Technology and Learning-Centered Education: Research-Based Support for How the Tablet PC Embodies the Seven Principles of Good Practice in Undergraduate Education

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Abstract - Student learning improves when faculty use learning-centered teaching practices, and a symbiotic relationship exists between technology and learning-centered education. One technological tool, the Tablet PC, offers university faculty a powerful way to enhance student learning. The Seven Principles for Good Practice in Undergraduate Education offer a framework for learning-centered education, and this paper illustrates the Seven Principles through research data focused on innovative and pedagogically appropriate uses of Tablet PCs. Examples include assessment research data from MIT, DePauw, Rose-Hulman Institute of Technology, University of Washington, Pace University, University of Michigan and Virginia Tech

Index Terms - computer science education, learning-centered education, Seven Principles of Good Practice in Undergraduate Education, Tablet PC

INTRODUCTION

There are clear benefits to students when faculty implement learning-centered pedagogies [1][2]. Weimer defined learner-centered education as focusing on “what the student is learning, how the student is learning, the conditions under which the student is learning, whether the student is retaining and applying the learning, and how current learning positions the student for future learning” [3]. The Seven Principles for Good Practice in Undergraduate Education offer a straightforward and powerful framework for learning-centered education [3]. Developed from a comprehensive review of educational inquiry that spanned decades of research findings and crossed disciplinary boundaries, the Principles were intended to “be accessible, understandable, practical and widely applicable” in higher education classrooms [4].

The Principles assert that “good practice in undergraduate education
1. encourages student-faculty contact;
2. encourages cooperation among students;
3. encourages active learning;
4. gives prompt feedback;
5. emphasizes time on task;
6. communicates high expectations;
7. and respects diverse talents and ways of learning” [5].

Pascarella and Terenzini [1][2], reviewing research spanning three decades, found decisive support for the effectiveness of teaching methods deemed learning-centered. The authors found evidence showing active learning techniques, such as small-group discussions, question-answer dialogues and case study debates, had a positive impact on student learning. Collaborative learning was also found to significantly enhance learning, and students using problem-based learning had a statistically significant advantage in problem solving. Guskin [6] advocated fostering learning environments that enhanced student learning by “restructuring the role of the faculty to maximize essential faculty-student interaction . . . , by making use of peer interaction and collaborative learning strategies, and by substantially increasing the amount of time and effort students spend learning” [¶12].

The basic nature and functions of the Tablet PC and its related software support the objectives of the Seven Principle of Good Practice in ways that have proven effective in higher education classrooms. This paper offers highlights of pedagogies and associated classroom research from diverse universities and classrooms. First, each Principle will be briefly described, the institution and pedagogical practice will be identified and the research data will be summarized.

GOOD PRACTICE ENCOURAGES STUDENT-FACULTY CONTACT

This principle draws from research findings that frequent contact between students and faculty, both in and out of the classroom, is “the most important factor in student motivation and involvement [4]. The content and frequency of student-faculty contact play an important role; interaction that focuses on ideas or intellectual areas appears to be greatly influential on academic outcomes [7]. Erhmann [8] developed a list of ways for technology to support good student-faculty contact. The list included making it easier for students to submit assignments and for faculty to provide feedback; the Tablet PC facilitates both of these activities.
At Massachusetts Institute of Technology (MIT), faculty used a Tablet-PC-based system called Classroom Learning Partner (CLP) to support in-class assessment in a computing science class [9]. Students wirelessly submitted digital ink answers to in-class questions to the instructor, allowing the instructor to display correct answers, provide feedback and address student misunderstandings when they occurred, rather than at a later time when the impact would have been lessened. In a large class of about 100 students, students were randomly assigned to a recitation section in which Tablet PCs were used. Of 16 students in the recitation section, 14 spent more than 90 percent of class time focused on classroom materials (rather than surfing the Internet, working on other projects, etc.), and the other 2 spent 80-85 percent of their time focused on class activities. Students reported that the immediate instructor feedback on in-class work helped them learn; students in the Tablet PC recitation made up 44.4 percent of the top 10 percent of the larger class in final grades. Additionally, none of the Tablet PC students failed the course. The authors felt the feedback mechanism was beneficial and were planning larger-scale deployments that reflected learnings from the initial study.

At the University of Alaska, Anchorage, faculty used Tablet PCs, Microsoft OneNote and a projection screen in the place of a traditional whiteboard [10]. The instructor could reshownotes (that previously would have been erased had they been written on the white board) and post lecture notes online after the class ended. Students reacted positively, and felt their attention to the projected notes was greater than when a whiteboard was used.

GOOD PRACTICE ENCOURAGES COOPERATION AMONG STUDENTS

This second principle points to improved learning as the result of team efforts, not individual endeavors. Chickering and Gamson [4] wrote that “good learning, like good work, is collaborative and social, not competitive and isolated” [p. 16] and research data shows the proven benefits of cooperative-type education [11]. The combination of social context and intellectual activity increased students’ engagement with the content and enjoyment of the experience.

Using the DyKnow system, a classroom interaction and managements system that operates on Tablet PCs, students at DePauw University received problems transmitted directly to their Tablet PCs by the instructor [12]. Students then worked collaboratively to solve the problems, and either submitted the answers directly to the instructor or shared them with the entire class. Of 81 students who each took an average of 5 pen-based courses, 73% “strongly agreed” that DyKnow “had a positive impact” on their learning, and 25% “agreed somewhat.” None of the remaining students “strongly disagreed.” In two separate studies, one classroom-based and the other a laboratory study, students consistently preferred to collaborate using the Tablet PC rather than using markers and overhead transparencies. One author in this study felt students could work together more naturally using Tablet PCs, which would encourage more informal interaction.

In order to promote more student-student interaction, faculty at the University of California, San Diego, had students use NoteBlogger, a Tablet PC application that works within the Ubiquitous Presenter digital classroom system [13]. Noteblogger allowed students to take notes over the instructor’s slides, and those notes were instantly available to other students through a web browser. The content of the blog entries was analyzed using Bloom’s Taxonomy as a framework to determine perceived understanding of the material. Students’ notes were found to span the levels of the taxonomy in cognitive engagement; bloggers reported a positive impact on student classroom experience and blog watchers appreciated the alternate viewpoints. The authors felt that the noteblogging activity supported a sense of community in the classroom.

GOOD PRACTICE ENCOURAGES ACTIVE LEARNING

This principle is based on the findings that active engagement with the curriculum effects more successful learning in students. Guskin [6] warned against lapsing into the all-too-common view that students are “passive recipients of information and knowledge” [p.23] because research shows active approaches promote the most effective learning in students. Brown and Ellison [14] described active learning as not just a “set of activities, but rather an attitude on the part of both students and faculty that makes learning effective” [p. 40]. Active learning techniques include writing, discussion, debates, peer teaching, interactive lectures, laboratory experiments, research, internships, group projects, performances, community experience, and other activities that promote engagement with the material.

Students in a geology course at the University of Michigan used Tablet PCs called GeoPads to record observations and create geologic maps [15]. Students were able to “record, analyze and manipulate their data in multiple contexts and representations” while in the field. Although the sample was small, students showed statistically significant improvement in spatial-reasoning skills such as visualization and interpretation of geologic structures; such results are worth pursuing further to see if they hold true with more students.

At Cañada College in California, faculty developed an Interactive Learning Network (ILN) that used Tablet PCs and wireless technology to promote active participation on the part of students through exercises, student surveys, group work, and increased interaction [16]. Two controlled studies of the ILN showed statistically significant positive impacts on students, and students were overwhelmingly positive about using the system. In one study, students who used the ILN system averaged 12.6 points higher on quizzes, 9.2 points higher on homework, 9.8 points higher on tests and 14.0 points higher on the final exam than students who did not use the ILN system. Additionally, fewer students withdrew from the class that employed the ILN system. Similar positive-although slightly less dramatic- results were
observed in the second study. The author recommended conducting larger-scale studies using the ILN system to verify its benefits and isolate the impact of the various functions of the system.

**GOOD PRACTICE GIVES PROMPT FEEDBACK**

The fourth principle offers the common-sense precept that students learn best when they find out what they do and do not know in a timely manner. Benson, Mattson, and Adler [17] defined feedback as “any procedure used to inform a learner of the degree of appropriateness or correctness of a response to an instructional stimulus” [p. 55]. Erhmann [18] listed in-class assessment and immediate feedback as one key element in following this principle; Tablet PCs are well-suited to meeting this practice.

At the University of Washington, Classroom PC, a Tablet-PC system that supports active and collaborative learning, both students and faculty used Tablet PCs. When faculty posed a question on data structures, only about half the students answered correctly. Faculty were able to use incorrect responses to immediately explain why an answer was incorrect [19].

At Queen’s University Belfast, Tablet PCs and PDAs were used to facilitate timely feedback. Multiple-choice questions were posed and the data automatically compiled and displayed to students. Additional feedback was promoted through the use of file sharing and streaming to allow easy submission of work and response by tutors. Course tutors felt they were better able to assess student progress and make changes in future instruction because of the regular opportunities for feedback [20].

**GOOD PRACTICE EMPHASIZES TIME ON TASK**

This principle confronts the assumption that if students would just spend more time studying, they would learn more. Vorkink [21] considered time on task as a complex issue, one that required consideration of not only students’ time management and study skills, but also of how the university structures time. Faculty can affect students’ time on task favorably by how they present materials, if they avoid tangential diversions, begin and end class on time, and implement the other six principles of good practice. Vorkink asserted that students should be encouraged to use their time in class well, not just “mark time,” and faculty must “demonstrate their own respect for the principle of time on task” [p. 69].

At the Rose-Hulman Institute of Technology, faculty were able to prepare models of systems ahead of time using digital ink instead of spending time in class writing on the board. Using the DyKnow system (which uses Tablet PCs to distribute the instructors’ presentation and notes), students were able to work on problems in class instead of having to copy the materials from the board [22]. Use of the Tablet PC facilitated time on task during class rather than time-intensive copying of materials.

Faculty at Morgan State University wanted to evaluate the note-taking ability of engineering students using Microsoft OneNote [23]. Nine students used a traditional pen-and-paper note-taking method, 4 students used laptop computers and 5 students used Tablet PCs. The exercise consisted of a 20-minute lecture, after which students paired up to compare notes and make annotations. Pre-test/post-test results revealed a gain 62% higher for the Tablet PC group than the total class gain. The authors felt that the Tablet PC users benefited from the ability to share notes and practice systematic organization.

**GOOD PRACTICE COMMUNICATES HIGH EXPECTATIONS**

The sixth principle states if you expect more from students, they will work to meet your expectations. Scott and Tobe [24] wrote that high expectations concern not only what happens in class but also what happens out of class. The authors acknowledged that all students will not achieve equally, but pointed out that all students can improve.

All students at the Virginia Tech College of Engineering are expected to purchase a Tablet PC for academic use starting their freshman year [25]. As the Tablet PC facilitated better active note-taking, students received the message that faculty expected them to exhibit better recollection and improve understanding due to Tablet PC use in courses. Additionally, faculty communicated expectations for better learning when they implemented active learning techniques with the Tablet PC. Initial results showed the high expectations were being met when faculty reported improvements in the classroom environment and more active participation on the part of students.

**GOOD PRACTICE RESPECTS DIVERSE TALENTS AND WAYS OF LEARNING**

The seventh principle acknowledges that today’s students are more diverse than ever before and bring unique and beneficial features to a classroom. Lidman, Smith, and Purce [26] described an environment in which universities “remain sensitive to and accommodate as many of the diverse needs of its students and faculty as possible” [p. 19] as they implement this principle. The authors asserted diversity matters because of the changing face of higher education and students. Today’s student body encompasses diversity of age, gender, race, cultural and socioeconomic background, previous experience, and levels of preparation. Accordingly, schools need to recognize that “students learn differently and acknowledge that fact in what is taught and how it is taught” [p. 97].

The use of Tablet PCs in classes at Rochester Institute of Technology helped “level the playing field” for students with disabilities, making it easier for them to participate in the educational process [27]. In particular, one student whose disability manifested in social outbursts was able to successfully take part in group activities through use of the Tablet PC; previously, other students found it impossible to work due to the student’s continual outbursts.

Faculty at the University of Washington agreed to teach a senior level algorithms course at Beihang University in Beijing, China [28]. The course was offered at a distance using...
a variety of hardware and software, including ConferenceXP, PowerPoint, and a Tutored Video Instruction (TVI) methodology that involves videotaping lectures that are then mediated with students by a teaching assistant. A significant challenge was posed by the fact that interaction is not encouraged in Chinese classrooms. As a result, even more interaction was built into the curriculum through identifying “stop times” during the videos and providing documents for TAs to use to create opportunities for interaction. These measures were successful in cultivating interaction; students reported speaking one time per week in other courses while speaking 2.8 per week in the algorithms class.

CONCLUSION

Technologies such as the Tablet PC facilitate each of the Seven Principles of Good Practice in Undergraduate Education, promoting learning-centered education and increasing student learning as a result. The research studies presented here offer a starting point for further exploration into specific practices of the Tablet PC that can enhance the student experience. Additional data is needed, however, to more fully emphasize the Tablet PC’s relationship to learning-centered education and improved student outcomes. The studies highlighted in this paper may inspire faculty to conduct research of their own using the Tablet PC. Because learning-centered education has proven benefits for students, any future investigation of Tablet PCs in classrooms is highly warranted.

REFERENCES