Technology-enhanced learning spaces called Active Learning Classrooms (ALCs) have become an important component of the teaching and learning paradigm at the University of Minnesota (see Figure 1). Since August 2007, the research and evaluation team in the University of Minnesota’s Office of Information Technology (OIT) has collaborated with the Office of Classroom Management (OCM) and other units in the university system in ongoing research to assess the extent to which ALCs shape teaching and learning practices, student and instructor perceptions of the educational process, and student learning outcomes.

In 2010, a new Science Teaching and Student Services (STSS) building opened. In 2011, a study was undertaken to investigate the impact of the STSS building and its ALCs on the teaching and learning environment at the university.

Figure 1. ALC at the University of Minnesota
1. Project Overview

1.1. Project Goals, Context, and Design

In fall 2010, the STSS building was opened on the University of Minnesota–Twin Cities campus, giving the university a total of 17 ALCs of various capacities up to 126 seats. In spring 2011, staff from OIT, OCM, the Center for Teaching and Learning, the Office of Measurement Services, and the Office of Institutional Research convened an STSS Research and Assessment Group to investigate the impact of the STSS building on the teaching and learning environment at the university.

In spring 2012, the group undertook a study of faculty and student responses to ALCs. The group used large-scale surveys of students and faculty, along with systematic class observations and focus groups, to assess perceptions of classes taught in the ALCs. In part, this work was inspired by research conducted at Stanford University that uncovered a systematic divergence in instructor and student perceptions of ALCs. In particular, Stanford researchers found that instructors reported significantly more frequent use of innovative instructional methods and classroom technology than students did, and faculty also reported significantly greater utility of the ALCs in promoting student engagement in the learning process.

Two central research questions guided this study:

- Do student and faculty perceptions of classes held in the ALCs differ systematically with respect to:
  - the quality of the student learning experience, including engagement, enrichment, effectiveness, flexibility, and fit;
  - the contribution of the ALCs to student attainment of institutional learning outcomes; and
  - the frequency with which various types of learning activities occurred in class?

- Do the results of class observations of in-class learning activities align with student and faculty perceptions of those activities?

1.2. Data-Collection Methods

Data in this study were collected by means of four methods: a student survey, a faculty survey, a class observation protocol, and student and faculty focus groups. (Surveys and protocols are available at http://www.oit.umn.edu/research-evaluation/selected-research/learning-environments/index.htm).

**Student Survey:** The student survey was administered to students in 22 classes taught in ALCs in spring 2012. The instructors of those classes responded to a call for participation in the study sent out in January 2012, and the sample of classes was reasonably representative of all classes taught in ALCs during spring 2012 with respect to class size, academic department, and class level. The survey was given to students in class near the end of term with the cooperation of the instructor. Virtually all students agreed to complete the survey, resulting in a response rate of nearly 100% (N = 723).

The student survey contained one set of questions designed to measure student engagement in the learning process, enrichment of the learning experience, effectiveness of instructor use of the classroom, flexibility of the learning space, and fit between course and classroom. These dimensions were identified via factor analysis, met the criteria for construct validity, and were highly scale-reliable (Cronbach’s α > .85 for each of the dimensions).
Another set of questions arose from the fact that, anecdotally, both faculty and students tend to find ALC-type rooms disorienting when they first encounter them. Three questions were developed to measure this disorientation, specifically asking about the degree to which it was easy or difficult for students in ALCs to focus on a source of information, to follow what was going on in class, and to identify who was speaking.

A third set of questions in the student survey addressed the University of Minnesota’s Student Learning Outcomes (SLOs). These questions were selected by an intensive student-driven process of mapping the SLOs to items found on the National Survey of Student Engagement (http://www.nsse.iub.edu/) and on the Student Experience in the Research University (http://www.seru.umn.edu/) questionnaires.

A final group of questions focused on the frequency with which various types of in-class learning activities occurred during the semester, including small-group activities, instructor consultation, display of student work, and use of learning technologies. These questions were developed by the research committee to dovetail with similar questions on the faculty survey and observation protocol.

In total, students were asked to answer 57 questions and to supply their student ID numbers so that cross-sectional analyses could be performed based on demographic data.

**Faculty Survey:** A questionnaire that paralleled the student survey was given to the instructors of the 22 classes involved in this study. The questions mirrored those on the student instrument, with only slight differences in wording to reflect the faculty role.

**Classroom Observation Protocol:** The instructors of four classes volunteered to allow a researcher to visit a randomly selected third of their class meetings and observe the class unobtrusively. A form was developed for use in these observations that measured 17 variables at 5-minute intervals throughout each class period. A team of four researchers produced the form, validated it through extensive iterative testing and discussion, and strengthened reliability by observing and rating a videotaped class and resolving any disagreements in the ratings. By the end of the development process, the team achieved 88.89 percent overall agreement and an overall free marginal kappa of 0.78, indicating what is often termed a “substantial” level of agreement among raters.3

**Student and Faculty Focus Groups:** Qualitative exploration of the survey results was conducted through focus groups that were held in summer 2012. One group involved seven students who took a class in an STSS ALC in spring 2012; the other group involved eight faculty members who taught such classes. A semi-structured protocol was developed for the groups by examining survey data and identifying issues that called for further investigation.

### 1.3. Data-Analysis Methods

Quantitative data analysis was performed using SPSS and STATA software. An external validity check was run for both the student and faculty samples by comparing each sample to a database of students and faculty at the University of Minnesota to ensure that the samples were representative of the larger populations on all available demographic variables (e.g., age, year in school, sex, ethnicity).

**Within-group analyses included:**

- Descriptive statistics, to examine central tendency and variability for all dependent variables
- Cross-sectional analyses using appropriate parametric and non-parametric tests, to investigate potential differences between subgroups (such as men vs. women; high-performing vs. lower-performing students; older vs. younger faculty) in their perceptions of and reactions to the ALCs
Between-group analyses included:

- Difference-of-means tests, to locate variables on which student, faculty, and observed responses diverged significantly
- Multivariate modeling, to understand the influence of different sets of predictor variables on outcomes

1.4. Findings

Early pilot-stage research in fall 2007 and spring 2008 showed that faculty and students had a generally favorable reaction to the ALCs, which were seen as enhancing the overall student learning experience and reducing the psychological distance between instructor and students and among students. Three more rigorous studies conducted between fall 2008 and spring 2011 found that the ALCs enhanced students’ academic engagement and had a positive effect on learning outcomes.

The current research confirmed the overall positive response to the ALCs from faculty and students and found that faculty members responded even more positively to the ALCs than students did.

Faculty-Student Comparisons

Theoretical Variables: When the aggregated dimensions of engagement, enrichment, flexibility, effective use, and course-room fit were examined, faculty ratings were higher on 4 out of the 5 dimensions, and approximately equal on the fifth (see Figure 2). The effect sizes were small to moderate, ranging from miniscule to about one-half of a standard deviation.  

![Figure 2. Faculty and Student Perceptions of Five Variables](image)

Attentional Variables: Both faculty and students were sanguine about students’ ability to focus on/identify/follow what is happening in class, as can be seen from the fact that all of the ratings given to this set of items were around 4 on a 5-point scale. Further, faculty and students were in approximate agreement regarding students’ ability to focus successfully on who is speaking and what is happening in class.
The attentional variables were also measured in one large non-ALC class. One point of interest that arises from comparing ALC and non-ALC responses is the similarity of scores between ALC and non-ALC students (see Figure 3). The non-ALC numbers are higher but not by much. (Because the surveys were administered in only one non-ALC class, the comparison between responses from the ALC faculty and the single non-ALC faculty member is suggestive but not definitive.)

Figure 3. Comparison of ALC and Non-ALC Classes

Learning Activities: Faculty reported higher frequencies than students for only 4 out of 11 items, which represented a reversal of the Stanford pattern, in which faculty reported greater frequency of every activity variable (more frequent use of technology, active learning techniques, etc.). The four variables on which faculty reported higher frequencies were medium-sized groups; consulting with groups of students; students as teachers; and playing media with sound.

Student Learning Outcomes: Faculty reported higher/more positive scores for 5 out of 12 items. There was no obvious pattern to the responses.

Student Demographics: We sought to see if the above relationships between faculty and student responses hold across demographic differences in the student sample. The main conclusion here is that of all the variables tested, none makes a difference to student reactions to the ALCs. Students respond positively to the ALCs (but not quite as positively as faculty members) regardless of whether they have prior experience and irrespective of gender and age.
Science versus Non-Science Classes

Different types of classes were distinguished and compared in order to determine whether the relationships between faculty and student responses to ALCs held in science as well as in non-science courses. For the purposes of this analysis, classes were categorized as “science” if the subject matter was biology, chemistry, statistics, genetics, industrial engineering, microbiology, anatomy, or measurement/data analysis. A number of interesting differences were found. In general, science faculty were noticeably more enthusiastic about the ALCs than either their students or their non-science faculty colleagues.

Theoretical Variables: Regarding these variables, science faculty were much more positive about the ALCs than their students, while non-science faculty and students were about equally positive (see Figure 4). Non-science faculty reported higher/more positive scores for 10 out of 23 items and higher ratings on 3 out of 6 of the aggregated dimensions. Science faculty reported higher/more positive scores for 21 out of 23 items and higher ratings on 6 out of 6 of the aggregated dimensions.

Figure 4. Comparison of Science and Non-Science Classes

This pattern seems to have more to do with differences in how science and non-science faculty rated the learning experience in ALCs than with differences in the ratings of science and non-science students. The differences between student ratings are small; the differences between faculty ratings are large and consistent.

Attentional Variables: This pattern held for the three variables that had to do with the ability to focus successfully on who is speaking and what is happening in class. Science faculty were more sanguine than their students about students’ ability to focus on/identify/follow what is happening in class, while non-science faculty were less confident than their students on this score (see Figure 5). And again, students in both types of class gave similar responses to these items, whereas science faculty gave substantially higher ratings than non-science faculty.
Student Learning Outcomes: Non-science faculty reported higher/more positive scores than their students for 1 out of 12 items; science faculty, for 10 out of 12. Once more, science faculty see the ALCs in a more positive light than either their own students or their non-science colleagues do—in particular, the extent to which the ALCs contribute to their students’ achieving the SLOs.

Conclusion: This is a conspicuous pattern that calls for explanation. One idea is that the strongly positive reactions of science faculty to the ALCs have to do with the aspirations of many science instructors to teach differently and to help their students achieve learning goals that go beyond the stereotyped learning of facts. These faculty members may see the potential of ALCs to help their students learn to think like scientists and bring creativity to scientific inquiry.

Student, Faculty, and Observational Data

The frequencies of a total of eight types of teaching-learning activities were observed in selected ALC classes, as described in “Data-Collection Methods” above:

- Small-sized group work
- Medium-sized group work
- Display of student work to the class
- Faculty consultation with groups of students
- Students acting as teachers to other students
- Accessing a course management system
- Accessing social media
- Accessing general Internet resources

Students and faculty members were also asked to estimate the frequency of these activities on the surveys using an 8-point scale (1 = never, 8 = more than once per class). A comparison of mean student,
faculty, and observed scores for each of these variables yielded no overall patterns that distinguish the three data sources. However, several other regularities were evident in the data.

First, across all ALC classes observed, faculty and students were fairly accurate reporters of the frequency with which active learning activities occurred in their classes. Regarding most of the measured variables, the quantities reported by faculty and students were within one point of the observed quantity on an 8-point measurement scale.

The main exception to this pattern was the item that asked about “display of student work to the class.” In this case, the observed frequency was substantially higher than what either faculty or students reported.

**Conclusion:** It is possible that this disparity is due to differential understanding of the measured quantity. Class observers debated the meaning and criteria for application of this item, deciding, for instance, that it would apply any time student work was visible to the whole class, whether or not the class’s attention was called to that work by the professor. While this consensus provided reliability within the observations, it may not have accorded with the way in which students and faculty understood this variable.

Second, with respect to the group-involving variables, the observed frequencies of the activities were as high or higher than either faculty or students reported. (This includes all types of student group work, the display of student work to the class, and instructor consultations with groups of students. The small-group item fits this pattern only moderately well—the observed quantity is very slightly below the quantity students reported—but it is close.)

**Conclusion:** If the observations are accurate, faculty and students tend to under-report the frequency of these activities and in general do not over-report active learning in ALCs.

Third, regarding the use of the Internet in class, students consistently reported higher frequencies than faculty did, or than were observed, whether this involved using a course management system, social media, or just general Internet searching (see Figure 6). Since this was true across classes, and because this sort of activity was difficult for instructors or observers to discern, it is likely that students were correct and they were actually using the Internet in class more than faculty believed.

**Figure 6. Comparison of Observed and Self-Reported Data**
Conclusion: Overall, one could draw the methodological conclusion that if you want to know how often certain student-centered teaching/learning activities occur in ALCs, you could ask either students or faculty and have confidence that the responses you receive will be fairly accurate, perhaps slightly underestimating the frequency of those activities.

Fourth, examining just the observational data, active learning was common in all of the observed ALC classes. To be more precise, the vast majority of the activities operationalized in the active learning variables that were examined occurred with moderately high frequency in the ALCs, at the “two or three times per month” level or more frequently. This included

- all types of student group work,
- the display of student work to the class,
- instructor consultations with groups of students,
- students accessing the Internet for class purposes, and
- students acting as instructors to one another during class.

By contrast, in the one lecture-hall class that was observed, no instances were recorded of any of these active learning activities except for small-group work and instructor consultations—and those occurred at levels equal to or lower than the ALC average (see Figure 7).

Conclusion: In general, faculty appear to be using the ALCs in ways that are consistent with their design and purpose.

Figure 7. Frequency of Active Learning, ALC and Non-ALC Classes
1.5. Communication of Results

The results of this study will be communicated to faculty and administrators on the University of Minnesota campus through presentations to a variety of governing committees. They will also be disseminated through scholarly channels such as conference presentations and journal articles. Finally, the findings from this study will form a key part of the curriculum of OIT’s faculty development efforts surrounding the ALCs, in particular a semester-long faculty development and research program focused on active learning pedagogy and spaces, which began in fall 2012.

2. Reflection on Design, Methodology, and Effectiveness

2.1. Project Design, Data Collection, and Analysis

This project’s design was strong inasmuch as it gathered data about the same phenomena (teaching and learning practices in ALCs) from three independent sources (students, faculty, and class observations), providing the basis for analysis of what is actually going on in these classrooms. The design also produced data about the effectiveness of ALCs in promoting desired outcomes from two independent sources (students and faculty), permitting comparisons between the faculty and student perspectives.

These advantages came at a cost, however. Designing an observation protocol and two surveys that measure the same phenomena and that yield data that can be compared meaningfully is difficult and time-consuming. Simply defining “active learning” or “student-centered learning” in ways that can be both observed and investigated through surveys is surprisingly difficult. Further, in this project the research team subjected the observation form to an intensive series of iterative revisions, yet despite this it is possible that faculty, students, and researchers understood certain key terms in different ways (see the discussion of “display of student work” above).

Nonetheless, the triangulation procedure appears to have worked well overall. Methodologically, this study provides some evidence that faculty and students can simply be asked about the frequency with which certain active learning techniques occurred in a given class, and their answers are likely to be fairly accurate. (An exception to this recommendation is student use of Internet-based materials, as noted above.)

As with any survey-based study, measurement issues are a possible source of concern. For example, while the student survey was tested extensively for validity and reliability, insufficient numbers of faculty members had taken the parallel faculty survey prior to this study to make a similar analysis possible. Factor analysis will be completed once faculty responses have been received.

2.2. Effectiveness and Influence on Campus Practices

Whether this study will have a direct influence on strategic directions, funding priorities, tactical planning, and staffing allocation at the university remains to be seen. The fact that the STSS was constructed in the first place underscores the commitment to ALCs, and it is likely that ALCs will continue to play a vital role in teaching and learning practice at the university.

3. Supporting Materials

See the survey instruments and related material at http://www.oit.umn.edu/research-evaluation/selected-research/learning-environments/index.htm.
Notes

1. See http://www.slo.umn.edu/.

2. Not all enrolled students were present in the classes in which the survey was delivered, but because the survey was not announced in advance, their absence can be safely assumed to be random with respect to the goals of the survey. Therefore, we consider that non-response bias was not an issue in this study.

3. For further information, see http://en.wikipedia.org/wiki/Cohen%27s_kappa.

4. Due to low faculty $N$ and low variability among the ratings, very few of the differences found in this research rose to conventional levels of statistical significance. This report therefore focuses on patterns in the response set and the effect sizes of any differences that were located.