

What is beyond the laptop initiative?

Perhaps: Tablet PCs and DyKnow Vision software

Zachariah Chambers, Archana Chidanandan,
 Rebecca DeVasher, Larry Merkle,
 Mark Minster, Sudipa Mitra-Kirtley,
 David Mutchler, Shannon Sexton,
 Anne Watt, Julia Williams
 and Meredith Zoetewey

Departments of:
 Mechanical Engineering (Chambers),
 Computer Science and Software Engineering (Chidanandan, Merkle, and Mutchler),
 Chemistry (DeVasher),
 Physics and Optical Engineering (Mitra-Kirtley),
 Humanities and Social Sciences (Minster, Watt, Williams and Zoetewey),
 Office of Instructional Research, Planning and Assessment, (Sexton and Williams)

Rose-Hulman Institute of Technology
 Terre Haute, IN 47803

Email for each of the above is of the form: Firstname.Lastname@Rose-Hulman.edu

***Abstract* - For over ten years Rose-Hulman has required all incoming students to purchase an institute-selected laptop computer and an associated suite of software. Students use their laptops in classrooms on a daily basis. More recently, we have begun to ask: What is beyond the laptop initiative? One possible answer is a combination of pen-based Tablet PCs and interaction-enhancing software like DyKnow Vision. This paper reports: our innovative use of DyKnow Vision software and Tablet PCs (hereafter, DyKnow/Tablets™) to promote active learning in the classroom; similarities/differences in our approach across 7 courses covering engineering, humanities and science and involving more than 20% of Rose-Hulman’s students; and studies that assess how DyKnow/Tablets affect student learning. Thus, the paper presents an innovative direction that engineering education may take as well as an assessment of some aspects of that direction.**

Index Terms – DyKnow, Tablet PCs, Pen-based computing, Digital ink, Collaboration, Active learning, Assessment.

INTRODUCTION

For over ten years Rose-Hulman has required all incoming students to purchase an institute-selected laptop computer and an associated suite of software. Students use their laptops in classrooms on a daily basis.

More recently, we have begun to ask: ***What is beyond the laptop initiative?*** One possible answer is a combination of pen-based Tablet PCs and interaction-enhancing software like DyKnow Vision.

The rest of this section explains what pen-based Tablet PCs are and what DyKnow Vision is. The next section gives concrete examples of our innovative use of DyKnow Vision software and Tablet PCs (hereafter, DyKnow/Tablets™) to promote active learning in the classroom. It also explains similarities/differences in our approach across 7 courses covering engineering, humanities and science and involving more than 20% of Rose-Hulman’s students. The third section presents studies that assess how DyKnow/Tablets affect student learning.

Thus, the paper presents an innovative direction that engineering education may take as well as an assessment of some aspects of that direction.

I. What are Tablet PCs?

Tablet PCs are like ordinary laptop (notebook) computers except that they have special pens that permit the user to write upon the screen, much like one would write on a tablet of paper. While Tablet PCs typically have a keyboard and mouse, the pen is intended to be the primary input device. Tablet PCs are usually smaller than ordinary laptop computers, although dual-purpose “convertibles” are fast becoming popular. The Tablet PCs in our studies are HP Tablets, models TC 1000 and TC 1100.

II. What is DyKnow Vision?

Dave Berque, the author of both the concept and first implementations of DyKnow Vision, writes that DyKnow Vision is “software that enhances the way teachers and students share written information during class using an electronic whiteboard and pen-based video tablets or Tablet

PCs. This system was originally named DEBBIE. The system has been greatly enhanced by a company named DyKnow and is now available as a fully supported commercial product named DyKnow Vision.” [1]

DyKnow Vision software makes the classroom appear as if every student is at the [physical] whiteboard, with a click of a button. Our experience is that Tablet PCs and their pen-based capability cannot be exploited completely without software like DyKnow that encourages many types of collaboration – between faculty and students, between students, and between one class and another. Thus, our work extends ideas reported at FIE 2005 where they use Tablet PCs and digital ink but not DyKnow Vision software. [2, 3].

USING DYKNOW/TABLETS – EXAMPLES

We have developed curricula that uses DyKnow Vision software and Tablet PCs (hereafter, “DyKnow/Tablets”) to promote active learning in the classroom. In each course, each student in the classroom has a Tablet PC and uses DyKnow Vision software. While we have experimented with other uses of Tablet PCs as well, this paper assumes the every-student-has-a-Tablet-PC model throughout.

I. DyKnow/Tablets in the Physics “studio” classroom

The idea of “studio physics” originally germinated at Rensselaer Polytechnic Institute [4] and has been used at Rose-Hulman for the past 10 years in our Introductory Physics classes (and later adopted by several other departments as well). The pedagogy of “studio” classes in physics is to give the students a hands-on experience just after a physics principle is introduced in class, so that the practical application of the physics principle is apparent to students. The instructor spends less time lecturing and instead follows up each lecture concept with an activity which reinforces the concept. The activities consist of small experiments, group problem solving, and/or answering concept questions. The separate laboratory and lecture sessions are hence combined into a common lecture/hands-on session. This ensures that the passivity of the students and the monotony of lectures are eliminated as an active and enthusiastic environment prevails in the classroom at all times. The students usually work in groups of two or three during these activities, consulting with each other, and a healthy team spirit is fostered during this process. These studio classes also ensure that laboratory experiments are in-sync with class lectures, which is often difficult in the traditional mode of separate lecture and laboratory sessions.

With the introduction of a wireless Tablet PC to each of the students in the physics classroom, the studio idea has been taken to a new level. First, the mobility of the tablets brings some experiments outside of the confined laboratory environment, which make several experiments with real-world flavor possible. This helps students grasp the relevance of physics principles to occurrences in the everyday world. Second, the tablet has also made some experiments much easier to perform; students may take data with the un-tethered devices and move around and discuss results with other

groups. Third, the pen-based capability allows students to take notes easily on the spot, even outside of the classroom or the laboratory. Suddenly, “the world is our classroom [5].”

DyKnow Vision software elevates the studio idea still further. First, whatever the instructor writes on her Tablet PC (whether in real time or prepared in advance) appears on each student’s Tablet PC. Note-taking changes from passive copying to active annotating, in accord with studio Physics’ always-active pedagogy. Later, a student can review his saved notes and replay them in sequence (stroke by stroke, if desired), making it easier to understand the progression of a particular example presented in lecture.

Second, students can ask the instructor anonymous questions within DyKnow and the instructor can poll students to check their understanding, all in real time – again in accord with the studio pedagogy.

Third, after a problem solving activity, a student can lead a class discussion by using DyKnow to copy the solution from that student’s Tablet PC (or from his group’s Tablet PCs) onto the Tablet PCs of all the members of the class.

II. DyKnow/Tablets for teaching Technical Communication

The Technical Communication course is required of most junior level students at Rose-Hulman; it is a named required course for students majoring in biomedical, civil, chemical, electrical and computer, mechanical, optical, and software engineering, as well as computer science and applied biology. The course is taught in 16 sections per year with approximately 25 students per section. The position of the course in the junior year of each degree program reflects the purpose the course serves, to prepare students for taking on oral and written communication tasks that they will have to perform in the context of engineering design courses in their senior year. Many of the engineering senior design courses feature client-centered design courses, and so Technical Communication emphasizes audience analysis, document design, and client communication, as well as the fundamentals of good writing and speaking.

One important dimension of Technical Communication is the role of Peer Review in the writing and revision of documents. In order to ensure that students have the opportunity to write and revise, we establish a due date for a draft and require students to participate in a Peer Review session on that day. Previously we asked students to exchange papers so that they had a draft of another student’s paper to review and make comments on. We also provided an Evaluation Rubric to guide the student’s review; the Evaluation Rubric establishes a set of criteria that are important for a successful document and provides expectations for what the student should pay attention to in reviewing another student’s document. Both the draft for Peer Review and the Evaluation Rubric were distributed in hard copy to students. They would then mark and make comments on the drafts and fill out appropriate sections on the Evaluation Rubric.

Providing each student with a Tablet PC immediately made the hard copy distribution of drafts and rubrics

unnecessary. Students would submit their document drafts to the course management system, then retrieve the drafts they were assigned to review. Students opened the drafts in either Microsoft Word or in Journal. From there, students could use the Tablet PC pen to make comments directly on the drafts and then save their comments by uploading the drafts (renamed as desired) back to the course management system. Students also used the Tablet PC pen to complete the Evaluation Rubric and saved that document in a similar manner.

The addition of DyKnow Vision software further enhances the collaboration and interaction during Peer Reviews. For example, while the instructor is roaming the class, she can easily pause to show the class an illuminating interaction between a Reviewer and Reviewee, by giving DyKnow control to the Reviewer. Or, she can have all the students mark up a single practice document in parallel and then share some or all of the results, as a way to practice a Peer Review. Finally, she can add her own markup to a Reviewer-Reviewee interaction in real time, either at her desk or beside the student (using the mobility of the Tablet PC).

III. DyKnow/Tablets for teaching specification and design in software engineering

We used DyKnow/Tablets in CSSE 220, Fundamentals of Software Development 2.

As in Physics, students work in small groups to solve a problem which is then shared with the class by using DyKnow Vision. For example, students were asked to work in small groups to design an algorithm that does such and such, writing their answer on a DyKnow panel. The instructor then adds the solution of a volunteer group to the shared class notes, after which the entire class can comment on the volunteered solution.

As in the peer reviews in Technical Communication, we used DyKnow/Tablets to review each other's work. For example, each student created one screen shot that captured a part of the specification of the capstone project software to be developed. Using DyKnow Vision, the instructor added all the screen shots to the shared class notes and then had students comment on the effectiveness of the specifications (screen shots) that their peers developed.

In addition, we frequently used DyKnow/Tablets for brainstorming: all students are given concurrent access to a panel in DyKnow Vision and brainstorm solutions to the given problem. This is much faster than oral brainstorming (because all students write in parallel), captures the brainstormed solutions effortlessly, and allows students to mark up the ideas easily after the brainstorming session.

III. DyKnow/Tablets across the curriculum – differences and similarities

As the above examples show, different disciplines can use DyKnow/Tablets in different ways. However, many of the differences are due more to differences in instructor's styles than to differences in subject matter.

The examples also show similarities in our use of DyKnow/Tablets. For example, all the disciplines used, in one form or another, the following ideas:

- An example is presented to the students. The instructor writes the example step by step, so that the student can replay the example later when reviewing the notes, stroke by stroke. The student annotates the example with her own private notes, rather than spending her time copying the example from the whiteboard.
- A panel in DyKnow Vision specifies a short problem to solve. Students solve the problem, as individuals or in small groups, by writing on the panel. Then one solution is added to the shared class notes and discussed and annotated by the whole class. That discussion is annotated both by the instructor (shared by the whole class) and by the student's private notes.
- Students mark up each other's work on DyKnow Vision panels and share that peer review.
- Students brainstorm concurrently on a DyKnow Vision panel.

We have developed other innovative ways to use Tablet PCs and other pen-based devices [5, 6, 7, 8, 9] and the literature contains many other examples of innovative ways to use both Tablet PCs and DyKnow [see 10, 11, 12 and 13, for example]. The above gives some indication of the state of development of our integration of Tablet PCs and DyKnow in three of our courses; we continue to develop that integration in those courses and others.

USING DYKNOW/TABLETS – ASSESSMENT

We report results from several studies.

I. Does the use of DyKnow/Tablets change the way that students complete their course task in RH 330?

Our largest assessment regarding this question has been in RH 330, Technical Communications. We report those results first, followed by results from similar studies in Physics classes and in Software Development classes.

This first set of results is for data that predates our use of DyKnow Vision software in RH 330. Thus, the study as described in the following paragraphs focuses only on the use of Tablet PCs. However, the studies for Physics and Software Development (reported below) and for the most recent term of RH 330 (currently being tabulated) follow a similar format to that described below, extended to evaluate DyKnow/Tablets as a package.

In order to collect data regarding this question, faculty teaching RH 330 worked with the Director of Assessment in the Office of Institutional Research, Planning and Assessment to design the Course Survey on Computer Technology Usage. The purpose of the survey was to gather information regarding students' usage of various computer technologies both prior to the course and again following completion of the course. The pre-course survey served as a baseline measurement for all students enrolled in RH 330, whether they used a tablet computer or not. The post-course survey was designed in two different versions: one for students enrolled in tablet sections

of the course, the other for students in the non-tablet classes. However, the latter version of the survey was not administered uniformly, so we report post-course results only for the tablet sections.

The survey instrument was developed to answer the research question in the title of this subsection and focused on collecting data regarding students' attitudes toward using the tablet computer. Students were asked to evaluate the usefulness of the tablet to their learning in the course, the usefulness of the tablet in gathering information (since one of their writing projects required locating published articles on technical topics through databases), the usefulness of the tablet in facilitating communication (via email), and their preference of the tablet computer over their laptop computer. The means for student responses to these questions are provided in Table 1 below.

The most striking results from Table 1 are how useful students found the Tablets for learning and that about half of the students preferred a Tablet PC to their own laptop computer, despite their familiarity with their own laptop computer.

In addition students responded to five open ended questions regarding the ways the tablet impacted various course functions. These questions focused on the impact of the tablet in the following areas: classroom interaction, class assignments, research, communication, and functionality.

Classroom Interaction: Students felt the tablet had both a positive and negative impact on classroom interaction. The positive aspects included improved ease while working on tasks requiring the internet and ability to multitask due to the limited amount of space the tablet takes up. Students enjoyed being able to follow along with the instructor on-line and to access Angel (course management software) during class. An increase in taking electronic notes was mentioned as an improvement in classroom interaction due to the tablet. Students enjoyed being able to show their work with other students with the tablet's rotating screen. The portability of the tablet and the improved battery life over a laptop made the tablet favorable with students as well. Negative aspects of the

tablet in the classroom included paying less attention in class as the tablet served as a distraction. Students reported class time was interrupted because of boot up time, shut down time, the tablet going off-line frequently, and other technological problems. The small keyboard was mentioned as a hindrance to replacing laptops with tablets.

Class Assignments: Class assignments changed with the inclusion of the Tablet PC. Students reported using the tablet to take notes, access Angel during class, and use the stylus for notes which could then be converted into Word. Utilization of the Journal feature for homework with the ability to import graphics into the document from the internet rather than hand sketching diagrams was brought up as an additional course related use of the tablet. Contrary to the positive uses of the tablet mentioned, some students felt the tablet did not change class assignments much, mentioning they used their laptops outside of class to complete assignments rather than utilizing the tablet. While some students enjoyed the stylus, others preferred to take notes by hand due to the awkward feel of the stylus and its slow response time in recognizing writing. Students agreed the stylus was an advantage over a laptop, but still felt it had some bugs.

Research: Student comments concerning the effect of the tablet on class research did not vary much. Many students reported the tablet did not change the way they did research or that they used their laptops and desktops instead. Students who did enjoy using the tablet for research mentioned contributing factors such as increased ability to do research when it was convenient to them due to the portability of the tablet, more research time available due to internet access during class, and the ability to write notes on the research topic as they found information.

Communication: As with many of the other categories, some students did not feel the tablet had an impact on communication for RH330. Some mentioned using other types of technology such as a laptop for email access. Other students did feel the tablet made a difference. Some mentioned an increase in email and Angel utilization because of the tablet. New ways to communicate because of the tablet

Table1 -- Pre- and Post-Course Survey Means

(Rating Scale: 4 = extremely useful, 3 = useful, 2 = not useful, 1 = not useful whatsoever)

Concept	Winter 2004-05		Spring 2005	
	Pre-Course	Post-Course	Pre-Course	Post-Course
Tablet usefulness in learning	3.64	3.37	3.75	3.74
Tablet usefulness in gathering information	2.39	1.30	2.28	2.09
Tablet usefulness in communication	2.86	3.12	2.73	2.91
* Preference for tablet over laptop	2.93	2.44	2.60	2.51

Notes: * rating scale for this item: 4 = strongly agree, 3 = agree, 2 = disagree, 1 = strongly disagree

The set of surveys were given three times: in the winter quarter of the 2004-05 academic year (2 non-tablet sections of the course (42 students) and 2 tablet sections (47 students)); in the spring 2005 quarter (2 tablet sections of the course (54 students)); and in the winter quarter of the 2005-06 academic year (2 non-tablets sections (48 students) and 4 tablet sections (95 students)). Post-course results are for non-tablet sections only.

included the ability to send graphics between computers; the ability to rotate the computer screen to share visual elements with classmates were mentioned also. It was mentioned communication became quicker and more consistent between classmates with the tablet, but students felt this same effect probably could have been accomplished by requiring students to bring their laptops to class.

Functionality: Students provided many comments on both positive and negative aspects of the tablet's functionality. The compact size and portability of the tablet were mentioned as its best features. Many students mentioned it was useful for taking class notes and enjoyed being able to edit Microsoft Word documents with the stylus. Students enjoyed the graphical capabilities of the tablet and its ability to run Matlab and Maple. Complaints about the tablet included the lack of a CD drive, unstable screen, instability in tablet start up so that sometimes it would start up and other times it would not. Many of the results regarding functionality reflect the age of the now-dated models used in the study.

The above results will be extended in 2006-2007 to include RH 330 taught with DyKnow Vision.

II. Does the use of DyKnow/Tablets change the way that students complete their course task in other courses?

DyKnow/Tablets were used in CSSE 220, Fundamentals of Software Development 2. The focus of the study in that class was "does the pen matter?" – see the next subsection. However, the first item of the survey in that class provides an overall assessment of DyKnow/Tablets that is similar to the overall assessment of Tablets alone whose results appear above. In particular, students in CSSE 220 responded to the statement: "*The use of DyKnow contributes to my learning in this class*" by choosing one of: Strongly Disagree, Disagree, Agree, or Strongly Agree. The results were striking: every one of the 24 students responded either *Agree* or *Strongly Agree*, with a mean of 3.44 on the 4-point scale. Comments indicated that they especially liked: more interactive discussions; permanence of the notes; dual use of laptop projector and DyKnow screens. A typical comment was "It is both fluid (able to be interacted with) and permanent (can be saved to access later)."

DyKnow/Tablets were also used in Physics 1. In the first term in which DyKnow/Tablets was used in Physics 1, we gave a survey to gauge the students' responsiveness to the new devices and the new software. Overall the students commented positively on the fact that the devices were easier to carry, notes were easy to take, and all the different class notes could be saved in one place. A large percentage of the respondents agreed that they would want to use the tablets for other classes. Almost all the remarks mentioned the versatility of the different features of DyKnow. One student wrote, "This program is excellent...we can pay more attention since we do not need to take notes". Another commented on DyKnow's aspect of "participating in class and asking/answering questions".

After the full implementation of DyKnow/Tablets in some of the physics classes, another survey was conducted in one of

them to judge students' responsiveness to the software. One of the questions addressed the concern if DyKnow was useful in the learning process. 73% of the students responded positively. The best feature of the software liked by the majority of the students was that the students received the exact version of the instructor's notes, with students' freedom to annotate them. One of the students commented, "Being able to distinguish between what the teacher said and what I was thinking is a nice thing that is hard to reproduce in a [traditional] notebook". Another popular feature among these students was the pen-enabled characteristic of this practice. One student remarked, "Novelty value...the stylus is useful for some things other than writing".

III. Tablet versus laptop – Does the pen matter?

DyKnow/Tablets were used in CSSE 220, Fundamentals of Software Development 2. The purpose of the study in that class was to gain preliminary insight into the question: *Given the use of DyKnow, is the presence of a Tablet PC (as opposed to an ordinary laptop) important? That is, does the pen matter?*

To that end, we administered a survey similar to and based upon those used in the studies reported above. The results showed that:

- 100% of the students liked DyKnow and found it very helpful. Comments indicated that they especially liked: more interactive discussions; permanence of the notes; dual use of laptop projector and DyKnow screens. A typical comment was "It is both fluid (able to be interacted with) and permanent (can be saved to access later)."
- 90% felt that for effective use of DyKnow, a pen-based Tablet is important as opposed to a mouse-based laptop, for reasons that included: "faster", "more natural", and "easier to draw pictures [and annotate]."
- Regarding whether Rose-Hulman should require entering students to buy a laptop (as now) or a Tablet PC, the students were split in their answers (40% suggested a tablet, 60% a laptop). However, they agreed on the issues, per the following representative comments:

"The tablet is great for educational use ["more versatility"], but the computer is for outside the classroom [use] as well."

"The tablets aren't useful for gaming or chatting."

These results, along with the positive attitudes toward Tablet PCs expressed in the above studies in Technical Communication and Physics, strongly suggest that Rose-Hulman should consider a multi-device solution. For example, perhaps we should require that entering students buy a Tablet PC and equip classrooms with docking stations with flat-screen monitors and pull-out keyboards. Students who want a PC with stronger entertainment value could buy a desktop for their dorm (as many do now). Additionally, perhaps the state of Tablet PCs will allow us to offer two options: a low-end machine that meets all educational needs and a high-end machine that can be dual-purpose.

IV. Measuring the effect of DyKnow/Tablets upon student learning more directly

We are in the process of developing more extensive assessment instruments, to be administered over a period of two years in at least six disciplines. Table 2 below shows some of the assessment questions to be answered in that study.

In particular, we want to measure more directly *how DyKnow/Tablets change students' behavior and learning*. To

do so, we will compare results from different sections of the same course that are taught using very similar pedagogy except that some sections will use DyKnow/Tablets and some will not. For example, we will measure the effect of DyKnow/Tablets upon the volume of markup in peer review in Technical Communication. Since we believe that, in general, more marks mean better peer review, measuring the volume of markup will tell us something about the direct effect of DyKnow/Tablets on student learning.

Table 2 – A study to be conducted in the 2006-2007 and 2007-2008 academic years

Assessment Question	Data Collection Method	Comments
How do Tablet PCs in conjunction with DyKnow change the classroom learning environment?	Student survey & focus groups	Ask students to compare class environments using Tablet PCs and DyKnow. Ask about experiences with Tablet PCs and DyKnow.
Were the students satisfied with their classroom learning experience?	Student survey & focus groups	Ask about advantages and disadvantages of both Tablet PCs and DyKnow. Ask about learning environment preferences.
Do the Tablet PCs in conjunction with DyKnow meet the teaching needs of faculty?	Interviews with faculty	Did the students perform as expected, did the technology meet their teaching needs, etc.
Is the Tablet PC and DyKnow combination applicable in a variety of disciplines?	Interviews with faculty, student survey & focus groups	Administer at the end of year 2
Do the tablets in conjunction with DyKnow improve the classroom learning environment?	Interviews with faculty, student survey & focus groups	Administer at the end of year 2

SUMMARY AND FUTURE WORK

In sum, our paper makes two important contributions – it gives detailed descriptions of innovative curricular activities that use DyKnow Vision software and pen-enabled Tablet PCs to magnify interactions in the classroom, and it reports results from an assessment of these innovations. Our assessment continues, both broadening the scope to include other disciplines and instructors and also increasing the depth of study by focusing on more direct measures of student learning like the amount of markup in peer reviews.

ACKNOWLEDGMENT

We are grateful for support provided by a *Mobile Technology Solutions in Learning Environments* grant from Hewlett-Packard, "Using Mobile Technology to Amplify Interactions and Enhance Learning in the Classroom and Laboratory." This grant provided the equipment used in this study. More importantly, it enabled Rose-Hulman's first steps toward using and developing pen-based technology in education.

Likewise, we are grateful for support provided by a *Tablet PC Technology, Curriculum, and Higher Education 2005* grant from Microsoft, "Assessing and Evaluating the Symbiosis of Tablet PCs and Collaboration-Facilitating Software in the Classroom."

Finally, we thank DyKnow for support they have given us in using their software and for their support in this study.

REFERENCES

[1] Berque, D. DePauw University. <http://people.depauw.edu/dberque/projects.html>.
 [2] Hulls, C. "Using a Tablet PC for classroom instruction", *Frontiers in Education 2005*, Session T2G, Indianapolis, October 2005.

[3] Theys, M. D., Lawless, K., George, S. "Tablet computers and the traditional lecture", *Frontiers in Education 2005*, Session T2G, Indianapolis, October 2005.
 [4] Wilson, J. M. "Experimental simulation in the modern physics laboratory", *American Journal of Physics* 48, 1980, p. 701.
 [5] Mitra-Kirtley, S., Mutchler, D., Williams, J. et al. "The world is our classroom", presentation at the *HP Higher Ed Mobile Technology Solutions Conference*, November 4-5, 2004.
 [6] Mutchler, D., Chambers, Z. et al. "Using mobile devices in the classroom and laboratory", *Pre-Symposium Showcase, Best Assessment VI Conference*, Rose-Hulman Institute of Technology, Terre Haute, February 2004.
 [7] Mitra-Kirtley, S. "The many uses of HP Tablets in Physics introductory courses", *Pre-Symposium Showcase, Best Assessment VI Conference*, Rose-Hulman Institute of Technology, Terre Haute, February 2004.
 [8] Mitra-Kirtley, S. "Wireless computers enhance education methods", *Pre-Symposium Showcase, Best Assessment VII Conference*, Rose-Hulman Institute of Technology, Terre Haute, February 2005.
 [9] Zoetewey, M., Chambers, Z., Mitra-Kirtley, S., Mutchler, D., Williams, J. "An interdisciplinary project using handheld, pen-based devices for project management, technical writing for mobile devices, and software development", presented at *First Workshop on Impact of Pen-based Technology on Education (WIPE)*, April 6-7, 2006.
 [10] Microsoft, *2004-2005 Technology-Enabled Curriculum Projects*, <http://research.microsoft.com/ur/us/tec/projects.aspx>.
 [11] Grisham, C. "The Tablet PC Project at the University of Virginia – Lessons learned", presented at the *2005 Tablet PCs in Higher Education Workshop*, July 20-21, Seattle, Washington, <http://www.cs.washington.edu/homes/anderson/tpc/>.
 [12] DyKnow. "Case studies in DyKnow", <http://www.dyknow.com/products/more/casestudies.htm>
 [13] Anderson, R., Anderson, R., McDowell, L., Simon, B. "Use of Classroom Presenter in Engineering courses", *Frontiers in Education 2005*, Session T2G, Indianapolis, October 2005.