved to be especially effective in terms of facilitating interaction. The instructional technology served as a medium to share ideas and demonstrate their knowledge for faculty. For instance, one student explained that the polling features were helpful: "Dyknow is a great interactive medium, if the instructor uses it effectively. Professor [Name] has by far the best practices out of any of my professors so far, actively giving pop quizzes and problems in class to keep students engaged." In some instances, students explained that interactive aspects of the Tablet and Dyknow forced them to become engaged where they may have previously let their attention wane. In addition, the handwritten notes on Powerpoint slides allowed students to review material after the class had ended, increasing organization and opportunities to elaborate further on what was learned during class:

> *The only consistent use of Tablet capabilities in my courses this year has been with the Dyknow slide show presentation software. In my opinion it is a highly useful review/study tool (if the instructor records the lecture w/ audio and slide replay). Essentially, Dyknow is like a second source of examples…*

Students enrolled in large classes identified the Dyknow software as especially helpful for shrinking the class and being able to communicate with the instructor. The software allows the student to view what the instructor is writing on their own computer, and then to capture and save the images for later viewing. If these panels are shared with other students in the class, feedback is further increased as students can write on and capture each other's ideas (refer to Figure 1).

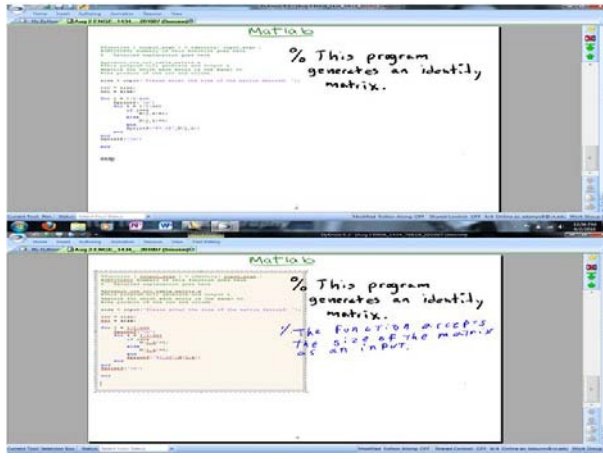

FIGURE 1
STUDENTS USING DYKNOW SOFTWARE AND INKING CAPABILITIES TO ANNOTATE INSTRUCTOR PROVIDED MATERIAL

One student explained:

> *I loved DyKnow, but I haven't seen it used since freshmen year (two years ago). Asking a huge lecture hall a question and have slides submitted to answer was a good way to keep the class engaged. Also, the ability for students in a 300 person lecture to quickly inform the teacher that they are collectively confused (via the "understanding" slider) was exceptionally helpful. I take notes for all my classes on my tablet. I basically don't use paper.*

While students explained that the instructional technology was helpful for creating a medium for interaction with the instructor, survey and interview data indicate that students only used this medium if it was initiated by the instructor. First-year students readily employed Tablet features and expressed a high degree of satisfaction with the manner in which faculty-student interaction occurred through the DyKnow software. Interviews with faculty members revealed that faculty teaching first year courses use the Tablet and Dyknow in most of the first year engineering courses while faculty who teach upper-level courses do not use this instructional technology to the same degree. Survey data supported the students' reported experience of progressing through their degree and having faculty use the Tablet and associated features less. Upper-class students indicated that this technology was used primarily during their first year and that during this time they made the best use of the Tablet to engage with faculty members in that this use was expected across their courses, used for different types of assignments, and provided a way for students to indicate how they had mastered the content in their courses.

Faculty Experiences

Faculty experiences with incorporation of the Tablet PC and the DyKnow software provide further detail related to how this type of instructional technology is being used to interact with students. Faculty experiences with using the Tablet to facilitate interaction with students were examined through individual interviews and a focus group held with 12 faculty members in the Engineering Education department who agreed to attend and participate.

Interviews with this group revealed that the department readily employs the Tablet in their courses, with the majority of faculty making use of the Tablet during each class session. Faculty used the technology to interact with students by encouraging their engagement through active note taking during lectures. Faculty teaching first-year engineering education courses noted, "DyKnow, obviously we use, in a large classroom setting to make students submit panels, submit ideas, display to the class, so they get more involved." In some instances, faculty used the Tablet and DyKnow software to create a "feedback loop" where they were able to poll students or ask students to submit examples of their work. This allowed many students to become engaged in the learning process:

> *I do feel like Dyknow or programs of that sort do encourage interaction a lot. I see people who I think otherwise be too shy to come up to the blackboard who are participating, they wouldn't otherwise, because you can do things like what is the answer to this question? Submit a panel anonymously and they submit their panel*

anonymously. They are actually participating as oppose to sitting in front of computer and being nervous.

Polling students was another way instructors interacted with students during class:

I love the abilities to have students submit their panels with information and submit their slides with information on it. So you can give the questions to class and say get ready your answers and submit it back to me. I use that for quizzes or sometimes I use that to make sure people are awake and paying attention. In Dyknow, I love that there's little like red, yellow, green pie chart so you can update your status and if you get the big flash of red, then you've lost everybody or if you get the big flash of green then you can see you are boring everybody. That is really helpful.

Faculty also used it as a means for student encouragement as illustrated in Figure 2:

I get people to submit panels with answers on it, I pull one that is correct and throw it up on screen and say here is an example of really nice correct answer. And so sometimes you get that. Shy person who is like oh yay my answer was right and it is now up for the roll to see. And they never would've gone to the board and worked the problem through. So there is a positive reinforcement in that.

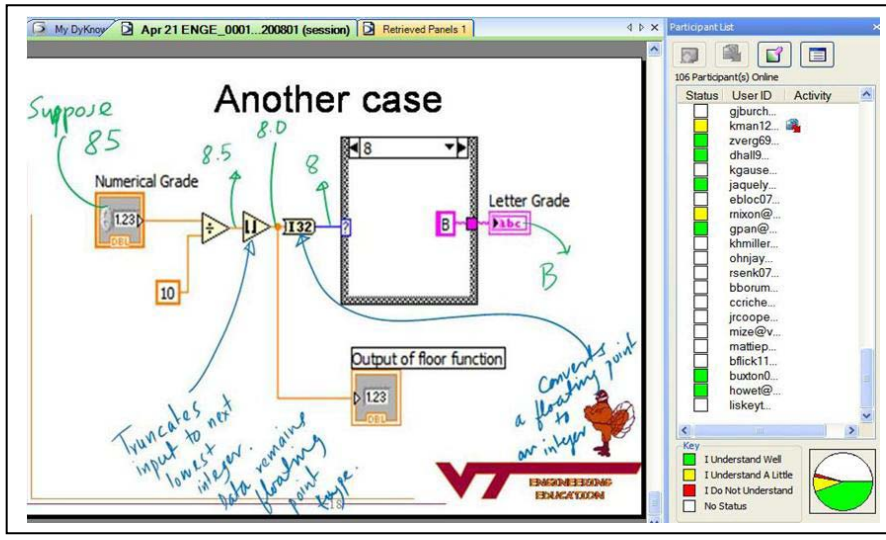

FIGURE 2
INSTANT FEEDBACK USING INKING CAPABILITIES

Faculty-student interaction was also encouraged outside of the classroom. The Tablet and related software can be used for virtual office hours. One faculty member explained:

So I can say: I am going to hold office hours from such and such and such and such and such. And as long as I got broadband access, I can be sitting at Panera Bread, if I wanted to, right? …I can then group students because I can put the students in

groups right in Dyno, so that I can say: you know, you four over here are all having the same question. So I am going to put you into a group. I want you to work on this. And, I am going to work with these two over here because they, they have a basic misunderstanding, and I need to work with them. So you all go over here and work on this, I'll come back and check with you later, and I'm work on these. I can even take a student in that environment and say: [Student's name], you figured it out! [Student's name], I am going to have you show everybody else that is participating of- how you solved the problem, okay?

DISCUSSION AND SUMMARY

Tablet PCs used in conjunction with the DyKnow software prove to be an effective medium to encourage faculty-student interaction among engineering undergraduates. In total the results collected show faculty can provide immediate feedback to students using this type of instructional technology. Students find this type of exchange with faculty members encouraging, even if it is not their personal work that is being projected or receiving direct feedback. In addition, interaction is encouraged as student engagement is facilitated through polling and active note taking. Our results show that when these activities occur students feel as though the faculty member is interested in their learning and comprehension of course content. The positive effects of in-class interaction carries over out of class as students can use this type of instructional technology to review materials and clarify questions about course content. Although the faculty member was not physically present when this review was taking place after class, students still considered this an important form of faculty-student interaction.

At the same time, faculty members can receive immediate feedback from students on whether students are learning a given topic, allowing students to self-identify if they are confused. This can help faculty address issues during a class session rather than waiting for questions or problems to arise later on. Faculty identified this as an important type of interaction that can occur with students enrolled in their courses. By selecting one student's work faculty can use their time in class effectively, making sure content is covered and checking for student understanding rather than using the time to only deliver course content. Students perceive they are getting personal attention related to their learning and interacting directly with faculty members.

While this form of instructional technology and types of interaction that it encouraged are beneficial, the interaction is one that can be considered instructor driven. Our findings also show that the technology is still being employed within a pedagogical framework that relies primarily on lecture. This form of pedagogy places the instructor in the role of the sole source of information and runs counter to constructivist learning theory that encourages active meaning making on the students' behalf and having the students see themselves as active contributors in the pursuit of knowledge. Faculty can use the information to consider how to shape class experiences such that instructional technology can be used for faculty-student interaction that moves beyond lecture and encourages students to become more engaged in the learning process.

In summary, instructional technology as described here can serve as a medium for faculty-student interaction. This type of interaction is primarily driven by the degree to which faculty employ the technology with students. Diffusion across departments and throughout a student's educational experience would provide additional opportunities to encourage interaction and reap the benefits of such exchanges between groups.

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