Faculty in Technology-Rich Contexts: Connecting Teaching, Learning, and Assessment in the Classroom

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Abstract

At the 2006 Teaching and Learning with Technology Collaborative (TLTC) Conference, we presented a vision and framework for assessing the impact of technology on student learning in face-to-face, technology-enriched classrooms (North Martin, Spurlin, Raubenheimer, Mehlenbacher & Murphy-Medley, 2006). At the 2007 TLTC Conference, we reported the results of a study conducted by a multi-disciplinary team in spring 2006 that used this framework. Findings include how faculty use technology in their classrooms, the level of student engagement in technology-enriched classrooms, and student learning assessment results. We discuss our results in the light of implications for (a) technology and classroom environments, (b) students, (c) faculty, and (d) assessment.

Introduction

The study is contextualized within North Carolina State University's Quality Enhancement Plan (QEP), called Learning in a Technology Rich Environment (LITRE). LITRE's ultimate purpose is to improve student learning in four dimensions:

- Problem solving
- Empirical inquiry
- Research from sources
- Performance in the disciplines

LITRE's primary strategy is to establish an ongoing, systematic investigation into the effectiveness of technology-based innovations to improve learning. Results of these investigations are being used to build on our successes, shape future investigations, and inform campus decision-making.

One of the initial LITRE projects on campus is the ClassTech initiative. As one of its functions, this initiative equips classrooms with a technology infrastructure for instructional purposes. Each room is equipped with a computer with Internet connection, a projector, a laptop plug-in, a VCR/DVD, a document camera, and an overhead projector. These are known as ClassTech rooms and the number equipped has been incremental since 2003. Because LITRE is our Quality Enhancement Plan, assessment of LITRE projects is a central process, and ongoing assessment reports have been produced (e.g. ClassTech, 2006a, 2006b).

In Fall 2005, the ClassTech assessment committee developed a conceptual framework around which to conduct assessment activities for 2005-2006 (North Martin et al., 2006). The committee generated four research questions and gathered data using (1) a fall and spring end of semester survey of faculty ClassTech rooms (ClassTech 2006a), (2) a focus group of staff supporting ClassTech rooms, and (3) an observational study of how faculty use the technology when teaching. This paper focuses on the latter study.

Research Questions

Question 1: How does technology use impact the course's pedagogy, faculty workload, faculty attitudes, and amount of material delivered?
Question 2: How does having the technology used in the classroom affect (1) use of class time, (2) students' learning ability, and (3) student achievement of course and program objectives?

Methodology

The methodology employed is described in detail elsewhere (see North Martin et al., 2006). The design was qualitative in nature, using a case study design with cross-case analysis and a purposeful sample. The study involved fifteen faculty participants from six colleges and represented upper and lower division courses as well as large and small section courses. We interviewed all faculty and made detailed observations of one class session using an extensive rubric developed by the team members. We observed both faculty and student activities during the lesson.

The rubric is based on a revision of Bruce & Levin's (1997) classification of types of activity when using educational technologies. Bruce & Levin (1997) identified 4 main *purposes for technology use*:

- Media for inquiry (theory building, data access, data collection, data analysis)
- Media for communication (document preparation, communication, collaborative media, teaching media)
- Media for construction (robotics, construction of graphs & charts, computer-aided design, designing virtual computer labs)
- Media for expression (drawing and painting programs, music-making or composing, animation software, multimedia composition media)

The rubric also contained ratings of the *learning direction* **(**Bain, McNaught, Mills, & Lueckenhausen, 2000), the *Structure of the Observed Learning Outcomes* (SOLO) taxonomy (see Table 1 below) (Biggs, 2003**;** Center for Learning Enhancement and Research, n.d.) and *classroom characteristics* (University of Texas, n.d.). The instrument was calibrated among observers to ensure inter-rater reliability. Using the observational rubric, these trained observers watched one lesson chosen by the faculty member. They scored faculty and student activities during the classroom session on a 5-point scale ('never', 'rarely', 'sometimes', 'often', 'always'). We generated composite graphs comparing the fifteen faculty members' use of technology as a group, the SOLO level at which they operated, and the level at which students were engaged during the lesson. We wrote a case record for each faculty member based on the interview, observation, syllabus and other documentation, and cross-case analysis conducted to look for themes and trends.

To assess student learning, we also collected and analyzed samples of student work based on the learning outcomes identified by faculty for the classes we observed. All work was “graded” by the faculty and stripped of identification. We related all tasks and student artifacts to the SOLO taxonomy levels to ascertain the level at which the task was set and the level at which students responded. Table 1 represents the various levels in the SOLO taxonomy and associated types of learning outcomes.

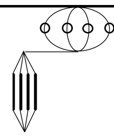
SOLO category	Representation	Type of outcome	
Unanticipated Extension (Extended Abstract)		Create Hypothesize Predict Theorize	Synthesize Validate Debate
Logically Related (Relational)		Apply Distinguish Classify Summarize	Outline Analyse Contrast Categorize
Multiple Points (Multistructural)		Explain List Describe	Define Solve Interpret
Single Point (Unistructural)		State Recall Note	Recognize Quote Name

Table 1: SOLO Taxonomy
Note: The terms in brackets are the original nomenclature used by Biggs (Biggs, 2003).
Adapted from: Center for Learning Enhancement and Research (CLEAR), The Chinese University of Hong Kong (n.d.). The SOLO taxonomy as a guide to setting and marking assessment.

Findings

Some Findings about Faculty

Learning direction.
In general, classes were teacher-managed, with twelve out of fifteen cases ‘always’ using a teacher-managed approach, and three ‘often’ or ‘sometimes’ being teacher-managed (Figure 1). Here the teacher controls the flow of information, questioning, and learning direction within the session. A student may be free to review a chosen aspect of the material; but within that area, the paths are laid down by the instructor. Three instructors out of fifteen used a teacher-guided approach ‘sometimes’ while twelve ‘never’ used this approach. A teacher-guided classroom is defined as one where the teacher provides a structured framework for students and guides them as they work on assigned tasks. One faculty member ‘sometimes’ used a teacher-facilitated approach--providing opportunities for students to explore their own lines of reasoning or questioning within the knowledge domain with the teacher assisting as required--while the others

‘rarely’ or ‘never’ used this approach. Similarly, only one instructor used some aspect of student-teacher collaboration--teachers and students collaborating to generate new knowledge and processes in the discipline--while none of the others did.

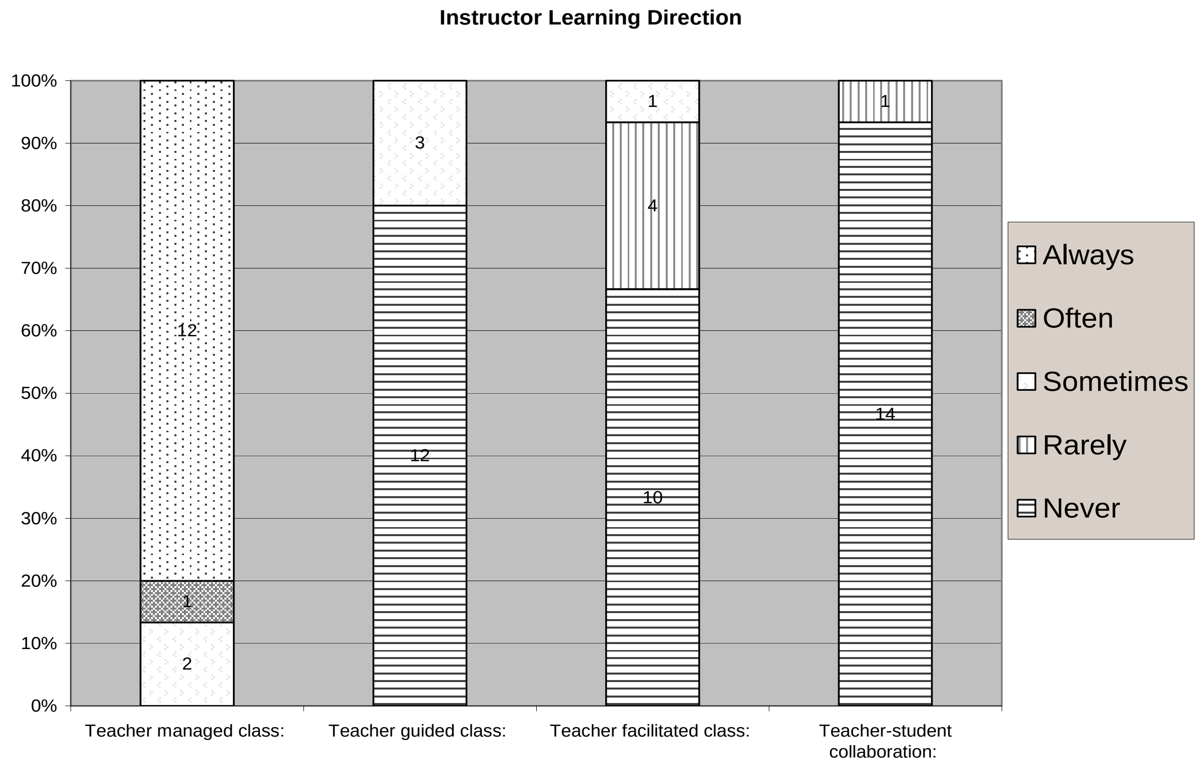


Figure 1: Instructor learning direction

SOLO taxonomy level of instruction.
Figure 2 (below) shows that all instructors were classified as using the single-point SOLO taxonomy level (Table 1) during the observed lesson (‘sometimes’ = 8, ‘often’ = 6, ‘always’ = 1). Twelve instructors ‘sometimes’ were rated at the multiple point level, while three ‘rarely’ or ‘never’ engaged at this level. Eight of the instructors were rated as ‘often’ or ‘sometimes’ being at the logically related level, while seven were rated as ‘rarely’ or ‘never’ using this level during the lesson. Only two instructors were rated as ‘sometimes’ being at the unanticipated extension level.

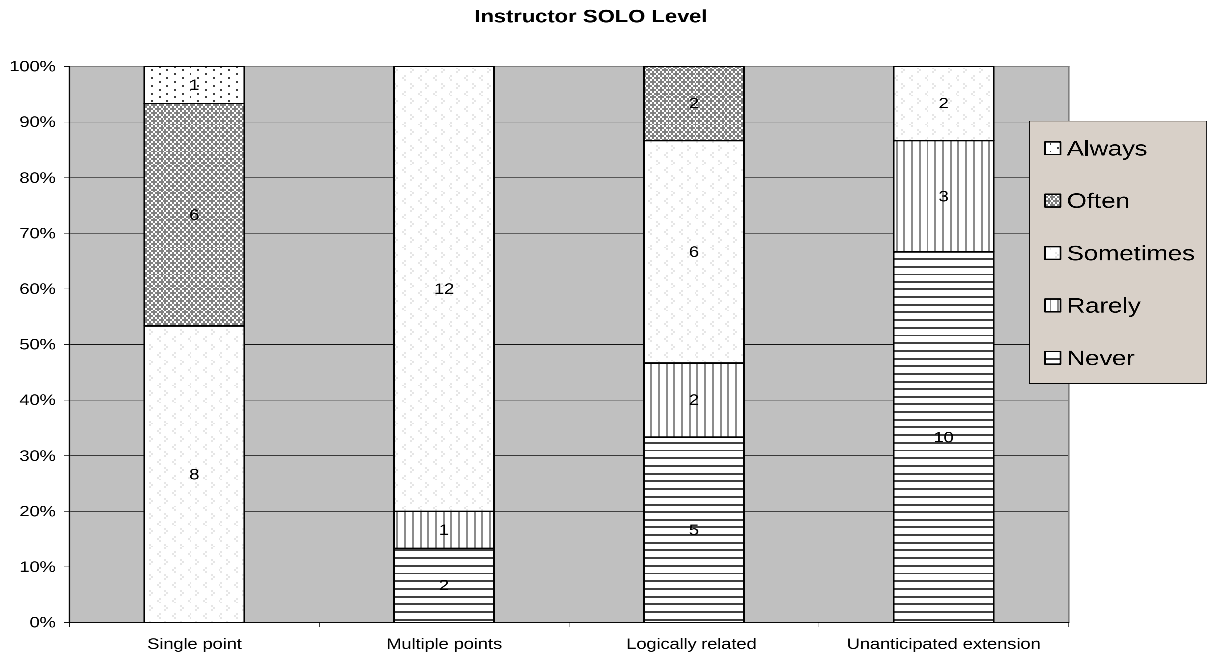


Figure 2: SOLO level of observed teaching

Purpose for technology use.

Using Bruce and Levin's categories for technology use, we found that the observed faculty primarily use technology for communication of information, with fourteen using it 'sometimes,' 'often,' or 'always' during the lesson (Figure 3). One instructor also used the technology for documentary preparation, one for collaborative media, and one for media construction.

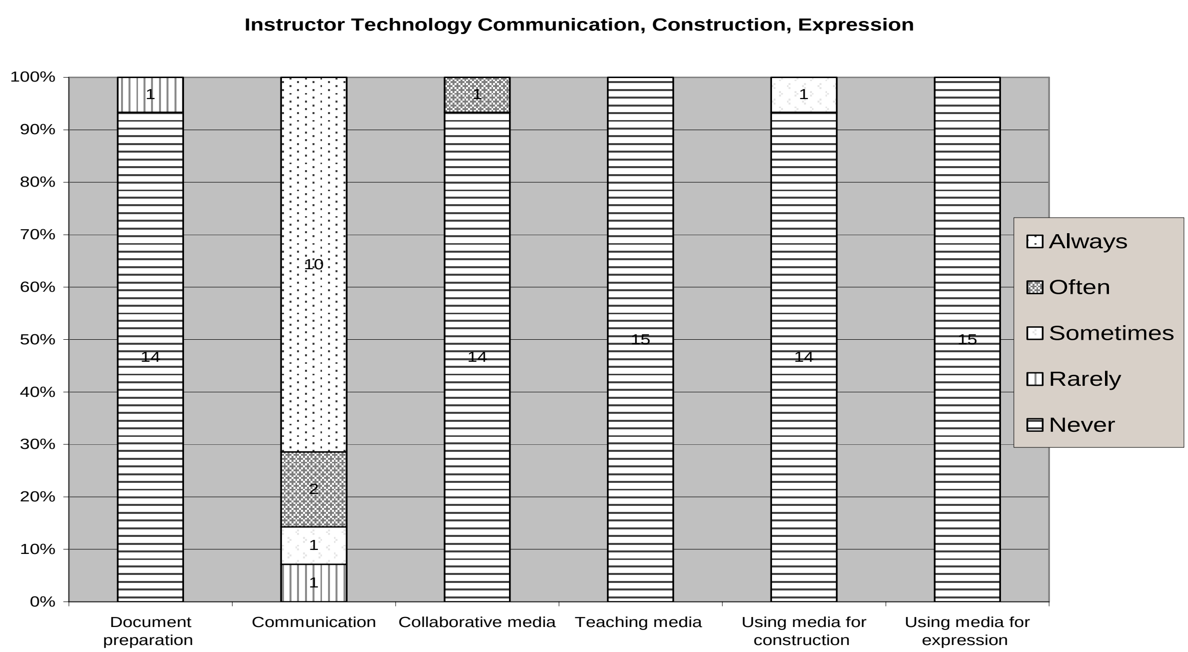


Figure 3: Faculty use of technology media for communication

Some faculty also used the technology for inquiry (Figure 4), with seven faculty ‘sometimes,’ ‘often,’ or ‘always’ using technology to access data from sources. During the lesson, two of the observed faculty used technology for theory building, one for data collection, and two for data analysis.

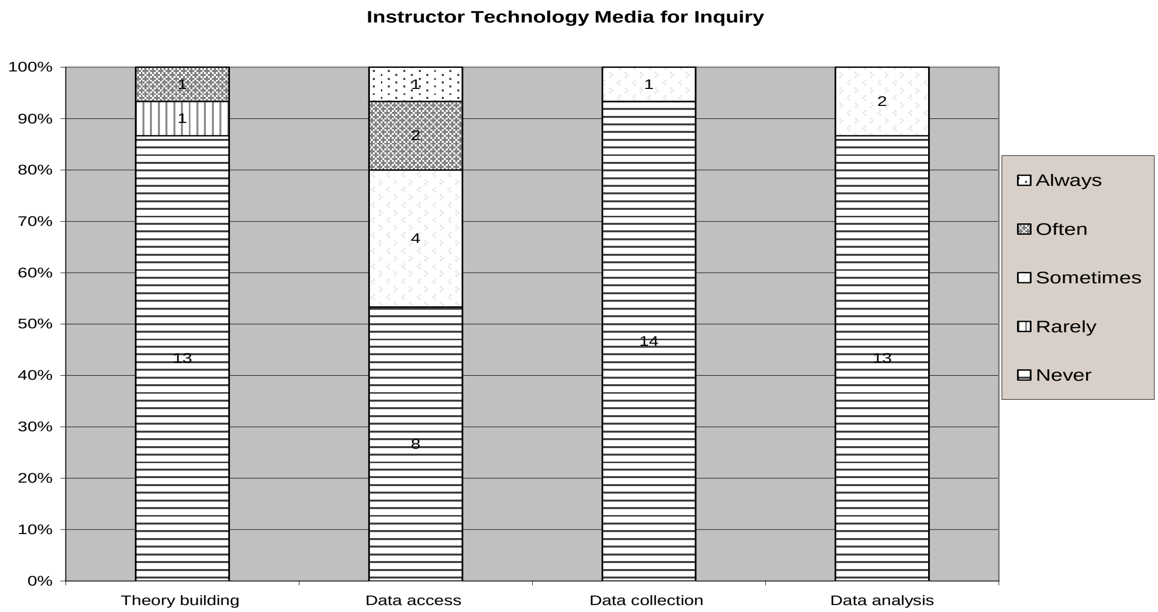


Figure 4: Faculty use of technology media for inquiry

Value of technology.
Typically, technology was viewed as a way to organize teaching and make it easier for students to access materials. Faculty attitudes towards technology use were very positive overall. Their reasons included technology’s making it easier to teach future course sections, increasing the enjoyment of teaching, and renewing enthusiasm for the profession. Some felt that visual aids made their presentations more accurate and enhanced their comfort level in the class. One faculty member noted that pedagogy should drive the use of technology, rather than technology being used for its own sake.

Technology and student learning.
During interviews, faculty articulated the following values of using technology in relationship to student learning in class:

- demonstration and visualization
- seeing applications of theory and learning processes to be applied elsewhere
- accommodating different learning styles
- students can process information because they’re not taking notes
- students have notes and materials before, in, and after class
- information is enhanced and faculty can show students how to get to the material
- students do not have to carry textbooks

Many faculty spoke of the value of having materials online outside the class, so that students could access it "anywhere, anytime, 24/7" (9 of the cases). Faculty cited other roles for technology impacting student learning including increasing student independence, allowing more time for study and homework, keeping students on task, providing immediate feedback on assignments (WebAssign), and providing access to examples and model answers.

Purpose of teaching.
Overall, faculty felt that the purpose of teaching was

- To provide students with materials & information (2 courses)
- To motivate students to learn (3 courses)
- For students to learn the content and/or structure of the discipline (10 courses)
- For students to learn particular processes and skills important to the discipline (5 courses),
- For students to apply course content (3 courses).

Some Findings about Students

Classroom involvement.
Students were passive in ten of the classrooms observed ('sometimes', 'often', or 'always') (Figure 5). Individual tasks were assigned 'sometimes', 'often', or 'always' in nine classes, while group activities only occurred in three classes and pair tasks in one class. Class discussion 'rarely' or 'never' occurred in eleven classes, and 'sometimes' or 'often' in four classes. Similarly, student interaction with the instructor 'rarely' or 'never' occurred in eleven classes. A general observation made by all observers was that most students did not take notes during the lesson.

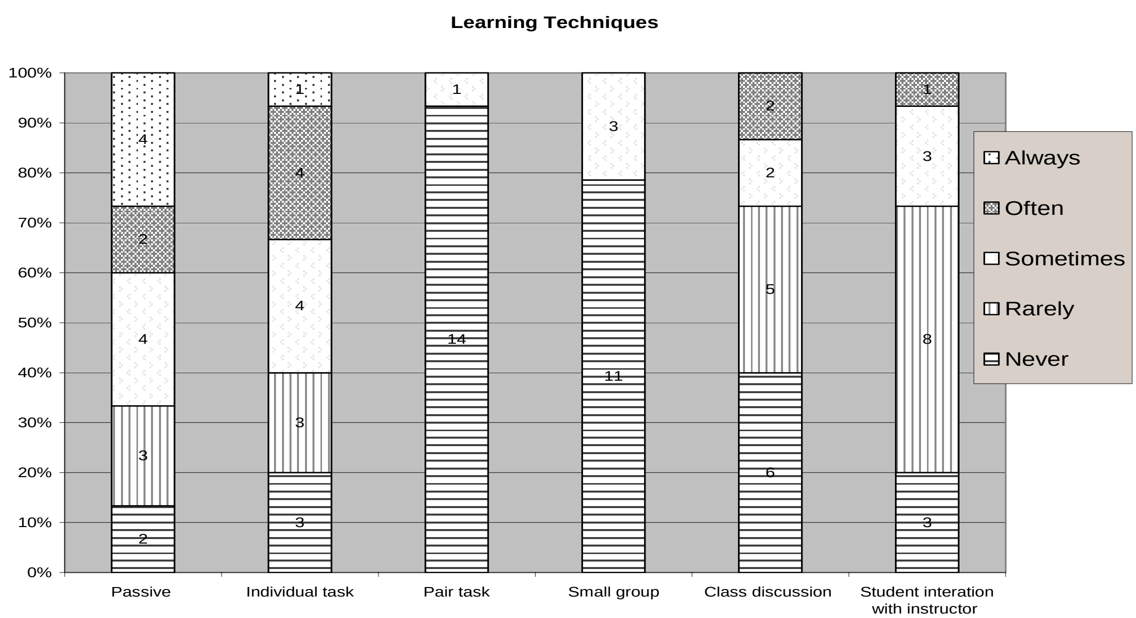


Figure 5: Types of classroom interaction techniques used

SOLO level of classroom activities.

The low levels of student interaction are reflected in the SOLO classification of student engagement (Figure 6). When students were engaged in the lesson, this was most likely at the single point level (7 classes = ‘sometimes’, ‘often’ or ‘always’). Students were ‘sometimes’ engaged at the multiple point level in three classes, ‘sometimes’ or ‘often’ at the logically related level in two classes, and ‘sometimes’ at the unanticipated extension level in two classes. Only three courses were observed in which students used the technology in class, and then it was for communication purposes.

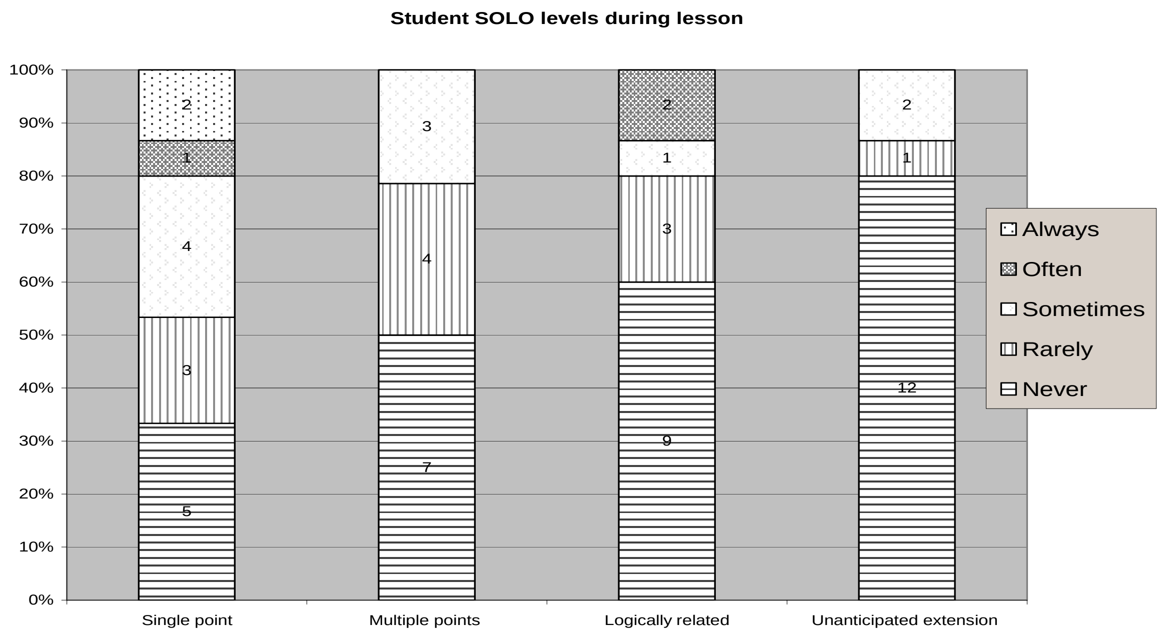


Figure 6: SOLO levels of student engagement during lessons

Some Findings about Assessment

Faculty and assessment.

Interview data showed that faculty had difficulty in identifying learning outcomes, especially when asked to specify a specific learning outcome related to a specific class period which was to be observed. They did not consciously think about the impact of technology on student learning. Many considered the technology of ClassTech rooms as an organizational tool only. Several of the faculty involved also had difficulty identifying the exact student work that showed student learning tied to a specific class period and a specific learning outcome covered in that lesson.

Even with prompting, they did not discuss the relationship of the technology to pedagogy, or the relationship among teaching, assessment, and student learning. They did not articulate that technology is a particular tool for teaching to be used to teach a particular learning outcome(s), and that an assessment task assesses the level of student learning of the stated outcome.

Assessing student learning.

The faculty chose student work so that we could assess students’ performance on the specific outcome related to the observation day and we received student work from thirteen of the study participants. Typically, these were exam or test questions, with only one faculty member assessing student work through their reflective postings on a discussion board. As stated previously, the researchers determined the SOLO level of each outcome specified by the instructors and for the associated student tasks. We determined only the level of the task, not the level of student performance. Many of the outcomes and associated tasks were at several SOLO levels for a single course. We examined the *highest SOLO level* of the outcome and tasks and found the following trends.

As a group, eight out of thirteen had a student outcome for the class at a logically related level, which means that the outcome was related to real life application. In contrast, seven out of thirteen assessed students using a task that was at a single point level, which means that they gave tasks that asked for recall of knowledge and information without reference to context.

SOLO Level	**Level of Learning Outcome** (Identified outcome is related to the observation day)	**Level of Related Assessment Task**
Single point	3	7
Multiple point	2	3
Logically related	8	2
Unanticipated extension	0	1

Table 2: SOLO Levels of Outcomes and Student Work (Reports highest level if more than one level was identified)

Five out of eight instructors, whose outcomes were at the logically related SOLO level, also used technology for data access functions, that is, as media for inquiry.

For individual instructors, seven assessed students at a lower level than their specific instructional outcome, while six assessed at the same level as the instructional outcome. One instructor assessed students at the highest SOLO level (unanticipated extension), where students were expected to critically reflect on scenarios and to apply theory to contexts they might encounter in the future. This instructor set the assessment task at a higher level than the specific class outcomes (multiple point and logically related). She was the only one who assessed at a higher SOLO level than the specified learning outcome.

The research team took the student performance on specific test questions/work and averaged the grades on this work for each SOLO category. In general, the lower the cognitive level of the task, the better the student performance. Across all classes, students performed best on the single point questions and worst on the logically related tasks (Table 3).

The best student performance occurred in the one case of a faculty member using an assessment task classified at the unanticipated extension level. In part this could be attributed to the way in which the lesson was conducted where students were engaged in class through group tasks around higher level outcomes (logically related), and to the nature of the assessment task which was a personal reflection and application on a discussion board (unanticipated extension). In other words, the lesson outcomes, the instructor’s approach to teaching, and the assessment task were at higher SOLO levels.

SOLO categories of student work	Number of courses that had student work related to observation day's outcome at each level	Student's performance on this task level (averaged across tasks/classes)
Single point	8	80.1%
Multiple point	6	71.8%
Logically related	2	57.5%
Unanticipated extension	1	92.5%

Table 3: Assessment of Student Performance
Note: N's more in Table 3 than in Table 2, because Table 2 only included the "highest level" outcomes.

Discussion

Implications for Technology and Infrastructure.
Generally, the technology and equipment provided in the classrooms worked and faculty felt it was important for their teaching. The faculty knew how to use it, even though they sometimes had problems and needed just-in-time help. Since 75% of faculty asked for support or training of some kind, it is essential that support infrastructure be in place to assist instructors when technology does not work. This requires personnel, resources, and a very quick response time. If faculty are not able to get assistance when they need it, they may become less likely to attempt new instructional strategies, including the integration of technology into their teaching.

Equipment must also be balanced with cost. For instance, an in-room computer is provided in ClassTech rooms. Even though most instructors have access to a laptop, and an Internet and a laptop connection are provided in the room, faculty consistently indicated that they preferred the convenience of using the in-room computer. We provided both a transparency projector and a document camera. Clearly, we should migrate to the latter, but there is still some faculty resistance. Similarly, VCRs need to give way to digital equipment and there are resources on campus to assist faculty with this process. Phasing out redundant equipment and reducing the diversity of alternatives will reduce maintenance and replacement costs but may be less convenient.

A critical fact that must be remembered is that the ClassTech classrooms in the study were "traditional" rooms designed for a lecture-based presentation format where there is only one access point to the technology and where student desks are generally arranged in rows. This fosters a one-to-many approach to instruction, particularly in the case of faculty who may not have been exposed to alternative approaches to teaching or newer models of integrating technology. In the cases reported in this study, we have shown that students were generally not actively involved in the classroom processes and that cognitive activities during lessons tended to be at lower levels. In contrast, we have shown in other LITRE project work that when students use technology in the classroom, it impacts their learning in positive ways. Other assessment results showed that when students' learning is actively involved with classroom technology use, five themes emerge:

(a) enriched content led to increased knowledge

(b) visualization of material facilitated student learning of the material

(c) communication/collaboration among peers and experts increased student learning and feedback on that learning

(d) motivation for learning increased with more technology usage

(e) technology stimulated students' engagement with learning material and as a result students learned more (LITRE, 2006).

Additional infrastructure, as well as different pedagogical approaches, may be needed to make this possible in the more traditional ClassTech rooms.

In considering current classroom and technology standards in the university context, we need to approach alternative models of classroom design and find ways to equip classrooms with technology that facilitates a move beyond the one-to-many approach. We advocate an approach to classroom design in which buildings are designed from the inside out using a needs-based approach rather than a formula-based approach (e.g. x number of chairs per x ft^2). This needs-based approach should include a functionality needs assessment, including but not limited to technology needs, at the programming phase. Once we understand the functionality, only then should the infrastructure be determined. Classroom design and technology standards should be driven by sound pedagogical practices and by the expected student learning outcomes rather than by a predetermined format and formula. This consideration is particularly important when examining the integration of new technologies and alternative formats for course delivery, such as online and blended environments. There is a need for flexibility in classroom and technology standards due to changes in technology, modes of delivery, and the integration into proven effective pedagogies.

Implications of Faculty and Student Expectations.
The study data showed that in the current ClassTech classrooms students met faculty expectations (for better or worse) as evidenced by several emerging themes:

- If faculty take total responsibility for producing and distributing class materials and notes, students do not produce their own.
- If faculty replace 'chalk and talk' with 'state the point and click,' students passively listen (or not).
- If faculty expect students to perform at lower SOLO cognitive levels, students will perform at those levels, and the level of faculty performance will cease to matter.
- If the cognitive demand required to use hardcopy materials was the same as dynamic materials, student performance remained the same.

While current students may accept this status, it is questionable how long this will continue, given emerging research data regarding student expectations about their education and the experiences with technology they bring with them to higher education. Research shows that most university students have grown up with technology, spending more time watching TV than they spend in school (Bransford, et al., 2000) and that they bring computer skills to the classroom. Ninety-one percent of American children (3-17 years old) use computers and 65% use the Internet (Burkhardt, et al., 2003; DeBell & Chapman, 2006). This runs alongside reports by technology users that technology diminishes attention, increases the ability to be interrupted, fosters multitasking and dual processing, and increases information overload and pseudo-attention deficit disorder (Hafner, 2005; Turner & Reinsch, 2007). Increasingly, students expect university work to be organized around teamwork, interruptions, deliverables, accelerated communication, and deadlines (Perlow, 1999). Students also expect content mobility, tailored programs, and just-in-time instruction (Berge, 2003), as well as a high level of customer service and convenience (Biggs, 2003; De Alva, 2000). Students see themselves as the client who decides on the value of a program in terms of time-efficiency and cost-effectiveness.

Most faculty in the study perceived that students want access to course materials ‘anywhere, anytime, 24/7’ and met this expectation by providing course documents and PowerPoint presentations online at a class website. Another student expectation is that of ‘edutainment’ and it can be argued that in some cases this expectation was met by faculty in ClassTech rooms using technology as a communication tool to deliver information in more visually enriched ways. However, it is questionable as to whether several of the other emerging student expectations are being met, particularly those geared towards different learning styles, value-added dimensions, customized options, choices, and customer satisfaction. This potential mismatch between student expectations and the traditional one-way mode of instruction is likely to become more important as alternative technologies and modes of course delivery unfold, and might lead students to exercise their consumerism by voting with their feet or their virtual presence.

Implications for Faculty.

As already noted, the technology and classroom structure supports traditional presentation and communication of instructional materials. Research shows that faculty perspectives on the role of technology in education are likely viewed on a continuum from negative (Dumont, 1996; Noble, 1998; Oppenheimer, 1997) to neutral (Clark, 1983; Russell, 1999) to positive (Kozma, 1991; Singh et al., 2005). Overall, faculty in ClassTech rooms noted that the technology was a valuable tool and that technology allows greater coverage and instructional pace (~50%). However, these comments reflect a view of instruction as the mere presentation of known facts, knowledge, and the true state of the world (Petraglia, 1998). The faculty in this study described their purpose for teaching in similar terms, focusing on content, discipline structure and skills needed in the discipline. Only a few mentioned roles that related to students, like encouraging students to apply course content and of motivating students. Technology in and of itself is very unlikely to shift the worldviews of the faculty about the nature and purpose of teaching and learning. Technology is easy to use, but not easy to apply to improving teaching methods or instructional materials (Austin, 2003; Baker & Saltmarch, 2000); and furthermore, faculty use technology in ways that are familiar to them, based on their own experiences as students (Johnson, 1996). We need for faculty to be exposed to alternative models of instruction and technology integration and not just to the technological tools themselves. Otherwise, teachers may “be tempted to use expensive and extraordinarily versatile technological tools in a one-dimensional manner, to imitate and perpetuate and aggravate traditional teaching and learning down to the very last detail” (Peters, 2003). More work is needed to assist faculty in making such pedagogical and philosophical shifts.

Implications for Assessment
The qualitative design of this study yielded very rich, in-depth data about specific classrooms. But, this process is time consuming and demands resources. This assessment process was complimented by university-wide surveys of faculty using ClassTech rooms, which yielded additional data about challenges and technical issues with technology use, patterns of use, views about student learning, and impact on course delivery. These results are reported elsewhere (see ClassTech 2006b). The mixed method approach to assessment enables a fuller understanding of context across a broader range of dimensions.

The study results showed that gathering data on student learning outcomes in relationship to course or lesson goals was difficult because many of the faculty did not understand the nature of this relationship. Learning outcomes were not related to technology use. Many of the faculty selected learning outcomes and assessment tasks at lower cognitive levels. In order to improve assessment processes, we need to foster faculty understanding about the nature of assessment and its relationship to teaching and learning. Technology is one component of a complex environment as evidenced in our framework document (North Martin et al., 2006).

Utilization-focused evaluation (Patton, 1996) stresses that evaluation processes should generate data that will be used to bring about change and improvement. The same is true of assessment data, where data needs to be used to close the loop by making programmatic improvements. To achieve this end, we have carefully and deliberately sought out and identified key stakeholders and included them in ongoing assessment processes. We have also reported findings with implications and recommendations to key decision makers, special interest groups, and other stakeholders. Finally, to increase levels of interest and understanding about assessment practices and its role in improving learning, we have showcased exemplars of good practice and assessment data as the basis for further development.

Finally, assessment inevitably leads to new questions. We have generated several that need further investigation:

- How can presentation software be used in ways that promote higher-level cognitive processing for students?
- What types of technology use and pedagogy best support student learning?
- What results would we find if the study were replicated in classroom where students have access to technology (computer labs, laptops, virtual computing)?
- How would different classroom arrangements/infrastructure impact teaching and learning?
- Can we replicate this approach in assessing teaching and learning in the online environment, in blended courses, or in other physical spaces?

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