

# Instructor Attitudes within the SCALE Efficiency Projects

## By Lanny Arvan and Diane Musumeci

### 1. Introduction

The SCALE Efficiency projects began in fall 1997 and have been ongoing since then. An explanation of how these projects came about was presented at the Third International ALN conference. See <http://www.aln.org/conf97/slide/arvan/arvan/index.htm>. The SCALE evaluation team performed an independent evaluation of the costs and learning outcomes associated with this first semester of the Efficiencies Projects. The results were published in the Journal of ALN. See [http://www.aln.org/alnweb/journal/vol2\\_issue2/arvan2.htm](http://www.aln.org/alnweb/journal/vol2_issue2/arvan2.htm). Below, we summarize some of the major points from these sources.

The Efficiencies Projects started in the third year of the SCALE grant. There already had been substantial ALN activity at UIUC. (In fall 1997, SCALE supported more than 7000 students in over 70 courses.) SCALE had promised at the outset of its initial grant, that ALN would produce efficiencies in instruction in a variety of dimensions, including increased retention, decreased time to degree, and lower cost of instruction. But progress on this was slow and indeed many instructors reported that while ALN teaching was rewarding in that it entailed more interactions with students (who were otherwise quite reserved in class) these instructors reported spending more time in their teaching. Frank Mayadas was disappointed with the pace at which SCALE was producing results. To counter this, SCALE came up with the Efficiency Projects.

The efficiency projects covered only a small number of courses – most SCALE-supported courses were not involved and SCALE continued its job of promoting ALN on the UIUC campus. However, each Efficiency Project was in a high-enrollment course. Indeed, the total number of students involved in the first set of Efficiency Projects was in the thousands. In many of these high-enrollment courses, graduate students do a significant amount of the instruction. In the JALN paper, we made a point of differentiating the productivity gains based on whether it was faculty productivity that was increasing or graduate student productivity that was increasing. Several of these courses also relied on undergraduate peer tutors. This is a way to maintain a substantial amount of human contact in a high enrollment course (something that is often lacking in the traditional approach) without incurring big cost increases from doing so.

In almost all of the Efficiency Projects, some form of automated, Web-based quizzing and grading software was used. There were two packages developed on the UIUC campus, CyberProf and Mallard. One course used the commercial package, WebCT, instead. Students were generally found to like learning this way. They liked the quick feedback, the ability to re-try quizzes for credit, and the ability to the work on their own time. There were some problems due to server congestion, hints in the quizzes that were not sufficiently intelligible to the students, and disdain for multiple choice questions where students could guess the right answer without understanding why the answer was right.

Most of the Efficiency Projects retained a face-to-face component to the course. However, two of the projects, advanced Organic Chemistry for non-majors, and Differential Equations taught with Mathematica, entirely abandoned the lecture component. An interesting side feature of both of these courses is that they ran afoul of the traditional course calendar. The instructor of the chemistry course, which was offered only in the fall semester, allowed the

students to start on the course in the summer. (Indeed, in subsequent offerings she has pushed up the starting date so that the students could do the necessary catch up work at their leisure.) The differential equations course, offered during the spring, was comprised in large part by students who had dropped out of traditional sections of the course and preferred to take a stab at the ALN version, rather than take the course during the subsequent year. The ALN version allowed these students to take the course in self-paced mode, as would the distance learning students enrolled in the NetMath program. Most of these students did complete the course, but not till several weeks into the summer term.

It is noteworthy that in most, if not all, of the Efficiency Projects, the students are taking these courses because they are required, but with no intention of majoring in the subject. It seems that a critical component in determining the faculty satisfaction when teaching these course is whether the instructors come to grips with the student motivation for being in the course.

Based in large part on the success of the original Efficiency Projects, the SCALE grant was renewed in the summer of 1998. The renewal was for another two years. There were six Efficiency Projects featured in the renewal proposal. Some of these were expansions and continuations of the projects started in fall '97. One of these (Physics) was an entirely new project. A few of the original Efficiency Projects were not included in the renewal grant because these course already had achieved a certain maturity and it did not appear that they would produce further gains that warranted additional funding.

Those that SCALE has supported in the renewal are:

- The Spanish Project: This was the most ambitious project. The project director is Professor Musumeci and in some sense represented the next logical step in ALN course development for her. She had first developed her own ALN approach in the introductory Italian sequence. Then she spearheaded the development of ALN in a Spanish grammar course, Span 210, an intermediate course that was one of the first SCALE Efficiency Projects. This project was able to achieve a doubling of the enrollments (there was enough pent up demand for this) without an increase in the number of course staff. Professor Musumeci encouraged the course coordinator, Professor Escobar, to adopt an approach similar to the one in the Italian sequence. As it turned out, this was to good effect. Based on Professor Musumeci's learning of how to use ALN appropriately in that grammar course, the introductory Spanish sequence, which has quite high enrollments and which experiences enormous excess demand, was also redesigned for ALN, to achieve a doubling of enrollments.
- Microbiology: This has also been an ambitious project. Bio 122 had been one of the original courses supported by SCALE in fall 1995. The project director, Professor Deanna Raineri, has designed a huge amount of very high quality Web-based materials for the course. CyberProf is used extensively. Initially this was for student self-assessment. Now it is for course credit. There were also extensive animations, created in Director and now viewable (with a plug-in) through the browser. These have helped enormously to illustrate complex dynamic microbiological processes, something that textbook presentation simply can't do. The purpose of this project was to introduce virtual labs into part of the course. This to achieve the following learning purpose. Because of the high enrollment in the course, students have limited time in the lab (three hours a week). Some of the labs require such extensive setup, that the students barely have time to do the data analysis from the experiment they have performed. Moreover, because the students are unable to repeat the experiment several times, they don't get to see the variation in experimental outcomes. Virtual labs allow for repeated trials and give the student the chance to do the data analysis more carefully.

Virtual labs economize both on expensive reagents and on graduate assistant time as the graduate assistants need neither supervise the students nor grade the lab homework.

- Economics: There are two distinct courses covered in this project. Professor Larry DeBrock, who teaches Microeconomics Principles, was one of the original SCALE grantees. After trying an alternative approach that relied on commercial software used in the basic Agricultural Economics course, Professor DeBrock put publisher-owned quiz material into Mallard and developed a very-extensive data base of questions of questions for this purpose. He also had his graduate assistants offer online help through an internally developed Web-based conferencing program. Initially those graduate assistants also met the students in recitation section for standard face-to-face meetings. Ultimately, that was dropped, (though face-to-face office hours were retained). Under the original SCALE grant DeBrock had both ALN and traditional sections in his course (all students attended his large lecture) and he was able to make performance comparisons between these students. In the renewal grant, DeBrock went to full-bore ALN implementation. The ALN TAs cover more students than do the traditional TAs, so this move has had efficiency associated with it. The other course is Econ 173, Economic Statistics II. Professor Pin Ng, after having spent a year apprenticing with Professor Lanny Arvan in teaching Intermediate Microeconomics with ALN using Mallard and FirstClass, introduced ALN into the Economic Statistics course. He authored exercises where Mallard was integrated with Excel. Mallard would randomly choose among a set of pre-selected data sets. Students would then run Excel to compute various statistics. And then report the appropriated ones in Mallard for grading. Professor Ng also made extensive use of WebBoard, to give students rapid feedback. By melding this ALN approach with a movement from a straight lecture to a lecture-discussion mode, the combination has been able to substantially reduce the number of graduate assistants.
- Mathematics: The original idea behind the project was that the NetMath approach, which has been successfully used for teaching off-campus students, could also be profitably be used by some subset of engineering students. These students take a high number of credit hours and would benefit from having a self-paced version of Differential Equations. A further thought is that the Calculus and Mathematica approach to the subject is alien to the instructors in the College of Engineering who advise the students in what they should take. As a result, these engineering students are disproportionately steered into the traditional sequence. Thus the ALN version of the course would focus on recruiting students who had dropped out of the traditional sequence and see if the ALN approach would be palatable to them. In the renewal grant, funding was given to increase the size of the ALN version of Differential Equations and then to expand the approach into the course on Matrix Algebra.
- Chemistry: Chemistry 102, the second course in the introductory chemistry sequence, was one of the original SCALE projects. It relied on quizzes written in CyberProf. Ultimately, the approach spread to many of the introductory Chemistry courses. In fall 1997, these courses became part of the SCALE Efficiency Projects. Because graduate assistants were relieved from a substantial grading burden, some of them were given additional sections to teach. That implementation suffered from severe server problems and much that been intended had to be scrapped. Under the renewal grant, the idea was to develop a successful implementation and expand the approach to the entire introductory sequence.
- Physics: In all the other projects, efficiency has been considered from the point of view increasing student/instructor ratios. This project, however, focuses on the retention problem in the engineering-physics sequence. Upwards of 20% of the students in the first calculus-

based course earn D's or E's and must repeat the course. The idea behind the project is to use ALN to achieve targeted intervention for those students who seem most at risk. Students are invited into a one-credit course based on performance on an exam offered to all first-year engineering students. Enrollment is voluntary. ALN is used for the students to get additional practice at problem solving that requires conceptual understanding. There are also face-to-face sessions where more problems are worked. These maintain a low student/TA ratio, so that those students who are struggling can get needed attention.

## 2. Rationale

While these Efficiency Projects have obviously been encouraged by Sloan Foundation dollars, each was selected on the basis of aiming to resolve some issue within the unit, the campus or, in the case of the Spanish Project, across the nation. These issues are not at first blush directly related to ALN. A list of these factors follows:

- The Spanish Project: For some time, the campus has experienced a chronic excess demand problem for the introductory Spanish courses. Indeed, this excess demand is a problem at many major universities around the country. Most of the teaching in these introductory courses is by graduate assistants. The number of these students is determined in part by the ability of the faculty to offer a quality graduate program and in part by the ability for these students to find decent jobs upon graduation. On the UIUC campus, there have been other attempts at trying to resolve this problem. They have failed. The campus senate recently passed a language requirement that all students would have to satisfy. (Previously there was a language requirement only for students in the colleges of Liberal Arts and Sciences and Business Administration.) The campus administration, anticipating further increased demand in Spanish as a result of this new requirement, was willing to invest significantly to resolve the problem. Given the concomitant developments with ALN on campus, it was determined that an ALN approach would be best to handle the problem. The plan, currently underway, is to hire some new course coordinators, adjunct faculty, whose sole province would be these introductory courses. What has been accomplished to date has been with other faculty for whom the introductory sequence is not their long-term charge.
- Microbiology: The primary rationale for this project was pedagogic. The labs in their traditional setup were not achieving the purpose for which they were designed. A secondary rationale is that the graduate students in this department have done too much teaching in the past and this would be a way to reduce their load. In this particular case, no new hires are involved in the project. As it turns out, the approach might allow the department to better confront some recent turnover it has experienced.
- Economics: The project was motivated by two interrelated factors. First, the placements of the Economics department's Ph.D. candidates have not been of the quality that college and the campus would prefer. To upgrade the quality of the program, it was determined that the graduate program should downsize. Second, it has been increasingly difficult for the department to recruit students into the doctoral program, especially those of whom the department feels comfortable putting into the classroom. The Microeconomic Principles course director is a long-standing faculty member in the department. The course coordinator for the Economics Statistics course, a recent adjunct faculty hire, was commissioned specifically to implement an ALN approach into that course.

- **Mathematics:** This project was also motivated by two factors. First, the department already had a distance learning program in place in the learning style known as Calculus and Mathematica. It seemed obvious that the distance learning approach would have appeal to some of the on-campus students, since in the on-campus approach to the material some of the students rarely, if ever, came to class. Second, it was apparent that some engineering students, especially those taking a high number of credit hours, would benefit from taking their non-engineering required courses taught in self-paced mode. Given that Math was already doing this as a distance learning activity, the approach here only entailed hiring additional undergraduate students who serve as graders and mentors.
- **Chemistry:** The rationale for this program was primarily pedagogic. The sequence has had some form of computer aided instruction since the Plato days. There has also been a need to lessen the graduate assistant teaching burden, to keep the Ph.D. program competitive. Many of the instructors in this sequence are relatively new and there has been high turnover historically. Some of these instructors are adjuncts.
- **Physics:** This project is distinct from the others both in the way efficiencies are to be obtained and in the underlying rationale. The project is motivated by a desire to overcome deficiencies in the secondary education of some of the students, in general, and to encourage more minority students to major in engineering courses, in particular. The staffing of the course has come exclusively from those who are also involved in the introductory engineering-physics sequence.

### **3. Background Information for the SCALE Efficiency Projects**

The Efficiency Projects were constructed either from already mature ALN course development by faculty who had been at it when SCALE started (or in some cases before SCALE came into existence) or from faculty who served in an apprentice relationship with others who had extensive ALN development. In no cases did we “start from scratch” and attempt to produce an ALN course that immediately delivered some kind of efficiency outcome. It should be emphasized that many of the instructors in these courses are graduate assistants and for all intents and purposes they can be viewed as transients to ALN teaching. In our data gathering, we tried to be sensitive to their perceptions as well as to the perceptions of the course coordinators.

All of the Efficiency Projects were in high-enrollment courses. This is an important point to consider in its own right. There are relatively few high-enrollment courses. Many of the faculty don't have experience teaching such courses. And of these it seems reasonable to conjecture that most don't desire to teach such a course. High-enrollment courses are likely to entail less personal interaction with the students and much more administrative overhead in the form of supervising teaching assistants and dealing with student complaints. To avoid the apples and oranges comparison of ALN in high enrollment courses versus traditional teaching in a seminar like environment, we think the right benchmark for comparison is the same course prior to ALN, not traditional teaching in general. The question to be addressed by looking at the data on faculty satisfaction is whether conversion of such high enrollment courses to an ALN approach can ultimately be implemented willingly by the participants. A related question, relevant for the Efficiencies Projects in particular is whether the cost savings that have been identified are real or if instead there are hidden subsidies in terms of increased effort from the course coordinators that produce apparent cost savings on paper. If those subsidies exist, they should show up in the satisfaction data.

The Spanish Project, Economics, and Mathematics use the software Mallard, developed at UIUC by Professor Donna Brown in the department of Electrical and Computer Engineering. SCALE has a staff person with title “Mallard Administrator” who assists faculty in the design of their Mallard-based materials and who also performs a lot of trouble-shooting functions. SCALE sub-contracts out for the administration of the Mallard server from the campus computer support organization. The Mallard Administrator manages that relationship. This service is provided for all instructors who use Mallard, not just those involved in the SCALE Efficiencies Projects.

The Spanish Project and Economics also use some dedicated conferencing software, either FirstClass or WebBoard. SCALE administers the servers for these products, creates class conferences and student accounts, and provides training for new faculty users and for students. Again, this is a service that SCALE provides for all campus users. In the case of the Spanish project, SCALE took the exceptional step of creating a FirstClass server dedicated exclusively to Spanish and Italian. This allowed SCALE to give the instructors administrative access to the server without compromising the privacy of other instructors and courses.

Several of the projects administered software themselves within their own units. Both Microbiology and Chemistry use CyberProf (which has a built in conferencing component) and while SCALE has had a hand in the administering of the large Solaris server that the campus has purchased to support both CyberProf and Mallard, SCALE has had no direct involvement in the CyberProf support. Mathematics relies on email and telephone for communication between students and mentors and provides its own support for Mathematica and the support of the software used to upload Mathematica notebooks that students submit for grading. This is the same software utilized for both their on-campus operation and their distance learning program. Similarly, Physics offers extensive support of its own software, which it has developed in house.

Other demographic information specific to each project follows.

- The Spanish Project: Diane Musumeci, an Associate Professor of Italian, is the project director. Diane has won numerous teaching awards on campus. Indeed, we consider Diane to be a SCALE early adopter. These early adopter faculty are disproportionately in the category of instructors who have exceptional aptitude for teaching. Diane started with ALN in the 1996-97 academic year after having received strong encouragement from Burks Oakley. Diane had workbook exercises she had designed in Microsoft Word that she had previously distributed to the students in paper form. She was able to port those exercises to Mallard. Prior to that Diane had no experience with using computers for instruction. (The technology emphasis among those teaching language acquisition was on television and tapes for listening.) In 1997, Diane recruited Anna Maria Escobar, who had just gotten tenure, for the Spanish 210 project. Anna Maria had no experience teaching with ALN and indeed could be characterized as a computer novice at that time. The success of the Spanish 210 project was pivotal in getting the larger Spanish project underway. The fact that Professor Escobar was the course coordinator gave credence to the idea that the good outcome was attributable to the underlying approach rather than to Herculean efforts and special talents of the instructor. For the big Spanish Project itself, Professor Musumeci partnered extensively with Giuli Dussias, the director of the introductory Spanish sequence and an Assistant Professor in the department. While Giuli was an attendee of a Faculty Summer Institute in 1996 that exposed attendees to ALN, Giuli also had no prior teaching experience with ALN. The plan was to hire course coordinators for each of the introductory Spanish courses and let the coordinating and supervising burden fall on them. The hiring of these staff has been delayed for a year. The first year of implementation proceeded without the benefit of having these staff in place. The courses in the introductory Spanish sequence covered by this project have

enrollments of around 800 per semester. The bulk of these students are there having had some Spanish in high school, yet without enough to place out of the requirement entirely. When the additional language requirement gets imposed, it is expected that these enrollments will increase to about 1200 per semester. The implementation in Spanish 210 was phased in. There were both ALN sections and non-ALN sections during the first offering. That turned out to create some ethical problems. Based on that experience, the implementation in the introductory sequence took place all at once.

- Microbiology: Deanna Raineri is the project director for the Biology 122 ALN implementation. Deanna is an assistant professor in the department of Microbiology in a tenure-track position, but her contract is unlike other assistant professors in that she has an understanding that she can devote her efforts to educational technology development rather than to research in basic science. Deanna got started using PacerForum, a now defunct Mac-based conferencing system. This was around 1993. She and her colleague Stanley Malloy got hooked on that. This started around 1993. When SCALE came into being Deanna was beginning to explore Web-based approaches and invested heavily both in CyberProf and in developing animations produced with Macromind's Director. Deanna teaches the first half of the Biology 122 course. The second half of the course is taught by Professor William Daniel and that part of the course has been taught in a more traditional manner, though now Professor Raineri is converting that part of the course to ALN with Prof. Daniel's supervision. Indeed, Professor Raineri is involved in converting subsequent courses in Microbiology to ALN. The enrollments in Biology 122 are roughly 400 in the fall semester and 800 in the spring semester. A large fraction of these students are pre-med.
- Economics: Larry DeBrock is the project director for the Microeconomic Principles ALN course. Larry is a professor in the department of Economics, known to be the best teacher in the College of Commerce, and a winner of teaching awards at the department, the college, and the campus levels. Larry DeBrock was an initial SCALE grantee in a project where he was co-PI with Lanny Arvan. Larry is quite a savvy computer user. Pin Ng, the project director for the Economics Statistics course, is a lecturer in the department of Economics. He is also quite savvy with computers. Pin spent a year co-teaching Intermediate Microeconomics with Lanny Arvan, using materials that Arvan had developed. This served as preparation for the ALN course development that Pin would put in for the Economics Statistics course that went to an ALN approach in fall 1998. The Microeconomic Principles course enrolls about 1500 students a semester (or more). Professor DeBrock teaches one large lecture (750 students) each spring. Prof. DeBrock's ALN implementation has occurred in stages and he has until recently had both ALN and non-ALN sections for the same lecture. In spring '96 the offering used some dedicated software from Agricultural Economics (which forced adoption of the Ag Econ textbook that accompanied the software) and was marred both by a lack of convergence between the topics in the two disciplines and by a failure for the software to work smoothly at the campus housing labs. In spring '97 Mallard was employed for the first time and the course returned to the traditional textbook. The approach was well received, much better than in the previous offering. In spring '98 the number of students assigned to the graduate assistants in the ALN sections doubled and the face-to-face component of the recitation sections was abandoned. In spring '99, ALN was implemented in all sections that DeBrock taught. The Economic Statistics course, which is the second in a two-course sequence, has about 525 students in the fall semester and about twice that number in the spring semester. The original implementation to ALN was in the fall 1998. Prior to that the graduate assistants taught their own independent sections. In the move to ALN, the course was converted to a lecture-discussion format where Prof. Ng met with the students

twice a week and the TAs met with the student once a week. This allowed a savings of 5 TAs over the previous approach.

- **Mathematics:** Professor Jerry Uhl is the project director. Professor Uhl has been working on teaching Calculus with Mathematica for at least 10 years prior to SCALE's coming into being. Prof. Uhl also runs the NetMath project, a project for teaching the C&M approach as a distance learning activity. The math department has been committed to teaching the required math courses in multiple modes and letting the students select the approach that is appropriate for them. The math department offers three approaches to its high enrollment courses. There is a traditional approach, a Harvard Calculator approach, and a Calculus and Mathematica approach. The differential equations course for engineering students has about 400 students a semester with two sections being taught in the C&M mode. The totally online, self-paced version of the C&M approach was an additional section of about 30 students (for which Prof. Uhl did not receive additional teaching credit.). It has been easier to offer this course in the spring (and allow the students to complete the course in the summer). This allows the C&M staff to recruit for this course from students who have dropped the traditional course and yet are trying to keep up a high number of credit hours
- **Chemistry:** Professor Steven Zumdahl is the project director for the SCALE project and is also the director of the Introductory Chemistry Sequence. He is the author of three textbooks in Chemistry, each of which is used somewhere in the sequence. Much of the authoring of the online content written in CyberProf as well as the supervising of the servers the department supports is done by Christopher Jones, an adjunct in the department. The entire introductory sequence is nearly 4000 students a semester. After experiencing severe problems with getting CyberProf to run smoothly when implemented on the Chemistry servers, and thus limiting its use and its effectiveness, they have had a stable implementation for that past year or so and now have the entire sequence operational in this manner.
- **Physics:** Professor Gary Gladding is the project director for the SCALE project in Physics 100. Gary is the associate head of the department. A major part of his charge has been the course redesign of the introductory physics sequence for engineering students. Professor Jon Thaler was the original instructor assigned to teaching Physics 100, but now Gary has taken over that function. There are about 700 students who take the first course in the engineering-physics sequence each spring. The rate at which students earn a D or worse (and therefore have to repeat the course) has historically been about 20%. All first-year engineering students are pre-screened for their Physics knowledge via an exam given in a required 1-credit engineering orientation course. Those performing in the lower 20% on that test receive an invitation to participate in Physics 100, a course offered in the second half of the fall semester, aimed at compensating for the students' weak prior preparation in Physics. (Some other students also receive these invitations, based on demographic information that puts them in the at-risk category.) About half of those who receive the invitation enroll in Physics 100. In the past year, it has been decided to continue with further follow up work with the students. This follow up is offered concurrently to their taking the actual first course in the sequence. The bulk of those enrolled in Physics 100 have voluntarily continued with this additional work.

#### 4. Method

Below is a table that provides information about each Efficiency Project. We list the automated software that was used and to what purpose that software was applied. Most of the

projects also had written work submitted online that was not machine graded. We list those and describe the use. We also summarize how the project attained increased efficiency.

<b>Categorization of the Efficiencies Projects</b>			
<b>Project</b>	<b>Automated Grading</b>	<b>Human Grading</b>	<b>Efficiencies From</b>
Spanish	Mallard - Grammar Exercises	Writing Assignments in FirstClass	TAs teaching more sections. Sections meet only twice a week instead of four times a week.
Microbiology	CyberProf - Lecture and Lab Homework	Lab Notebooks	Virtual Labs - Save on reagents, TA supervision of the labs, and grading lab homework.
Economics	Mallard - Problem Sets Econ 102 - Test Bank Questions Econ 173 - Regressions in Excel	Econ 102 - Term Paper Econ 173 - Course Project	Econ 102 - Eliminate f2f recitation section - TAs teaching more sections. Econ 172 - Move to lecture-discussion format. TAs teaching more sections.
Math	-----	Mathematica Notebooks	Heavy reliance on undergraduate tutors. Professor used only to write and mark exams.
Chemistry	CyberProf Homework WebCT in One Lab	Additional Homework	Some TAs teaching more sections
Physics	Assignments in Tycho (Physics department software).	-----	Greater retention by at-risk students

## 5. Results

Lanny Arvan interviewed each of the project directors for about 2 hours per interview. In some instances, there were follow up email threads and in a couple of cases the project directors supplied their own written documentation of their projects. Since it was clear that graduate students do much of the teaching in these Efficiency Projects, attempts were made to interview them as well. That happened in Economics. For the other projects, these interviews are still pending. The interviews with the project directors covered several topics: first, a brief history of the project; second, a discussion of the efficiencies component and a review of any measure of learning effectiveness; and only then did we turn to the third topic, the faculty satisfaction question. In some cases, there were also software demonstrations as part of the interviews.

It became apparent from the interviews that faculty satisfaction can generally be divided into two separate components. The first and simplest has to do with workload. The second and a bit harder to get at is the perceived quality of teaching experience, abstracting from the time commitment. We begin this section with some general lessons garnered from these interviews and then proceed to some more project-specific information.

The role of automated grading software (CyberProf and Mallard) as a device for giving students informed feedback and keeping them current in the course has already been documented

in our JALN paper. The effect on the graduate students and their relationship with the undergraduates they teach has not been commented on as much. The most obvious effect, freeing the TAs from some of their historical grading obligation, seems to impact most on the workload component. However, there are some other effects that are perhaps more significant. Many of the interactions that TAs have with their students are either in some clerical role, “the grade on my exam should be an 80 instead of a 76,” or in a policeman role, “I missed the exam because I overslept, but I still think I should be allowed to take a makeup test.” The automated software eliminates the great bulk of these transactions. In some cases this allows class time to be used for other purposes that give the instructor the feeling of helping with instruction. In other cases, it simply eliminates the need for the class time entirely. Moreover, the power relationship between the TA and the undergraduates changes as a result. Because it is the computer that gives the feedback that the answer is incorrect, the TA is no longer the bearer of this bad news and the students can accept the feedback as objective rather than as personal and vindictive. This makes the student more comfortable in seeking out the TA for additional mentoring. In general, this means the relationship is less adversarial. Not surprisingly, that seems to really improve TA satisfaction.

All of the courses are based to a large extent on students doing homework. The students drive many of the interactions between the instructors and the students, as they seek out help doing the homework. This means a disproportionate number of the interactions come from those students who are relatively weak. The strong students can proceed on their own without this sort of help. This is just the opposite of what happens in a face-to-face class, where it is usually the better students who continue to raise their hands and where these outspoken students often drive out those who are shyer or have a less firm grasp on the course material. The effect on instructor satisfaction here is mixed. On the one hand, the instructors do see the utilitarian end for the interactions of the type, “how do you do x?” Through these threads, the instructors are helping the students gain understanding with the material. In the Math and Physics cases, in particular, the teaching assistants have self-selected into the job to fulfill this utilitarian mission. On the other hand, some of the instructors miss the banter with the better students. The instructors do recognize that these good students are getting this type of interaction in some of their other courses. So the regret does not stem from a feeling that somehow these students are missing an educational opportunity. Rather, it comes from the loss of a joyful part of the job in the traditional approach.

On a related note, some of the instructors who are now doing less presentation of materials in class also expressed mixed feelings about that. They acknowledged that the presentations themselves may have little learning benefit for the students. But some of these instructors like to perform in front of an audience and miss the opportunity to use lecture to do so.

All the project directors showed immense pride in what they have accomplished. Their design improved the instruction in concrete ways and there was a great deal of satisfaction expressed by each of them on how their design solved the learning problems that were specific to their course. Because this group consists of dedicated teachers, this finding may be better attributable to instructor characteristics than it is to ALN course design per se.

One significant problem that several course coordinators commented upon is the abundance of email traffic that is directed to the course coordinator from the students and that is not related to course content per se but instead to some course management issues. Living under a flood of email has a deleterious affect on faculty satisfaction. One tactic to mitigate the problem is to get a course email address and strongly encourage students to use that rather than to use the faculty member’s personal email address. This has no affect on the volume of the traffic

generated but does allow the instructor to “shut out” the class when engaged in other activities. Another tactic is to make responding to this email the primary responsibility for some member of the course staff, other than the course coordinator. It should be noted that conferencing doesn’t solve this problem. Even if there is a WebBoard and a conference setup for just these type of messages, the students often send email posts instead.

Additional observations about instructor satisfaction that are specific to the individual projects follow.

- The Spanish Project: Professor Musumeci took a great deal of satisfaction in that her model for teaching the high enrollment introductory courses produced substantial and replicable productivity improvements. She was more cautious on the learning-improvements front, as the outcomes seemed to depend on the way learning was measured. They used pre-course and post-course performance on the Spanish placement exam as one such measure. For that, the ALN approach outperformed the non-ALN approach. They also used comparison of final exam performance. For that, the rankings of the ALN and non-ALN approaches were reversed. In spite of these mixed results on learning outcomes, Professor Musumeci was clearly satisfied with the work she had done. Professor Musumeci did express some displeasure with how her achievements seemingly fell out of the range of the traditional rewards system. This is a comment that SCALE has seen quite frequently from faculty not involved with the Efficiency Projects. It is obviously a serious concern on whether large-course ALN development is sustainable, as the up-front development in these courses is even greater than for the more standard sized course. Indeed, to emphasize the point, Professor Musumeci relayed how Professor Escobar felt that there was an enormous amount of work in the course development component of designing materials for Spanish 210 in Mallard. The course redesign in Spanish 210 clearly was labor saving for the graduate assistants, evidenced by the graduate students preferring to teach in that course over their other alternatives. This in spite of the fact that they are teaching twice the number of students as they have historically and that they have gone to two class meeting times per week (down from the historical norm of three but not as low as the one meeting hour per week in the first year of the ALN implementation.)
- Microbiology: Professor Raineri relishes designing online material for use in microbiology courses. And she likes teaching the course when the students use the materials she has designed. These are her passion. Hence, her satisfaction may not be an appropriate measure to gauge the likely faculty attitudes that her colleagues (who are not in the true believer category) would have if they taught their courses via ALN. Perhaps a better indicator is how ALN is diffusing through the department. Professor Daniel is now beginning to teach with ALN, using materials he is having Professor Raineri design. Professor Daniel is doing this by his own choice. He sees the benefit from teaching in this mode. As long as he doesn’t have to design the materials himself, there is no additional burden on him. Moreover, the students have been demanding it and he is happy to oblige them. Similarly for some of the instructors in the upper division courses. As long as someone else constructs the virtual labs and the CyberProf homework and these faculty are confident of the quality of the online materials, they’d be delighted to teach this way. This has been the diffusion strategy in Microbiology and it seems to be working.
- Economics: Professor DeBrock was quite entrepreneurial in designing the course. He assembled a team for his ALN work that included an ace programmer, to put the materials online, and some of the better graduate assistants, to serve as TAs for the ALN sections. Professor DeBrock had to oversee this staff and make sure the various pieces fit together.

But he was able to delegate a lot of the responsibility for course creation to others. Ultimately, using FrontPage, Professor DeBrock took more direct control of the course Web site. He did this for the first time in spring 1998. But otherwise, Professor DeBrock seems to have managed his course development without the enormous personal up-front investment that others have faced. To a large extent, this was done by using a test bank of questions supplied by the textbook publisher, to upload into Mallard. The use of such a test bank may have limited the pedagogic effectiveness to some degree, but it allowed him to create a functional set of assignments. As the students have generally favorably received the approach, he is quite satisfied with the effort. He is less satisfied with his effort in creating the lecture material done in FrontPage. A significant fraction of the class appears to have not accessed that material at all. Apparently, for students at that level (mostly first year undergraduates) presentation of material, without linking assessment of the comprehension of that material, is inadequate, especially when that presentation is online. Since Professor DeBrock had gone to some effort to construct those materials, the result was demoralizing. The TAs for this course reported in the interview that there was some need to revise the instructions they received on how to respond to students. Originally, they were told to get online in the Economics department lab, set up for online interaction with students, and to respond to student queries immediately after the posts were made. This meant, however, they really couldn't do anything else, even when there was little activity, because they had to maintain a degree of readiness. They soon moved to an approach where they logged in from home via modem once an hour. This reduced the workload and let them focus on their graduate work, when not occupied with a student. With this modification, they found ALN teaching more enjoyable than the traditional mode.

Professor Ng's ALN implementation is going through yet a further substantive redesign. Part of this is a change in pedagogical approach; to make the course more team oriented. Another part is to better control for TA workload. Prior to the ALN implementation the course was taught in straight lecture mode. Each TA would be assigned one section to teach in the fall and two in the spring, meeting every section for three hours per week. Following the approach taken by Lanny Arvan, ALN allowed the lecture component of the course to be de-emphasized. The course was converted to lecture-discussion mode. The students met in large lecture twice a week. Professor Ng gave those lectures. They would then meet in recitation section once a week. Each TA had three sections in the fall and *five sections in the spring*. This high workload in the spring occurred because the demand for the course in the spring is essentially double the demand for the fall. While TA contact hours were actually reduced, averaged over the entire academic year, the TA's non-prep out-of-class time increased dramatically, because of the much higher student/TA ratio. Especially in the spring semester, this led to a degree of TA dissatisfaction with the course. Under the subsequent redesign the plan is to have the TAs teach three sections each semester and have them move between the first course in the sequence and the second course, in accordance to where the bulk of the demand currently lies.

- Mathematics: Jerry Uhl, like Deanna Raineri, is a true believer. He gets great satisfaction from his work. He especially enjoys taking certain risks with the establishment that might have payoff for the students. A feature of his asynchronous offering is that all the students in the class get incompletes at the end of the spring semester. They end up finishing the course during the summer session, as true distance students, when they've gone home. This is a perfectly sensible solution for this type of course, but the institution frowns on it. The thinking is that undergraduates should not get incompletes – to ensure they are making good progress towards their degree. Getting accommodation on the incompletes appeared in the interview to be as satisfying as the fact that the students performed well in this totally self

paced arrangement. Jerry has built the bulk of the C&M operation relying on undergraduate student labor. He is very proud of this – his assistants have gone through some C&M offerings already so there is no need to train them in the approach. They do the work in part for the money but also because they believe in this style of learning. And in this way he is able to give rather personal feedback to students currently taking the course without swamping himself or his professional staff. But he has run up against the following barrier. His department (and many others) recruit graduate students and assign them TA-ships as part of the recruiting package. As long as TA-ships are viewed as a recruiting lure, rather than as a wage for teaching, the Math department views the graduate students as cheaper than the undergraduate hourlies, since the graduate students would need to be compensated even if they didn't teach. Jerry counters this with the observation that not all of the incoming students are of such high quality and many are admitted primarily because there is a need to put them in the classroom. In this case, the C&M approach is cost effective. But it is so out of the norm to use a substantial chunk of department funds to finance undergraduate teaching assistants that his operation is in long term financial jeopardy. In general, that appears to be the major downside to his innovative approach. In some instances the institutional constraints seem to be too great a barrier and it is frustrating not having the right set of tools to fix those problems.

- Chemistry: As with Microbiology, the evidence on faculty satisfaction is probably best garnered from the information about diffusion of the approach within the introductory sequence. Two years ago there were many instructors in the sequence who resisted teaching with ALN. The reasons are many and varied. There was a general distrust of the approach. The servers didn't appear to be stable. And the content that was written into CyberProf didn't necessarily match the content that the instructor wanted to emphasize. This past year, the entire sequence was taught in an ALN mode. The stability problems seem to have been resolved. That allowed everyone to gain confidence in the approach. The course coordinators continued to author questions for CyberProf. Individual instructors were then able to choose from a menu as to the topics they would cover, rather than be forced into a prescribed curriculum. Indeed, if the instructors wanted to author additional questions to contribute to the database, that was instructed. One more important point. There was substantial instructor turnover. The new instructors are younger and more comfortable using technology in instruction. Ultimately, the graduate assistants have captured many of the efficiencies produced in this sequence. Their workload has gone down. Apparently, the market for Ph.D. students in chemistry is tight, and the schools compete for incoming students based on their TA burden. This has been confirmed by talking with the director of Introductory Chemistry at Wisconsin, John Moore. (Illinois believes Wisconsin is its primary competitor for grad students in chemistry and vice versa.)
- Physics: All the instructors who are involved in this project are there out of altruistic motives. They want to be there. But they also want to be effective in what they are doing. That is, they want to improve the retention and the understanding of Physics for the at risk students enrolled in this course. During the first year of the course, it wasn't apparent that what the instructors were doing mattered. That was the cause of some frustration and anxiety. But in the next iteration of the course, there were improvements in the teaching approach and the outcomes. Now, the course staff seems quite happy with what they are doing. During the first year, the conjecture was that some of these students were having problems because their general reasoning skills were weak. So they were given some exercises in general reasoning that were unrelated to physics. The TAs thought that was a bad idea and apparently so did the students. The students couldn't see the connection between these more general problems and the content in the physics course. In the next

iteration, that part was eliminated and replaced with more physics materials. That seems to have worked.

## **6. Conclusion**

Teaching assistants in high enrollment courses seem generally to like the ALN approach. It improves their work environment. The PIs on these projects are extremely upbeat about their ALN experiences. That, however, may say as much about them as it does about the satisfaction of teaching with ALN. Where these instructors show dissatisfaction, it is with various institutional rigidities they must confront, not with the teaching approach itself. In some of these courses, we are seeing more broad-based diffusion of the teaching approach. This is happening through a de-coupling of the online content design and the course delivery. That diffusion is an indication the ALN approach is as satisfying for mainstream faculty as the traditional approach.