WHAT TECHNOLOGIES STUDENTS ARE USING
AT NORTH CAROLINA STATE UNIVERSITY: A CASE STUDY

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Executive Summary

This case study describes information and opinions about how students at North Carolina State University use technology, which were obtained directly from undergraduate students enrolled in on campus degree granting programs across the NC State campus. The initial concept for the study was presented with the idea of learning what technologies students were using to "survive" at the undergraduate level. Drawing from prior NC State surveys of on-campus student technology use and *The ECAR Study of Undergraduate Students and Information Technology, 2006* (Salaway, Katz, Caruso, Kvavik, & Nelson, 2006), this research project focuses on investigating and identifying technology resources students have been using for classroom activities, for completing coursework assignments, and for social and recreational purposes.

Earlier this year (2007), the *LITRE Executive Council* and *LITRE Advisory Board* reviewed proposals from faculty seeking funding to incorporate technology into teaching and learning at NC State, and to investigate ways to incorporate technology into learning environments. The main purpose of this report was to provide information to help LITRE select the "second phase" of research projects. More specifically, the knowledge acquired about students' use of technology was compared to the objectives for each LITRE proposal, and used to determine projects that would effectively incorporate technology use by students into the learning environment and provide informative student learning outcomes. The projects selected for funding are listed below (LITRE, 2007). (Please reference the LITRE website for more information about each project.)

- "Computer Based Modeling for Engineering Project: This project is based on development of curricula to educate students to model problems, solve these problems using modeling tools, and then to analyze the solutions through decision support (i.e., become "power users" not programmers)."

- "Thoroughly Modern MILLIE (Methods of Incorporating the Latest Learning Innovations in Education): This project seeks to update the traditional lecture/lab-based university course and take advantage of recent advances in instructional technology and pedagogies."

- "Virtual Online Learning and Teaching (VOLT): The goal of the project is to immerse students in rich, photorealistic environments where they can actively participate in online courses through synchronous communication. (LITRE, 2007)"

In addition to the main purpose of the research, secondary objectives were established in order to utilize the information in ways that continue to span beyond LITRE:

- Students' feedback would be used to guide NCSU faculty, staff, and administrators with an understanding of what technologies students are using now and anticipating what they will be using in the future to plan for campus computing environments, technology, and technology-services support.
- The data would also be used by support staff who focus on educating professors and graduate teaching assistants about what technologies undergraduate students are using on a daily basis (education and recreation). The outcomes would help instructors at NC State effectively integrate technology into their teaching, either in blended or online environments.

Method

Professional staff from technology-support units, instructional technology services, teaching and learning support and university planning services formulated a collaborative team to create questions intended to collect students' opinions, likes, dislikes and suggestions about computing resources for analysis. Students participated in focus group interviews where they clearly articulated well-informed insights and opinions based on their experiences using technology at NC State.

Key Findings

Key student responses are summarized by topics that were generated either by the research questions and the feedback collected from the research.

Technologies used for completing coursework and other tasks at NC State

A large percentage of NC State students arriving on campus every year bring with them technology to help with their coursework or for social and recreational purposes when they are not studying: alarm clock, DVD player, computer and video games, iPod®, television, and so on. We did learn that not all students bring computers to college when they begin their freshman year. These students learn about and discover what technologies to purchase after they have arrived at NC State.

A majority of students interviewed are satisfied with the hardware and software available for them to use at NC State. Technologies[1] students use to complete coursework and other tasks range from calculators, laptop computers, desktop computers, cellular phones, commercial software applications, wireless access, NC State's Wolfline Transit Visualization System, microphones at students' seats in large lecture halls, digital cameras, printing services, Instant Messenger, e-mail, and more. They continue to prefer and rely on e-mail to communicate to faculty, and use IM in limited ways to talk with classmates about course assignments and group work. Overall, students expressed satisfaction with the technology resources available at NC State, and provided suggestions in areas in need of improvement.

Student reactions to technologies used by professors for teaching

[1] The term "technology" was not predefined for students participating in the focus groups. How students defined technology and the examples they gave was an important first step in understanding that their view of technology was not defined as a computer hard drive and monitor.

Constructive feedback about what students liked and disliked, and what worked and did not work for learning, shows a preference for faculty using document cameras during lecture. However, not all instructors could effectively use in-class technology. Students lose their motivation when professors spend up to ten minutes of time at the start of class trying to project presentations. Students are also cognizant of pedagogical decisions that do not engage students in learning. Students indicate that the difficulties they have navigating and using software applications can misrepresent how much they know about a subject. Pedagogical decisions made by faculty who require students to use technology for learning, i.e., MAPLE and classroom response systems (clickers), are not focused on learning course content. Instead, students often tackle a difficult learning curve when using software packages, because of the emphasis on how to use the tool. The ways in which clickers are used in large lecture courses often times does not engage students in learning.

Student use of and opinions of campus resources
Students express satisfaction with the technology resources available at NC State. They state that campus resources are valuable for conducting research, writing reports and studying. The Learning Commons, D.H. Hill Library, is mentioned as an often used and popular location for studying, working on group assignments and socializing. NC State's Digital Media Lab, Collaboratory, and Flyspace are not as well known and therefore are not used for creating visual media or collaborative work. Students often learn which computer labs they can use for specific tasks and assignments, relying on only those facilities that they had used in the past and deemed reliable for their computing needs.

Student Experiences with and Preferences for Technologies Used for Teaching and Learning
Students use Blackboard Vista and WebAssign for online courses or as a supplement to learning in the traditional classroom. Students who take online courses choose basic level, GEC courses in which their friends or peers from other classes are enrolled. Familiarity with other students in an online class makes them more comfortable asking questions and learning in a virtual environment. Students are direct about the difficulties they experienced using Blackboard Vista, and described it as being "adequate" for learning. Because they see its drawbacks outweighing its benefits, students prefer to be in a traditional classroom setting where they can interact with their professors and peers.

WebAssign—an online system that lets faculty distribute, collect, grade, and record homework assignments online—is popular among students and preferred to Vista. Students like WebAssign, because it gives them the ability to work through assignments in an organized, step-by-step process and they receive immediate feedback to their answers. When compared to using MAPLE and clickers, students say they prefer WebAssign for completing homework assignments and taking quizzes.

How Students Learn About New Technology
Learning about new technology and how to use software applications is determined by students' needs, course requirements and personal interest. Students learn how to use technology from peers, friends, and family, as well as using Google® to search the Internet. Programs and workshops offered at NC State that focus on teaching specific software applications are not convenient for students' schedules, the content is too basic, or the events are not publicized in ways students can find the information.

Students at NC State believe their professors assume that all students have a high level of instructional technology (IT) literacy and that all students have access to IT resources. More freshman entering college are "computer literate," but there is still a significant number of students who do not know how to use the most common hardware and software needed for their courses. Students interviewed want faculty to include software instruction as a part of their curriculum, especially when students are required to use applications for homework, research papers, graphic design projects, and quizzes. It is important that faculty understand how students differ in literacy and access to technology. Instructors assume all students have high level of IT literacy and access to IT resources. However, students want to understand how students differ in IT literacy and access

Students do rely on the NC State Help Desk to answer technical problems relating to ResNet, the residential computer network service provided to students living at NC State. Opinions about NC State's Help Desk are generally positive. Students did say that waiting for the Help Desk to reply to a request often takes too long. They find friends and classmates with the knowledge to troubleshoot and fix their hardware and/or software problems.

Student use of Social and Recreational Technologies
Students use DVD players, video games, the Internet (Google News®, Wall Street Journal®, YouTube™, Facebook®, etc.), cell phones and iPods® for social and recreational purposes. Students watch movies and play video games for recreation, and listen to iPods while walking to and from classes. Some students perceive listening to iPods while crossing campus as taking away from the time they spend after class reflecting on what they had just learned.

Students check the social networking sites MySpace and Facebook multiple times a day to keep up with what is being discussed by friends and classmates. They prefer these sites remain student-student social spaces. They do not want professors using these sites to find information about students or to communicate with individual students. Students prefer to communicate with their professors using email. It is more acceptable for a professor to use social-networking sites when students develop a friendship and/or have a mentor-like relationship with their instructors over multiple semesters.

Students' Suggestions and Recommendations
Students use course lecture notes and course materials in various media forms that are posted online by their instructor(s) and by other professors not teaching the course(s) in which they are enrolled. Students emphasize the benefits of having online access to class lectures to supplement the information they need and help with learning. They ask that all departments and professors make available course material online for classes in which students are not registered. This will allow them to build upon what they learn and increase the likelihood the transfer of knowledge will span from course to course and from college to their professional careers.

The term "convenience" and the need for "face-to-face" interaction are reoccurring themes throughout this study. The need and desire for face-to-face interaction with professor and students in a traditional in-class setting is emphasized by a majority of students. Students want their professors to use technology but they do not want technology to drive or dominate how they are taught and how they learn at NC State. According to the students interviewed, a moderate use of technology is ideal, providing their instructors are capable of using hardware and software correctly and in ways that engage students in learning.

Methodology

Research previously conducted at NC State (Figure 1) as well as national studies (i.e., Salaway, et. al., 2006; Soan Consortium (Sloan C), 2005; Oblinger & Oblinger, 2005; Oblinger, 2003) was used by the research team to develop the topic, methods and instrumentation formulating this case study. A review of prior studies was used to develop questions asked of participants, with the goal of having a more in depth understanding about their use of technology. We wanted to expand upon information already published and prevent the duplication data already shown to be reliable and repetitive. For example, we determined that feedback about technology use based on gender would not add to our findings in ways that would expand upon what was learned from other NC State and national studies (Salaway, et. al., 2006; 2007).

Figure 1:

NC State Studies reviewed:

- *Survey of On-Campus Student Technology Use* (http://www.cals.ncsu.edu/caat/survey/inf_survey.htm)
- 2005 ResNet survey and 2006 ResNet/ComTech survey (http://www.ncsu.edu/ResNet/survey_data/2006/results_06.html)
- *ResNet Survey Trends since 1998* (http://www.ncsu.edu/ResNet/survey_data/2006/results_06.html)
- *Technology Assessment Student Survey 2005* (http://www.ncsu.edu/techknow/tests/Student_Survey2005.pdf)
- *ClassTech User Surveys and Assessment Research* – The evaluation of the performance of faculty use of resources in rooms outfitted with instructional technology (http://www.ncsu.edu/classtech/survey_results/)

The research team was made up of campus partners whose daily interactions were primarily with faculty from across the NC State campus: Traci Temple, DELTA; Janet Fortune, FCTL; Stan North Martin, ITD; Charlie Morris, DELTA; Geetanjali Soni, UPA; Joe Willliams, NC State Libraries; and Nancy Whelchel, UPA. We worked to identify specific topics not addressed by previous studies and those unique to NC State students' use of technology on and off campus. Having representatives from multiple units helped us structure interview questions that would serve as an outline for gathering information needed to meet the overall objectives.

This qualitative study utilized focus group sessions to gain feedback from undergraduate students enrolled in diverse academic disciplines. We constructed semi-structured, open-ended questions asked during each group interview. Questions used to elicit more in depth responses were also outlined for the moderator in each focus group to reference (Appendix D). The main questions asked were as follows:

1. What technology—hardware, software, or anything else you can think of—do you use to help you with your coursework at NC State?
2. How do you accomplish tasks using technology?
3. What campus resources do you use?
4. How do you learn about new technology?
5. What technology would you use if you knew how to use it?
6. What do your professors use that is important to you?
7. What technology do you use when you're not studying?

Sample, response size and characteristics of student participants
Two forms of communication were used to advertise the study and recruit volunteers. Faculty teaching large and small courses from NC State's colleges[2] were asked to email students a pre-written description about the study and a request for participation. The request for participation was also advertised in the *The Technician* (Appendix E)—NC State's student-run newspaper—in hopes of reaching undergraduate students not contacted by email.

NC State undergraduate students 18 years of age and older and enrolled full-time and part-time were asked to participate on a volunteer basis. Graduate students from all levels were excluded from the study in order for the research team to meet its main objective—to learn what technologies undergraduate students are using for educational and social/recreational purposes. To increase interest and participation in the study, one iPod® Shuffle was given away by raffle at the end of each focus group session. Attendance was required to be eligible for the raffle. Six total iPod Shuffles were given away.

Students submitted a request for participation by completing and submitting an online form. The number of students who expressed interest in participating in the study was significantly larger than the number of students who attended the focus group sessions. Out of 140 students requesting participation, 90 were selected based on college/major, undergraduate year, self-rated level of technology experience, and the time of day they could attend an interview session. These students were divided into six groups. (The goal was to have ten students at each focus group session.)

A total of 21 students participated in the research study. These students were enrolled in an on campus program in the following colleges: Design, Engineering, Humanities & Social Sciences, Management, Physical and Mathematical Sciences, Textiles, Veterinary Medicine, and First Year College (Figure 2).

[2] Students from the following NC State colleges were contacted: College of Design, College of Humanities and Social Sciences, College of Engineering, College of Education, College of Physical and Mathematical Sciences, College of Veterinary Medicine, College of Natural Resources, First Year College, College of Agriculture and Life Sciences and College of Management.

Figure 2:

NC State College Represented	Number of Students
College of Design	6
College of Management	1
First Year College	1
College of Humanities & Social Sciences	1
College of Textiles	1
College of Engineering	8
College of Physical & Mathematical Sciences	2
College of Veterinary Medicine	1

All 21 students had enrolled in a class where the professor made available a course website, while only 13 students had enrolled in an online course. Their level of experience was self-rated using a "beginner," "intermediate" and "experienced" scale (Figure 3).

Figure 3:

Self-rated level of experience using technology	Number of Students
Beginner	1
Intermediate	9
Experienced	11

Students were selected and equally distributed based on undergraduate year; however, the research team could not anticipate equal distribution based on who attended in the interview sessions. A majority of the students who participated in the focus groups were seniors (Figure 4) and who graduated at the end of the Spring 2007 semester.

Figure 4:

Undergraduate Year	Number of Students
Freshman	3
Sophomore	1
Junior	4
Senior	13

Findings

The students who participated in this study gave well-articulated responses, opinions and suggestions about what technologies they come into contact with and are using in their college courses and when they are just having fun. By combining the topics we hoped to generate from the questions and themes that evolved from the student responses, we were able to outline six categories to use for organizing their responses. In this section, the information gathered from the students' feedback summarizes their use of technology as it relates to the following topics: 1) Technologies used for completing coursework and other tasks at NC State; 2) Student reactions to technologies used by professors for teaching; 3) Student learning experiences with and preferences for technologies used for teaching and learning; 4) Student experiences with and opinions of campus resources; how students learn about new technologies, and 5) Student use of social and recreational technologies.

Technologies used for completing coursework and other tasks at NC State

The most common technology[3] students brought to campus are thought of as a desktop and/or laptop computer with some software packages mentioned. It is important to note that not all students bring computers to college when they begin the freshman year. A small number of students do not bring with them the "latest technology," i.e., laptop computers and Adobe® software. Instead, they purchase and/or discover where to find the hardware and software they need for their major and for social/recreational purposes after they arrive at NC State. The most common technologies students bring to campus are as follows: desktop computer, laptop, alarm clock, cellular phone, calculator, iPod®, video and computer game hardware and software (Nintendo, Xbox, PlayStation), television, DVD player, Instant Messenger (AIM, Yahoo!, iChat, etc.), Adobe Creative Suite, and Microsoft Office.

"How do I use technology to not accomplish tasks? Technology is everywhere…"

A majority if not all students are satisfied with the hardware and software on-hand at NC State. This includes technologies in specific departments and campus computing labs open to all students from all majors, i.e., the *Learning Commons*, D.H. Hill Library. Students explained that, "there is a lot of technology available" and computing labs have "a lot of technology that students don't have to buy." They use hardware and software in their dorm rooms, apartments and computing facilities for completing coursework and other tasks: ResNet, NOMAD, VCL software, FireFox, WebCT Vista, Adobe Suite, Microsoft Office.

Digital Cameras and Cellular Phones

Digital cameras are popular among students majoring in textiles, graphic design and physics. They use digital cameras (not cell phone cameras) when generating data and documenting all lab events for lab reports and for documenting finished design projects. The images are then used as a visual resource, helping students remember assignment information more accurately.

[3] The moderator for each focus group did not define "technology" for the participants. Students were encouraged to think about the term "technology" as not being limited to what can be generalized as a computer hard drive, monitor or laptop.

Students use cell phone cameras and digital cameras differently. Cell phone cameras are not used to document lab procedures because students found they captured better images at a higher resolution using digital cameras. Cell phones are brought to class as a medium for taking pictures of PowerPoint presentations and course material written by faculty on chalkboards and white boards. They also use their cellular phones to take pictures of course notes posted outside faculty offices.

Desktop and Laptop Computers
Students use laptop computers in lecture to take notes, to complete homework, to work on projects in studio courses (College of Design) and to "stay awake." There are situations when it is important for students to be able to switch from using a laptop to taking notes with pen and paper, i.e., when learning calculus. Students who do not carry their laptops say it is because the computers are either "too heavy" or they have a professor who does not want students using laptops in class.

Students did not mention the use of PDA devices or Smartphones. One student mentioned having a PDA but does not use it often or for educational purposes.

Online and Wireless Technologies
All students talked about using home or university computers (desktop and/or laptop) and software to complete homework assignments. Students from physics, chemistry, engineering, etc., found the Virtual Computing Lab (VCL) software beneficial. Students login to VCL from their home computers to complete assignments. They believe this resource gives them a "convenient" opportunity to use software that will carry-over into real-world experiences. It also gives them access to software that is too expensive to purchase. Overall, students believe the VCL is beneficial to everyone who uses it.

Wireless access (NOMAD) is seen as making information more accessible from multiple locations across campus. Students benefit from "anywhere" Internet access for researching information. They "Google" a topic they do not understand and conduct online research about a subject using professors' websites at other universities. Centennial campus is "the place for some students to use everything. Wireless is everywhere, there is more than one network to join and empty classrooms are conducive to group work and studying."

The NC State Wolfline Transit Visualization System (TVS) is touted as "One of the best things NC State has recently done!" The online TVS helps, and continues to be available for students to locate where a Wolfline bus is on route. Students are able to manage their time getting to and from classes.

Participants understand the benefits and drawbacks of using Wikipedia to find information about a subject. Students understand they cannot rely on the accuracy of Wikipedia but continue to use it to begin research and answer homework questions.

In-class and required technologies
The availability of microphones in lecture halls is not consistent—some rooms are equipped while others are not. When lecture halls are equipped with microphones, students know how to interrupt the audio, which prevents the rest of the class from hearing both faculty and students speaking. When classmates are bored, they dismantled or press

their microphones to cause "screeching," and/or put their books on the microphones to override the professor's voice. This negatively impacts the ability for other students to learn, either in class or from remote locations (telecommuting). Students suggest that faculty use public speaking skills, i.e., repeating student questions so the entire class can hear, as an in-class solution to this problem. Instructors should practice these speaking skills before NC State invests in upgrading microphone technology in large lecture halls and classrooms.

While NC State has a wide-selection of hardware and software for students to use, specific colleges require students to purchase their own equipment. Students in the College of Design are "strongly encouraged" to buy a computer, scanner, printer, and the Adobe Creative Suite software in order to "survive" in their majors. The high cost of commercial software is frustrating for students. They talk with friends and classmates to find the best educational prices—sometimes going to other university bookstores that sell software for less than what they are charged at the NC State bookstore. Students find that labs on campus have a majority of the hardware and software they need; however, they acknowledge that if all students use these labs there will not be enough resources available for everyone.

Communicating with professors and peers
Most students prefer face-to-face meetings with instructors. When using the Internet for communication, email continues to be the technology primarily used for student-faculty interaction. iMac® computing stations found at various points on campus (i.e., Talley Student Center) are well-received and popular for checking email if students do not have a laptop with wireless connection. A small number of participants talk to their professors and teaching assistants using IM. This lets them to communicate in real-time about specific questions. Students IM their instructors during scheduled office hours and because it is "faster than email," however, this is not typical of all students.

Collaborative and group work
There is not a single, most popular technology used by students when collaborating with peers and working on group projects. A majority of group work is completed face-to-face and not using technology, except to ask brief questions. How students communicate is a personal preference, ranging from face-to-face discussions to the use of cell phones (voice and text messages), email, IM and Facebook. Students are influenced by friends, family and peers to adopt one or more modes of communication.

IM and e-mail are used to send short messages and benefit groups of students enrolled in majors with smaller student enrollment; they know everyone and can "see" them to ask online questions. Buddy names are shared less as students advanced in undergraduate level. Students believe people are more "accountable" when using IM compared to email because communication is immediate and spontaneous. They know when a classmate is online and receives an IM versus not knowing when or if email is received and read. The drawback when using IM is that individuals are more "empowered" when writing "behind the computer." They share more information than necessary or express themselves in ways

they would not typically do if the conversation occurs in person[4]. Students do advocate for reliable collaborative software that will combine email, calendar and IM. Blackboard Vista provides an online space for collaborative work, but is it not viewed as reliable. (See page 15 for more information about Blackboard Vista.)

Some students, but not all, describe cell phones as indispensable for communicating with classmates. Cell phones are used to organize meeting times (voice calls and calendars). For example, cell phone text messages are used when groups discuss how to format information pertaining to an assignment. Cell phones are also used to contact fellow classmates when lab equipment is broken or class is canceled, often saving students who commuted an unnecessary drive to campus.

Students congregate in large classrooms not in use. They make use of the space to work together, to access a projector with a laptop connection and as a place for more than one person to study at the same time. Laptops make it easier to work in groups and conduct research. Students can gather around a table and work on designated portions of group assignments.

Student reactions to technologies used by professors for teaching

"Screen your professors as people, not just lecturers.
The professors who go the extra mile are the ones you want."

"Some professors go out of their way to use technology which ends up
getting in the way [of learning], such as showing how to pull up a word document."

What do your professors use that is important to you? What do your professors use that does not matter? What don't you want your instructors using? Responses to these questions are both positive and negative, but always prefaced with empathy for faculty trying to use technology yet not succeeding according to students' expectations. There is a noticeable contrast regarding the types of technology used by faculty from different departments. Students have a positive reaction to the use of document cameras because faculty can make changes to lecture notes quickly, and the information is available for everyone to see. Students use screen captures to study, especially when professors post these on course websites. Students' primary concern is that professors do not know how to use document cameras and often write outside of the projected viewing area.

"Sometimes faculty use technology when they don't need it; it gets in the way."

There is aversion to the use of specific technology by faculty. Students report a "disconnect between professors and technology, and professors and students." It is important that instructors know how to use technology when teaching in a classroom and online setting. Examples are provided below that demonstrate ways in which the use of technology for

[4] Facebook is used to send messages to peers, i.e., "… to see what classes they are taking," however, this was not the most popular technology used for communication.

teaching interrupted the professor-technology, student-instructor and student-content interaction during lecture.

- Students observe many professors spending the first ten minutes of class time each day trying to figure out how to project PowerPoint slides and use document cameras. Technology is described as interrupting the learning experience and causing lost class time. Students begin sidebar conversations or check their email while waiting for the professor to begin class. A similar student experience that relates to this point is an example of how technology can be an impediment during a quiz. In this specific instance, the instructor used PowerPoint to project pictures for students to identify. Identification was difficult because "the slides ran off the edge of the screen and half of what we needed to see was gone."

- Pedagogical decisions made by faculty requiring students to use the software, MAPLE, emphasizes usability skills instead of focusing on students learning the processes for solving mathematical problems. Accurate reflection of students' knowledge of the course material, i.e., algebra and calculus, is overshadowed by the difficulties students have with learning how to use MAPLE.

- Classrooms on campus are not all equipped with sound, which makes it challenging for students to hear when faculty play multimedia presentations from laptop computers.

PowerPoint

"It takes a certain teacher to have a presence in class to make [PowerPoint] an effective teaching tool…"

Ah, PowerPoint! It is the presentation application we seem to love to hate. Students are positive about having projected slides, whiteboard and document camera notes, and other course content available online. They use PowerPoint presentation notes to review course material prior to lecture, use printouts to take notes during lecture, and/or print uploaded notes to study after class. Used in combination with effective in-class teaching strategies, students see the benefits of PowerPoint. Five comments/suggestions were made during this study:

1. A successful way to use PowerPoint is to "have five words on the slide" and talk more in depth about the topic.
2. Professors should create their own, unique presentations versus using what comes with the textbook.
3. Apply what is discussed in class with the concepts students are learning and do not use PowerPoint just because it is available.
4. Notes from a presentation can be a useful reference to review information students may have missed during lecture or if they missed class.
5. "Teach outside the PowerPoint."

Lectures online

Videotaped lectures, for all students to access online, are viewed as valuable for understanding course content. For example, students believe they were passing their math course because "one of the best math teachers NC State has posted his lectures." They watch online video lectures for alternative explanations for problem solving and as a supplement to their course. When a student looks for additional resources, typically those resources are posted by a professor who is not the instructor teaching the class in which student is enrolled.

Podcasting is not universally known or understood by all participants. Its use in higher education had to be defined for at least one student in each focus group. Those who access podcasts say the resource is useful when a professor records a review of the main points from an in-class lecture.

It would be misleading to state that all students use online information to supplement their course(s). Some students admit to watching online lectures instead of being physically present in class. Not all students like the idea of faculty using podcasts for posting lectures, because listening to these requires "extra effort" on the part of both the student and professor; it is not seen to be a good use of the professor's time.

Student experiences with and preferences for technologies used for teaching and learning

Faculty are sometimes limited when it comes to the technology choices they have to use for teaching due to privacy guidelines and accessibility requirements. Still, faculty and students have an array of software applications available to them for teaching and learning at NC State. Students have a preference when using some technologies for learning in class and online as we might expect. The preferences are based on the immediate feedback they receive from *Blackboard Vista*, ongoing access to grades, and access to multiple forms of media.

Webassign

"WebAssign was good until they [NC State] started charging for it, then teachers dropped it."

WebAssign is an online system that lets instructors distribute, collect, grade, and record homework assignments over the Internet. Students like WebAssign, because it gives them the ability to "work through problems one step at a time." They receive immediate answers, which adds to the information they learn in class. "You get immediate feedback whether or not you are doing the problems correctly." The only negative comment about WebAssign is that a simple grammatical error can result in a wrong answer. Students interviewed stated that they prefer using WebAssign to MAPLE because it is more intuitive and provides immediate feedback on homework assignments.

"There are plenty of creative ways to use technology that is available but faculty are ignoring it or don't know how to use it."

Classroom Response Systems
Participants' describe classroom response systems (clickers) as more useful to teachers than to students. According to students interviewed, instructors use clickers to take attendance and answer quick, multiple-choice questions. One student in the study said that the radio frequency of clickers used in one class was strong enough that he did not have to actually go into lecture to record that he attended. He simply walked past the building, pressed a button on the clicker, and it was recorded that he was in class.

Students want faculty to "Take a step back and look at the big picture. I'm not paying the professor to… [give me] clicker quizzes. I do want to learn." Clickers are not used effectively to enhance learning. When clickers are used for quizzes, "it [is] easy to cheat because you can see what buttons other students are pushing." WebAssign is preferred to clickers because the online system can be used in addition to face-to-face class meetings, increasing students' contact with the instructor and course content.

Course Websites
Course websites are a valuable resource for students to use throughout each semester. When websites are not available, students miss having access to a course syllabus, especially if they misplace the print version handed out the first day of the semester. A quality website should be shared by other sections of the course, include all assignments, have a "news" section where the instructor can post information, and have links to websites mentioned in class. In addition, students like to check a course schedule on a daily basis to see what is "going on," what is due and what they will be learning.

Multimedia
The use of multiple forms of media (video, audio, PowerPoint slides) for teaching is described as increasing students' knowledge of course concepts, i.e., watching a video online which demonstrates how bees can dance helps students visualize information. Students appreciated access to media online, because it saves them time from having to go to the library to get additional materials for learning.

Student experiences with and opinions of campus resources
A majority of students interviewed gave positive responses about computing resources across campus. They believe NC State has a lot to offer, and in general, technology is easily accessible. Convenience and predictability determine if students used specific resources.

Campus Computing Labs
Campus computing labs are described as being uncomfortably hot and posed distractions for students wanting to concentrate. Distractions are mainly from the ambient noise often from people talking and the use of printers. If students are unable to study in these spaces, they seek out private, quiet places to work and often use their laptops in the library.

The D.H. Hill Library and Design Library are used for studying and to complete homework assignments because of the locations and the ability to isolate oneself in a quiet atmosphere. Students often use the library website to search the online catalog, to conduct

research and to get general information about the library. Personal laptops are used in the library because the wireless network is reliable.

The most outstanding feedback students gave about a campus resource that is used for group work is specific to the *Learning Commons*, D.H. Hill Library. The Learning Commons is an ideal space for students to work because they can study in groups using tables with or without computers, access the Internet and socialize. The space is described as open and inviting. The only drawback, which should be viewed as positive, is its popularity, making it difficult for students to always find a computer and space to work.

The Digital Media (DM) Lab, located in the East Wing of D.H. Hill Library, is a convenient space used by only a few students for video editing, scanning images and group projects. A small percentage of students use the DM lab, while many were unaware it is available or where it is located.

Approximately half of the participants did not know about two collaborative meeting spaces available on the NC State Campus: Flyspace and the Collaboratory. Flyspace is made up of two small customizable, collaborative rooms located in basement of the Talley Student Center. The Flyspace rooms are equipped with power connectors for equipment but do not house a lot of technology. Instead, the idea is to have minimal technology in hopes of fostering collaboration among small groups of students. The Collaboratory, located in D.H. Hill Library, East Wing, is a state-of-the art space designed for computer-collaboration activities. Where Flyspace and the Collaboratory are located is confusing for students therefore these facilities are not used frequently. Participants who have a general idea of where these spaces are located have not used them for collaborative work. Students who do know about and use these facilities find them to be very useful when working on collaborative projects.

Online Courses and Blackboard Vista

Students use their personal computers and/or university resources for taking online courses. Thirteen out of twenty-one students participating in this study had enrolled in a distance education course. Typically, students take basic level GEC courses because the classes are convenient and before enrolling in a higher-level course required for their major. Online courses help students fit classes into their schedules, especially if an in-class course section conflicts with another class or work. They can study where they want, when they want, and with whom they want. Learning online is more "enjoyable" and "helpful" when students know people from conventional classes who are taking the same online course. Familiarity with who is enrolled in the online course makes them feel more comfortable asking questions about concepts or problems they do not understand. One freshman student reported not taking an online course because, "My advisor told me not to take a distance education course… she was afraid I would not be able to understand the material."

Blackboard Vista, the learning management system (LMS) used at NC State, is described as "adequate" for when faculty post lecture notes for students to review. The online tool is "convenient" for submitting homework and accessing grades. Interacting with course materials in different media forms wrapped in Vista is seen as beneficial—learning occurs when students use the media best suited for students' different learning styles.

The drawbacks when using Vista outweigh the benefits; however, according to a majority of the students who had used the LMS. The most commonly stated issues regarding Vista including the following:

- Vista is slow, taking "forever [for documents] to download."
- It spontaneously logs off students while they are trying to complete an assignment or retrieve course information.
- The email function is poor therefore students communicate using "real mail" (Yahoo®, Gmail™, .Mac Mail®, etc.).
- The interface is difficult to navigate.
- Pop-up windows get in the way and are not necessary.
- "Professors do not have a mastery [using Vista]."
- Students prefer to be in the classroom with the professor and their peers so they can hear verbal discussions and interact with each other.

Printing at NC State

Consistent with the NC State *Survey of On-Campus Student Technology Use* and annual *ResNet Survey* a majority of students say that the NC State printing system is "frustrating," printing "poor copies," and students cannot "get their money back" if they have problems caused by printer failure. Campus printers do not consistently process print jobs, but students are still charged for prints they cannot use. In addition, students are "never sure" if they should use the D.H. Hill or Wolf copy cards, and suggest these be combined to eliminate confusion. They do note that the expense of owning a printer and the cost of toner cartridges make them appreciate having campus printing resources.

How students learn about new technologies

"We have become a web-based university and when you can't find something you need, it becomes frustrating and paralyzing."

How students learn about new technology is happenstance. Programs and workshops available to students across campus are either not publicized in ways students can find the information, are not convenient to students' schedules, or what is taught is more basic than what students need. Overall, all students learn in the same ways how to use technology and what technologies are available.

Students learn how to use hardware and software from peers, friends, family, and as a part of classes, or they "figure it out" themselves. They rely on the NC State Help Desk for solutions and answers to technical problems. While some students request the Help Desk be open later in the evening when they study, others recognize that there has to be responsibility on the part of students to know when they can get help. They cannot procrastinate calling about a problem.

Google® is used to conduct Internet searches for finding answers to questions about what and how to use software. Many students are self-taught and/or learn how to use commercial software (e.g., Microsoft Office and Adobe Creative Suite) in high school. Overall, they do not rely on manuals or purchase software books. There is a strong reliance

on professors teaching basic software knowledge specific to their major, integrating this information into the teaching and learning of course content.

Technology workshops
The Information Technology Division (ITD) at NC State provides scheduled technology education for faculty, staff and students. The Student Education program teaches a variety of technology workshops such as Microsoft Office Basics, Web Help, "Vista for Students" and more (Instructional Technology Division (ITD), 2007). Less than half of the students interviewed were aware of this resource and stated they will attend workshops if they know about them. Students who know about the workshops do not attend either because they need more advanced instruction than what is offered, i.e., advanced instruction on how to use Excel, or they do not have the self-motivation to go.

Student use of social and recreational technologies
What technologies do students use when they are not studying? What do they use for socializing and recreation? Students use IM or cell phones to text message or call friends and family. They search the Internet using a personal desktop or laptop computer, read news sites such as CNN®, MSNBC®, Google News® and the Wall Street Journal®, or view videos on YouTube™. "Recreational" uses of technology is interpreted by the participants as playing games on their Xbox® or PlayStation®, and using DVD players brought with them to watch movies when they were not studying.

iPods®
Simple observations of students walking across campus includes seeing them talking on their cell phones and listening to music on their iPods. Students talk about how they and their friends listen to music while walking to and from classes and going to the gym. One group of students shared what they thought was an interesting discussion they had with a professor: When students put headphones on to listen to their iPods after class, they do not take the time to reflect on what they just learned. These students believed they lost the time when they typically did their "best thinking."

Social Networking Websites
Students use online social networking websites (MySpace.com® and Facebook®) to "find out what's going on." They check Facebook multiple times a day to see what is being discussed among friends and peers. When asked about their opinions of college professors using MySpace or Facebook, they stated that they prefer these sites remain student-student social spaces. Professors are using these websites to find out about students, which they say is "strange." They want professors to use email when communicating with students. Students find it more acceptable for an instructor to have an online profile in MySpace or Facebook if the student will know the teacher over an extended period of time, with whom they become friends, or when a mentor-like relationship is established and maintained for more than one semester.

Professors are warning students of the risks when posting personal information online. Prospective employers can find out about students and their personal activities, which students understand may impede a their ability to get a job.

It is important to note that not all students are using social networking sites and have no interest in using them at this time. These students prefer email, cell phone or face-to-face communication and interaction with family, friends, classmates and professors.

Suggestions and recommendations

A majority of students interviewed are happy with the technologies NC State has available for them to use. They have access to industry software specific to their major(s) and they do not have to purchase expensive commercial software. Students offered suggestions and recommendations for faculty, staff and administrators at NC State. I have listed their recommendations below, with the inclusion of what we know about how teaching and learning using technology can improve faculty-student, student-student and student-content interaction. In support of their suggestions, I have referenced published research studies and related information, which may be used to compare common themes that evolve from NC State students' opinions and suggestions and students from higher education institutions across the United States.

Technologies for completing coursework and other tasks at NC State

- The focus group interviews were held during the Spring 2007 semester at the time the Virginia Tech shootings occurred. Students were quick to suggest that if text messaging is used to contact students in emergency situations, the information will reach students sooner. Similar comments were noted in the ECAR (2007) report, and public universities are investigating and implementing new emergency alert systems that utilize text messaging instead of broadcast email procedures.

- Respondents participating in the ECAR report (Salaway, Caruso, Nelson & Dede, 2007) stated that they "prefer communicating with their institution using their university email account" (p. 45). In many instances, the feedback we received correlated with what is reported in the ECAR study, but preference for using the university email system was not the same. NC State students interviewed said they chose to use Gmail so they could "funnel email" from multiple accounts and check all emails received at one time. NC State limits the amount of storage space available for students. Additional space can be purchased; however, the students we interviewed found using Gmail was a better solution for consolidating and storing email attachments in one space. Students recommend that more disk space for email is given to students and faculty to store attachments and presentations using their university accounts.

- Technology support staff and faculty should continue to investigate ways in which students' use of digital cameras and cell phone cameras can contribute to successful teaching strategies using technology. Visually documenting classroom and lab assignments provides a way for students with different learning styles to interact with and learn course content. For example, images may be used as a part of student submissions to a course wiki and/or blog.

- NC State gives students access to software through the VCL. Convenient access to expensive software gives students the opportunity to learn software that they imagine using in their careers. According to the students interviewed, this type of

remote software access program at NC State should continue because it is beneficial to the many students who use it.

- One student commented, "The people making decisions think the best way to fix a problem is to throw more technology at the problem, when … there is usually a simple solution." Students recommend that NC State seek out simple solutions to problems faculty have using technology in the classroom. Specifically related to using technology in large lecture halls, students want faculty to remember basic speaking skills when teaching and not rely solely on technology to communicate information to all students in the class.

Student reactions to technologies used by professors for teaching

- Students' self-motivation to access course websites and video-taped lectures online as an additional resource to understanding course content should continue to be taken into consideration by faculty and technology support staff. Students want the best professors to post their lectures online as a supplement to their learning. They rely on the better instructors to supplement the information they need to understand course content. Faculty should update their course websites frequently, have available useful resources to compliment course material and eliminate extraneous information. This increases student-content interaction that can result in meaningful understanding of the subject.

  Expanding upon the above suggestion, students want all departments and professors to make available course websites for courses in which students are not registered. "As long as you are an NC State student you should be able to look at a website for… at least the courses you have taken…." They want the opportunity to review materials from courses they completed in previous semesters to help them with current classes. This would help them build upon what they learn, increasing the transfer of knowledge from one course to another and from college to their professional jobs. This is characteristic of today's "millennial" student in that they are aware of and concerned with what they learn benefiting them beyond higher education and helping them succeed in their future careers (Strauss & Howe, 2006; Strauss & Howe, 2000).

- Students want more faculty trained in the use of technology for teaching both in the classroom and online. Professors often spend the first ten minutes of class time resolving technical problems with projectors, document cameras and laptop computers. Students lose the time when they should be learning, become distracted and sometimes leave class.

- Not all classrooms on campus have built-in technology for faculty who want to use multiple forms of media during lecture. Students become frustrated because they cannot hear or see information they are required to learn. In order to keep technology from getting in the way of teaching and learning, instructors' mastery of online and in-class technologies needs to improve.

- There are many workshops on campus specific to the uses of basic to advanced technologies for teaching at NC State. Seminars are also available (DELTA, ITD,

FCTL, etc.) for faculty to learn about trends, pedagogical strategies, and what is on the horizon. We need to continue to encourage faculty and offer incentives for them to attend these workshops and seminars in order to improve students' learning experiences with the goal of improving student learning outcomes in today's supplemented, blended and virtual classrooms. Students are not adverse to faculty using technology when teaching. Contrary, students want document cameras, as an example, to be used more often. How technology is used increases the time students spend learning from and interacting with course materials.

- We will continue to use PowerPoint as long as it is available and as long as there is not a competitive alternative for delivering presentations. A teacher's presence in class is still more effective when teaching than the technology they use. Students do not want faculty to use PowerPoint just because it is available. Students have offered recommendations for how faculty can improve PowerPoint presentations. These recommendations are limiting the number of bulleted points on a slide, creating their own presentations, and giving students access to presentation notes for review and studying for tests. Remember, students are making recommendations about which courses to take to their peers, and they are listening: "Screen your professors as people, not just lecturers. The professors who go the extra mile are the ones you want."

- Faculty need to make pedagogical decisions that give students the opportunities to learn the processes that lead to problem-based, inquiry-based and active learning. Less emphasis should be made on how to use software applications, and for those applications that require a steep learning curve students need and want more usability instruction. Students recommend having more than one software program from which to choose to complete their course assignments. This will increase the chance they have access to an application that is intuitive to use and does not interfere with student-content interaction and successful learning outcomes.

Student experiences with and preferences for technologies used for teaching and learning

- NC State students are in agreement with the respondents participating in the ECAR (2007) study of undergraduate students and information technology. Students prefer face-to-face interaction with faculty and a moderate use of technology when learning.

- Clickers should be used in ways that engage students in learning. Faculty using clickers for quizzes need to be aware of the ability for students to see what other students are selecting; it is easy for students to cheat on quizzes. Using clickers to take attendance does not guarantee faculty will get accurate information because students will find ways to record their attendance when they are not actually in class. Clickers should be used to gauge if students understand concepts taught. This can be done if professors use clickers to ask questions during lecture.

Student experiences with and opinions of campus resources

- The *Learning Commons*, D.H. Hill Library is liked and popular among students because it is an ideal space for them to work alone or in groups. Students say that

they would like to see more of these types of computing spaces available across campus.

- Students suggest more consistency across all campus computing labs. Students learn which labs they can use for certain tasks. It would be helpful if labs were "more uniform." Students do not rely on using a specific computing lab unless they have used it in the past. For example, all computers at NC State should have sound cards; they want to know before they login if the computer has audio capabilities. There should be a consistent use of technology from department to department.

  Technology-free spaces with open tables for students to work were requested. "Take all the technology out so you can work, and plugs in the walls for you to use." Rooms that can be considered "technology-free" are available in Flyspace and the Collaboratory. Information about the availability of these spaces is not reaching our students. Alternative ways for getting this information to students should be reconsidered. Faculty can play a role in letting students know about these facilities and promote their use. Information about these facilities can be made available on websites visited by undergraduate students.

How students learn about new technologies

- There is not a predictable or structured way in which students learn about and learn how to use existing and new technologies on campus. Students interviewed did not have specific recommendations for improving advertisement about workshops, but NC State may want to consider improving communication about workshops for learning software commonly used on campus. Faculty can also play a role in making students aware of the resources available to them by encouraging students to attend workshops. In the meantime, students will continue to rely on departments and faculty to teach software as a part of class or a pre-requisite to courses.

- Faculty should not assume that all students have the same knowledge and familiarity with IT. Students come to college with different IT skills. Students want faculty to include software instruction as a part of their curriculum, especially when students are required to use applications for homework, research papers, graphic design projects, and quizzes. It is important that faculty understand how students differ in literacy and access to technology.

Student use of social and recreational technologies

- Does listening to music on their iPods after class take away the time when students do their best thinking? Do we assume all students do their "best thinking" before and after class? How can faculty take advantage of students' use of iPods to increase student contact with course materials? Podcasts are not widely available at this time and most students interviewed did not know about podcasting. Those students who understood and had listened to a podcast for a class said that these recordings could be used for students to access lectures online and to supplement in-class discussions. Students recommend that if podcasts are used for teaching, faculty should record key points of a lecture for students to listen to for reviewing in-class lectures and study for exams. As faculty begin to record and offer lectures

using podcasting, more students will begin to benefit from 24/7 access to information, whether for review, online learning or to supplement in-class learning.

- Students are upfront about how they feel when faculty use social networking spaces such as Facebook and MySpace. Students want online social spaces to remain private and they do not want these sites used for student-faculty communication. The same is true for IM—students prefer it remain a tool for socializing with their friends and not their teachers.

  Faculty are successfully using IM to communicate with students during scheduled office hours and students appreciate having immediate communication with faculty. Students believe the use of IM for communication about a course should be limited to informal dialogue.

  How NC State faculty and staff proceed in investigating ways peer-to-peer networking should be used for teaching and learning should continue. More information can be gathered as to why students want social networking to remain something they use in their private lives. Faculty can plan a key role in helping students understand the risks of posting private information online for anyone to access. Potential employers are finding information about job applicants from online profiles in Facebook and MySpace, and using this information to determine if they applicant will be hired for a job.

Conclusion

With the second phase of LITRE research projects chosen, NC State's faculty and support staff can continue to use what we learned about undergraduate students and IT to find better ways of integrating technology into teaching in the classroom and online. Administrators and technology-services support staff can reference the findings when planning for future collaborative computing spaces for students to use.

Pedagogical decisions NC State professors make when using technology for teaching should also be informed by national studies about undergraduate students and IT. Much of what we learned from the students participating in this study reflects the findings from respondents who participated in the nationwide research reports, *The ECAR Study of Undergraduate Students and Information Technology, 2006* and *2007* (Salaway, et. al., 2006; Salaway et. al., 2007). When compared, NC State students' opinions, experiences, preferences and suggestions about the availability and use of technology for teaching and learning are consistent with the feedback from students attending colleges and universities nationwide. Continuing a dialogue with current, incoming and future students will help us monitor changes, trends and future developments in the use of IT at the undergraduate level.

Appendix A: Glossary

Document cameras— The document camera serves many functions—as a chalkboard, overhead projector, opaque projector, and magnifier.
http://distance.ncsu.edu/faculty/videoclassroom_based/equipment.html

LITRE (Learning in a Technology Rich Environment)—A research program aimed at enhancing the extensive learning with technology opportunities available at NC State (http://litre.ncsu.edu/).

NOMAD—Found almost anywhere on campus, the NOMAD network allows for simple registration to connect to the network.

ResNet—The residential computer network service provided to students living at NC State University (http://www.ncsu.edu/ResNet/).

Virtual Computing Lab (VCL) software—VCL is a remote access service that allows students to reserve a computer with a desired set of applications for themselves, and remotely access it over the Internet (http://vcl.ncsu.edu/).

WebAssign— WebAssign is a way to deliver, collect, grade, and record assignments instantly and accurately. Students using WebAssign can receive immediate feedback on their homework and use the service to master information and skills, leading to more competence and better grades. Teachers using WebAssign can free themselves from the drudgery of grading papers and recording scores, resulting in more free time for meeting with students and preparing for class presentations.
https://www.webassign.net/ncsu/login.html

Wolfline GPS—"One of the best things NC State has recently done." http://ncsu.transloc-inc.com/

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Appendix C: Acknowledgements

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Appendix D: Qualitative Interview Questions

Question 1: What technology—hardware, software, or anything else you can think of—do you use to help you with your coursework at NC State?

- What do you bring with you… to use for your classes?
- What do you like to use? Why? Why not?
- What don't you like to use? Why? Why not?

Question 2: How do you accomplish tasks using technology? (See Charlie's suggestions)

- … research?
- … when you study?
- … when working in groups?
- … communicate with your professor and/or communicate with your classmates?

Question 4: What campus resources do you use?

- How are you using the library for your coursework?
- What do you like to use? Why? Why not?
- What don't you like to use? Why? Why not?
- What do you wish you were using and for what purposes?

Question 5: How do you learn about new technology?

- How do you find out about what's new?
- Why do you want to learn new technology?
- Is there something you would like NC State to make available for you to use?

Question 6: What technology would you use if you knew how to use it?

- What makes doing work easier for you?
- What kind of help do you need when using technology?
- Who would you talk to if you need to ask questions about how to use something?

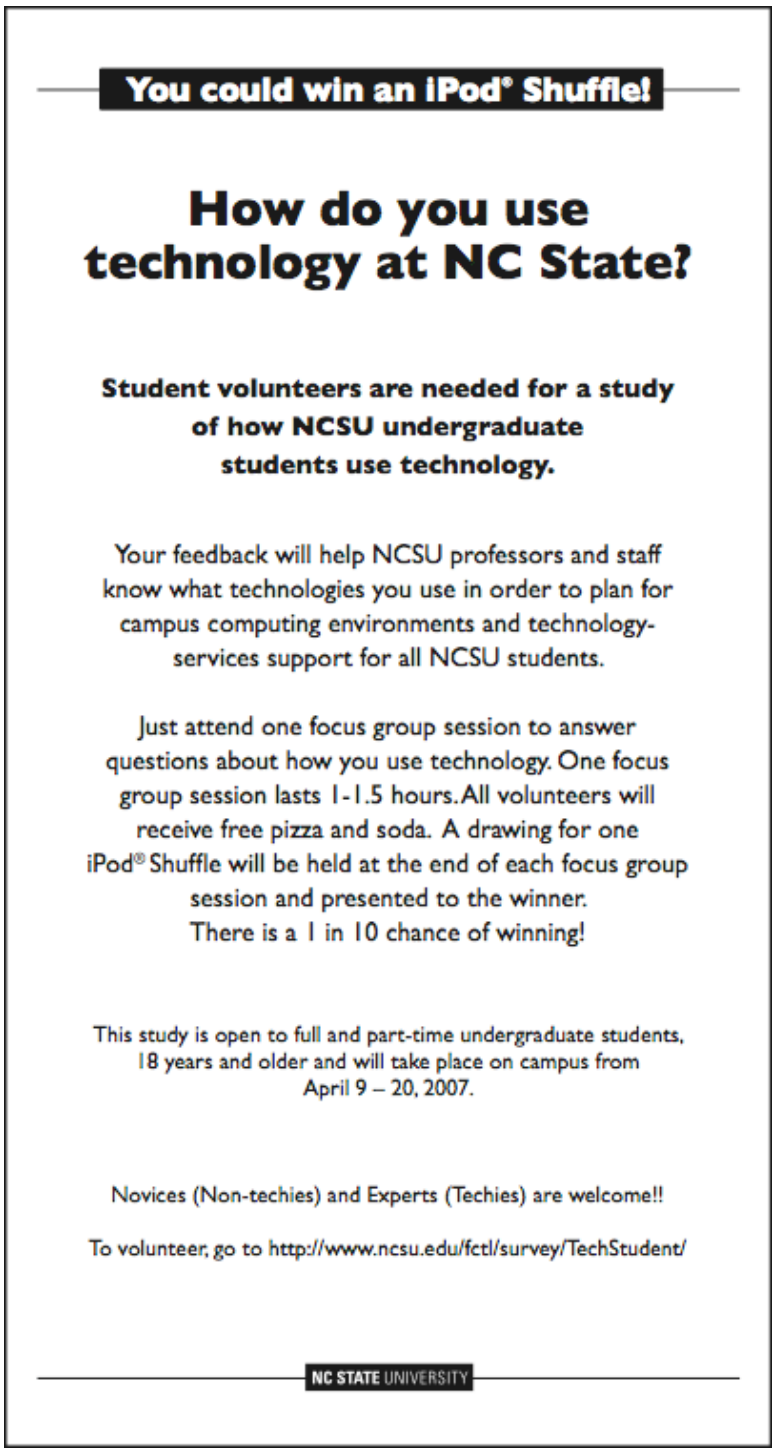
Question 7: What do your professors use that is important to you?

- What do your professors use that does not matter?
- What don't you want your instructors using?

Question 8: What technology do you use when you're not studying?

- Socializing with friends?
- Recreation?
- How do you feel about your professors using IM, Facebook, MySpace, etc.?

Appendix E: Request for participation advertised in The *Technician*



You could win an iPod® Shuffle!

How do you use technology at NC State?

Student volunteers are needed for a study of how NCSU undergraduate students use technology.

Your feedback will help NCSU professors and staff know what technologies you use in order to plan for campus computing environments and technology-services support for all NCSU students.

Just attend one focus group session to answer questions about how you use technology. One focus group session lasts 1-1.5 hours. All volunteers will receive free pizza and soda. A drawing for one iPod® Shuffle will be held at the end of each focus group session and presented to the winner. There is a 1 in 10 chance of winning!

This study is open to full and part-time undergraduate students, 18 years and older and will take place on campus from April 9 – 20, 2007.

Novices (Non-techies) and Experts (Techies) are welcome!!

To volunteer, go to http://www.ncsu.edu/fctl/survey/TechStudent/

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