TABLET PCS AS AN ENABLING TECHNOLOGY FOR STUDENTS WORKING WITH THE HANDICAPPED

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Abstract - The Tablet PC has served as a new and unique platform for Computer Science students to use in developing systems for the disabled. As part of their education, student teams in Software Engineering classes at the University of Buffalo interact with clients at the Center for Handicapped Children in Williamsville NY. The effort is to invent and implement Tablet PC-based systems as augmentative talkers, educational aides to teach cause-and-effect, light and sound activators, and many other devices that address the special needs of handicapped children and their therapists. This paper explores the role of the Tablet PC in developing the projects and curriculum, with positive and cautionary issues regarding the effort.

Problem Statement and Context - In the Computer Science and Education department at the University of Buffalo (NY), our capstone design course involves the conception and implementation of complete systems motivated by socially relevant problems. Socially relevant projects have long been used in the social sciences, education and health-related professions to provide real-world experience. It is a welcomed contrast from a curriculum where students are exposed to well-defined problems with well-defined solutions. Often, they were simulations and "what-ifs", and lacked deployment to an eager client.

The Tablet PC - as the first portable, personal, cost effective. large-screen touch-actuation computer - has proven to be a very useful device for working with the severely handicapped. The Tablet PC has been an enabler in creating student projects that directly affect the quality of life of those who suffer from physical and speech pathologies, and learning disabilities (to name a few).

The experience has been very positive. Students have responded with intensity and philanthropy. The Tablet PC has more than met our expectations. Our disabled clients have participated in the classroom experience as both recipients and teachers. The program has rescued students at academic risk, given students a better understanding of special needs individuals, and enhanced the school’s reputation in the community.

In developing our capstone curriculum, we as faculty were faced with a difficult problem that presented itself every semester. We needed an experience for undergraduate projects teams that was un-simulated, intense, meaningful, and reflective. We looked for a target population who could benefit from the intelligence, creativity, and hard work of students; who could not command the technology themselves; and whose quality of life would benefit. We also needed a cost-effective means to produce live systems, deliverable to clients and customers.

Solution Employed:

The Tablet PC
• reduced the cost of touch-activated control from $6,000 (for customized hardware) to $1400
• reduced the cost of programmable touch-activated control from $10,000 (for commercial augmentative communications systems, capable of speech) to $1400
• made touch activated control available to an army of students

Students were assigned to teams of 5-8 members (depending on enrollment), and tasked with the
following (these were the actual instructions to students):

1. Send at least one team member to the Center for Handicapped Children and meet with people there, to discuss the needs of students, parents, teachers and therapists. The school is located at 80 Lawrence Bell Drive, Williamsville (near ECC North). Dress nice. Please wait until we talk about the center’s students in class. The tour times are on the class web site, but we can arrange additional times if needed.

2. Identify a need, and design a system to address a quality of life, or a quality of education issue apparent from your visit to the school. You have a budget of $1500, and laptop or Tablet PC to use. Be creative.

3. Find at least 10 web sites that offer information or products dealing with augmentative input devices or other hardware related to the problem that you have chosen to address. List those sites.

As an outstanding case study and review of a very typical result, one system that resulted from this effort is outlined here:

The DISCO System

Simple choice making and the realization of cause-and-effect are important milestones in early education, particularly among physically handicapped and developmentally delayed students. The relationship between physical action and ultimate effect, and the ability to select between alternatives of increasing number is part of a student’s Individual Education Plan (IEP) from early on.

The DISCO system consists of a programmable station that can enhance choice-making and the teaching of cause-and-effect in physical, speech, and occupational therapy sessions. Utilizing light, sound, videos, music, spoken-word, and tactile stimulation such as soft vibration (as feedback to the selection of alternatives), the DISCO system helps therapists and teachers create a positive feedback, or a calming environment, for students who react positively to enhanced sensory experiences and make correct choices.

The DISCO system can be profiled for particular students or disabilities. Any form of choice making input (touch-screens, actions, words) is acceptable. The system keeps statistics on successes and failures during use, so that teachers can alter the experience, and use it as part of a child’s IEP.

The mechanism that is used presents large colored buttons (with combinations of graphics and text) on the touch screen Tablet PC, which respond with different noises or spoken words when touched: first a single button, then two, then four, until sufficient cause-and-effect is established to graduate the student to a more powerful augmentative communications device such as a touch-screen talker.

Technical Features

Lights for the DISCO system currently consist of a stage lighting frame with color spotlights, rotating lights, traveling/sequenceable lights, brightness controls, color wheels, lasers, and fog. The various lights and changeable properties are under computer control.

Music is provided via a midi-compatible keyboard with programmable sounds and intonation, able to mimic a host of instruments, and capable of producing a variety of sounds under computer control. MP3 files through amplified speakers are used as well.
A wireless Tablet PC is used as the sole input device, incorporated to achieve various means of actuation and input so that choices can be made by the physically and developmentally impaired, to select sound, noise, music, and lighting programs. “Puzzles” are constructed by therapists to present choices to the handicapped students: pictures are chased on-screen, presented in increasing complexity, shown with variations, divided between graphics and text, and many other combinations to present selections that are enabled through touch. **The therapist’s screen:**
The control/programming computer is implemented using a desktop PC with digital I/O, midi, and sound capability. The PC controls the lights, noise, sound, and music based on the pre-programmed interpretation of the Tablet PC, or via the control of a therapist or teacher who selects programs. Therapists use a programming language that consists of an easy, graphical, drag-and-drop means of individualizing the experience for each child. The language is a tool for teachers and therapists to configure a sensory experience to be integrated with speech, physical, and occupational therapies, and special education.

Creating Lessons with the DISCO System

Individualized experiences and lessons are created for students through sequences of “puzzles.” Each puzzle consists of a single cause-and-effect, stimulus-to-response, input(s)-to-outputs(s) item (e.g. “Hit the green square, then the blue square, and the disco ball will rotate with your favorite song playing.”) The puzzles can be presented serially – in increasing difficulty – or in parallel (all at once); or the same puzzle presented repeatedly, giving the student many cause-and-effect possibilities to experience at once. All puzzles are presented as pictures on the touch screen Tablet PC, and the students make selections with a holstered pen, attached to their grasp.

Therapists and teachers can structure puzzles into lessons, and then link lessons to form a time-based session. They can automatically or manually control session start, finish, and assessment that a right or wrong answer was given. The results of each session are saved as an accumulation of right and wrong choices, so that teachers can chart the student’s progress over many weeks and months. In summary, the DISCO system can help teachers and therapists to determine information such as:

- Is the student capable of following verbal instructions?
- Does he/she need visual cues?
- Does he/she require hand-over-hand help?
- Are the results repeatable from session to session?
- Is the student demonstrating progress?

Evaluation – Impact of the DISCO System so far

Results are largely anecdotal, but an assessment survey was used for the first time in the Fall 2005 semester. In particular, we were hoping for high ratings on the following questions, and we got them (on a rating scale 1- strongly disagree agree up through 5 - strongly agree):

Working on a socially relevant project will contribute to keeping my interest in the project throughout the class. (Average response 5/5)

Developing software that will be used interests me. (Average response 5/5)

Developing software for assistive technologies (for the disabled) interests me (Average response 4/5)

Therapists at the Center for Handicapped Children have stated that there is no commercial equivalent, nor could we find one.
It is important to note that projects such as the DISCO system have evolved into extremely valuable and symbiotic experiences for UB students, faculty, and our collaborators. Some UB students who engaged the handicapped population for the first time were initially uncomfortable with the interaction. However, this discomfort faded quickly, as the students realized that their intelligence and programming skills could help facilitate choice-making, selection, and communication to help improve clients’ quality of life. At the same time, clients and their caregivers have made important contributions as recipients and teachers.

These experiences have rescued college students who were at academic risk, broadened their understanding of the needs and experiences of special needs individuals, and delivered much-needed devices to disabled clients. Participating UB students now see themselves as having the power to make a difference, and have expanded their view of the world. As one student said, “It turned on a switch inside.” Indeed, some students have altered their career paths in response to these learning experiences. One woman now works for Microsoft in their user-interface division. Other students chose to go onto graduate school – not just in computer science and engineering or artificial intelligence, but in linguistics and cognitive science as well.

The Lab at the Univ. of Buffalo - Students with Users of the DISCO System

Summary - We continue to work with Tablet PCs, almost exclusively as the platform of choice. Ongoing projects include talking devices specific to children, literate adults, the blind, and other targeted disabilities, a custom teaching aid for reading, a wheelchair remote control to teach ambulation to young children, and a means of surfing the Internet through touch screen targets.