# The Clipper Project:

## *A Web-based Curriculum Research and Development Initiative*

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The Andrew W. Mellon Foundation
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**Confidential**

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## *The Clipper Project*

> *Let's suppose for a moment that it's the 1930's. You're the captain of the luxury liner, the Queen Mary, steaming across the Atlantic to New York. Suddenly, you hear a low drone. You look up and see a Pan Am Clipper, winging its way from London to New York. Would you realize that the age of steamships is about to end? Would the steamship company understand that its business actually is transportation, not ships? Would the passengers guess that seats at the captain's table, strolls on the deck, steamship trunks, and days at sea are about to become a six hour-flight in row 17 – a window or aisle please, but not the middle?*
>
> -- April 9, 1999, President Gregory C. Farrington's inaugural address, Lehigh University

The Pan Am Clipper did more than announce a paradigmatic shift in the way goods and people were transported. Indeed, it forced new ways of thinking about how we work and live. With the proliferation of flight, the transportation industry engendered a societal transformation. We have a similar opportunity today in higher education. Learning--not teaching--is the business at hand. The classroom as we know it today is our Queen Mary, and technology will be our catalyst--our Clipper, if you will.

The Clipper Project is unique in two very specific and important ways. First, this project will provide a baseline for future research into the effects and impact of Web-based courses on students and faculty--something that does not exist at this time--despite the tremendous amount of time and money invested in distance education today. Second, this project will focus on a student population who typically have not been considered when one investigates technology-based learning in higher education--that is, pre-college students.

### THE GOAL

This project is intended to enhance the collegiate experience of Lehigh freshman students by accelerating their entry into advanced studies in their specialties and in complementary fields. We propose to design and offer Web-based instruction based on the typical freshman year curriculum to high school seniors who apply for early admission to Lehigh. We have designed a quasi-experimental study with both qualitative and quantitative measures to determine the behavior of students during the Web-based instruction, the extent to which this instruction has prepared them for advanced instruction, whether this vehicle indeed opens broader learning experiences to them, and the effects of such a project on the faculty engaged in the process.

### THE NEED

Approximately $237 billion is spent each year on post-secondary education in the United States--roughly $2 billion on distributed learning, alone. Nearly 10% of the GDP each year is spent on education--and an increasing percentage of this is dedicated to technology-based experiences and materials. More than 700,000 students are now taking some form of distributed learning coursework at some level--and this number is expected to top 2.2 million by 2002. By the turn of the century, it is estimated that as many as 72% of four-year colleges will offer some form of distributed learning. Some well-publicized efforts have been underway for several years now--projects like Western Governors University, the California State University initiative, and Phoenix University, to name a few.

Distance education is making its way into the high schools, as well. The Concord Consortium has operated the Virtual High School for several years--amassing a group of cooperating high schools that each offer and take courses from one another at a distance. The University of Nebraska recently spun-off a company--Class.com--whose mission is to create and offer courseware to high schools. Other virtual

high schools have surfaced in Arizona, California, Florida, Kentucky, Massachusetts, Michigan, Nebraska, and Utah (Carr & Young, 1999).

As more learning becomes digitized, it becomes imperative that we understand what factors influence success. Yet, there exists a critical shortage of research on the effect and impact of technology-based learning on the way faculty teach, on the way students learn, and on the costs associated with creating and delivering this new form of education. Research on these factors is virtually non-existent. At best, one may find anecdotal accounts of successful instances ("I did it in my class and it worked great!") or reports of success based on student and/or faculty self-reported preferences ("The students noted on the end-of-course survey that they enjoyed the course, therefore it is good"). Given the pace of change and potential impact of distributed learning on higher education, we must now undertake due diligence and begin investigating empirically the exact impacts--if any-- of technology-based coursework on teaching and learning at the university. The Clipper Project is an attempt to do just that.

## THE RATIONALE

According to the U.S. Department of Education (1997), approximately 65% of high school graduates in 1995 moved on to higher education -- compared to only 49% in 1980. However, the number of adults over age 25 who hold baccalaureate or higher degrees remains steady at approximately 21%. As an increasing number of 18-22 year-olds *enter* higher education, what barriers are they encountering that impede them from continuing? Perhaps one important barrier is increasing cost. Whereas it is clear that a college degree "pays off" for students who obtain them--the average salary for a college graduate is approximately 100% higher than a high school graduate--it is important to note that the average tuition has increased fivefold in the last two decades. The cost of obtaining a college degree may be approaching a prohibitive level for some.

Technology may help.

The focus of the Clipper Project is on the use of technology-- specifically, Web-based coursework--to make the residential college experience more cost effective for students. The benefits would be achieved by opening up opportunities for advanced work at earlier stages in students' academic careers--thereby creating a "value-addedness" to their college experience, and allowing students to, for instance: complete two degrees in a shorter time period; advance into graduate work at an earlier stage; or perhaps even graduate in less than four years. The primary candidates for this project will be those high school students--most likely, seniors--who apply to Lehigh for early admission.

> *"Before you build a better mousetrap, it helps to know if there are any mice out there."*
>
> **--Mortimer B. Zuckerman, Chairman and Editor-in-chief, U.S. News and World Report**

During the early planning stages, it was our assumption that students would be interested in accelerating their course of study via Web-based coursework prior to coming to Lehigh, and therefore would likely participate in any program we designed and offered. However, the Clipper Project planning committee determined it important to conduct a survey of all incoming first-year students to verify or disprove our assumption. The issues of feasibility, capacity, and interest are paramount to a project such as this, and should be well-understood at the outset. The questions were posed: Is Web-based instruction feasible with entering high school seniors? To what extent would high school seniors be interested and willing to participate in Web-based courses designed and offered by Lehigh?

To explore the feasibility of delivering courses over the Web to students in high school, we distributed a brief survey to all students from Lehigh's entering freshman class. This survey (see Appendix A) included

11 questions designed to measure students' Internet access, prior experiences with the Web, and level of interest in taking Web-based college courses during their senior year of high school. Of the approximately 1100 students in the incoming class, 340 (31%) returned completed surveys. The demographics of the respondents were representative of the Lehigh University student body (see Table 1), and the results provided us with some data to guide the planning and development of the Clipper Project.

**Table 1**

**Demographic characteristics of survey respondents and Lehigh's first-year students**

| | **Survey Respondents** | **Lehigh First-year Students ('99-00)** |
|---|---|---|
| Sex | | |
| Male | 52.9 | 59 |
| Female | 47.1 | 41 |
| College | | |
| Arts & Sciences | 43.5 | 41 |
| Business & Economics | 20.3 | 21 |
| Engineering & Applied Sciences | 35.6 | 38 |
| Location of High School | | |
| Urban | 14.7 | Not available yet |
| Suburban | 70.9 | from university |
| Rural | 12.4 | database |

As displayed in Table 2, more than half of the respondents indicated that they would have taken at least one Web-based course during the first or second semester of their senior year in high school, and approximately 39% indicated that they would have taken at least one course during the summer. The percentage of respondents who indicated that they would have taken more than one course at a time ranged from 13.5 to 17.1%. Almost all of the first year students (98%) had access to computers and the Web during their senior year of high school. Although a small percentage of respondents had access only at home (18%) or school (9%), most students (68%) had access to the Web at both locations. A large percentage of students had access to the Web during the last eight hours of the day, with the highest percentage (81%) of respondents having access between the hours of 8-10 in the evening.

**Table 2**

**Number of students interested in taking Web-based courses during the first semester, second semester, or summer following their senior year of high school**

| **Number of courses would take** | **1st semester** | **2nd semester** | **Summer** |
|---|---|---|---|
| **1** | 140 | 143 | 73 |
| **2** | 34 | 32 | 29 |
| **3** | 4 | 7 | 9 |
| **4** | 8 | 8 | 20 |
| **Total n (% of sample)** | **186 (54.7)** | **190 (55.9)** | **131 (38.5)** |

Note: Sample n = 340

Most students (92%) had access to the Web for at least 30 minutes at a time. (The Clipper Project team estimated this to be the minimum amount of time necessary to participate in a Web-based instructional unit.) Hardware requirements also do not appear to be a major barrier to implementation, with approximately 81% of the sample having access to a computer with a Pentium class or iMAC processor.

Regarding prior experience with Web-based courses, 25 respondents (8%) participated in such a course during their senior year of high school. Twenty-four of these students participated in computer-related courses (e.g., Web design, Internet, computer business applications, etc.) offered by their high school. At least 20% of the respondents indicated that they would enroll in one of the six Lehigh courses being considered for Web-based instruction. Based on priority rankings, students were most likely to enroll in English I, then Mathematics 21, Economics I, Engineering I, Chemistry 21, and Physics 11 (**note**: only 2% of respondents expressed interest in Physics; therefore, Physics 11 was removed--reducing the project proposal to five courses).

Although the primary focus of the Clipper Project is on high school students, the nature of the research design for this project--discussed later--necessitates the involvement of first-year students enrolled and residing at Lehigh University. Therefore, it is important to note that the Clipper Project planning committee consulted data on these students, as well. The Information Resources division of Lehigh University sent a survey to all Lehigh students who lived on campus during the Spring 1999 semester. Of the 1085 respondents, 448 (41.3%) were freshmen. Two items are of immediate relevance to the Clipper Project. First, 55.3% of respondents strongly agreed and 31.6% of respondents agreed with the following statement: "Having an Internet/LAN connection in my room has had a significant positive impact on my ability to get my course work done." Second, 69.7% of the survey respondents strongly agreed and 23.7% of the respondents simply agreed with the statement: "Having an Internet connection in my room has increased the level of communication between me, other students, and professors." Based on these items, the planning committee has concluded that an adequate infrastructure exists in the first-year dormitories to support the inclusion of this population as a sub-group of the project.

In sum, the response to our brief survey indicates that a large number of students are interested in participating in introductory college courses offered via the Web. In addition, the majority of these students have adequate equipment and sufficient Web access to allow them to participate in such courses during their senior year of high school, as well as on-campus. Finally, additional survey data of current Lehigh students suggests that it is reasonable to assume that those students who participate from campus will benefit from the experience, as well.

## THE PROJECT DESIGN

As we conceived this project, we understood the important role championship would play within the university for this endeavor to be successful. Therefore--as detailed in the planning grant proposal--one of our immediate goals was to identify "early adopters" among Lehigh University faculty. We defined early adopters as those who have already pursued or who are committed to investigating and implementing some form of Web-enhanced instruction within the Lehigh curricula. We felt it imperative that these individuals be identified early and involved in every aspect of the project planning--to bring about the requisite championship for success. The project proposal that has emerged is the direct result of a systematic, concerted effort by a collection of faculty from each of the four colleges, all of whom have some experience, expertise, and/or interest in the use of Web-based instruction with young students. This planning committee met once per week to prepare the project proposal (**note**: in an effort to understand *best* the process of implementing the proposed project activities, data have been gathered on these meetings--as well as other planning communications and activities--and will be evaluated as part of the research design described in this proposal).

The planning committee created this design. This proposal is the result of investigating: currently-available models/resources, the target audience, what is currently being done, and what *should* be done in the future. The project identified six courses within the first-year curriculum that would allow this project to engage the largest number of entering students possible. The sixth course (Physics) was dropped from the proposal--due to a lack of interest from the target population, as demonstrated by the student survey issued to all entering first-year students. For the five courses that remain, the faculty from the planning committee will serve as the content experts and--in conjunction with technical support staff--will

design and deliver a Web-based version of each course. What follows is a description of the models investigated and the courses to be delivered.

### Models

The first responsibility of the committee was to identify working models--if any exist--in Lehigh's or other educational systems that might be utilized or, at the very least, inform our process. The charge was to investigate these models and adopt what we could from them, as well as to recognize major barriers others encountered. The planning committee went to great lengths to identify and to investigate rigorously any other models that would provide useful and/or interesting models for the Clipper Project. The result of this investigation is most evident in the course descriptions, below. In addition, the committee spent a significant amount of time considering whether or not it would be best to partner with an educational management organization (EMO), rather than to design and deliver the courses internally. The committee investigated the offerings of several EMOs and even entertained site visits from companies such as: Eduprise.com, Learningstation.com, and eCollege.com. Whereas the committee feels that partnering with such companies at a later date should be an option left open, it is the opinion of the committee that the industry is--at this point--not at a level conducive to a project of this nature. Issues of development time/cost, ownership, responsiveness to students and faculty were among those not answered satisfactorily at this time. Therefore, the model that will be advanced is an internal one, where we will solicit the services of our own Information Resources department to design and deliver this first collection of courses. Throughout the Clipper Project, however, we will continue to communicate with potential industry partners and--should one emerge--we will actively investigate the merits of such a partnership.

## The Courses

The following are descriptions of the five courses that will be offered via the Clipper Project. The faculty member who will design and deliver the course prepared each of these descriptions. Within each description is a stated objective for the course, a description of current activities in the course, a description of anticipated activities in a Web-based version of the course, and an evaluation of what is currently available via other institutions relative to the course:

### Chemistry 21

**Objectives of the Course:** The Web-based version of *Chemistry 21: Introduction to Chemical Principles* has the same objective as the traditional course: the students will become conversant and skillful with the way chemists view the world. The atomic nature of matter, states of matter, chemical bonding, physical properties, chemical reactions, thermochemistry and the quantitative and qualitative treatments of these topics are all included in this view. The course requires the student both to learn a significant amount of factual information and to develop problem-solving skills involving quantitative and descriptive material.

**Components of the Course**: The Web-based instruction for Lehigh's Chem. 21 will be prepared using a combination of readings by the student from a standard textbook[1], conversational presentations by the instructor including notes via streaming media, and computer-based activities on the Web fully integrated with the audio and video presentation and designed to put the information in context for the student. The students will also be encouraged to interact directly with the instructor by email, discussion board, chat room, and telephone, as necessary.

**Structure of the Course**: The following example describes a typical unit of instruction. The first chapter in almost all freshman chemistry books introduces the student to the way chemists view the world by acquainting the learners with the vocabulary of the science. In the Web-based course, a student first reads the chapter in the book. Information covered includes definitions and illustrations of elements,

compounds, mixtures, solutions, physical and chemical properties, chemical formulas, and laws of conservation of mass, definite proportions and multiple proportions. The student then watches and listens to a presentation by the instructor on the Web.

This presentation consists of a conversation by the instructor on the key points of the chapter and includes written class notes that appear on the screen along with the video of the instructor and accompany the conversation, highlighting the important features of the material and illustrating and expanding upon the information in the text. These written notes may be thought of as containing the items that are typically written on a blackboard during a lecture but may also include pictures, graphs and additional visual displays to illustrate what the instructor is discussing. It is essential to note that the Web presentation is not simply a taped lecture; we are intentionally breaking away from the lecture paradigm. The information is in the textbook, not on the computer. The presentation will be prepared more in the style of a brief exposition on the topic at hand in a more conversational mode and will intentionally be kept short, highly focused and specifically crafted for viewing on a computer in tandem with a special computer-based activity.

An integral feature of the Web presentation is an activity, in context, for the student to do. After reading and hearing about elements, compounds, mixtures, percent composition and physical and chemical properties, the student moves to a computer-based activity in which these definitions related calculations and concepts are used. In the case of the first chapter, this activity consists of a virtual column chromatography experiment.

The student reads a brief introduction describing the uses of chromatography for separating mixtures and the instructions for running a column. The student then follows several sets of samples through a column chromatography exercise and requests other analytical data about the samples to assist in defining their composition. This activity is accompanied by graphics and quantitative data that underscore the principles in the chapter: molecular structure does not change when a compound undergoes a physical change; molecules of a pure material have a constant composition; mixtures have variable composition; equal quantities of matter exist before and after a chemical change. The student carries out this activity, makes several suggested calculations, and interprets the results. As a form of self-evaluation, the student then has the opportunity to compare notes, observations and comments associated with the activity to actual assessments of the same scenarios by a chemist. The key feature of the activity is that it pulls concepts and ideas together into a meaningful context rather than making the terms and information an exercise in rote memory. The computer-based activity is a bridge between the information in the text and the discussion by the instructor. The role of such computer-based activities is to put the information presented in some context and to engage the student in working with the concepts presented. The computer activities are the core of the Web-based chemistry course, and their selection, development and design is a crucial component.

**Existing Computer-based Materials:** Most current textbooks targeted to the students in introductory courses offer some computer-based supplements for use by students. Books now typically contain CDs ranging in content from “the book on the Web” to additional material beyond that contained in the text to problems and self-testing exercises. Several publishers have developed on-line materials specifically tied to a given text; others offer Web sites that are largely independent of textbooks. The bulk of these materials, however, have been prepared with a standard lecture course in mind or at least a course where the student and faculty member interact face-to-face.

Whether the model is ‘teacher-as-preacher’ or teacher as ‘the-guide-on-the-side,’ these products on the computer are not the only materials or even the primary materials with which the student interacts; they are supplements. Experiments in more extensive Web-based instruction are certainly not unknown. Indeed, components of a curriculum in molecular science delivered over the network have been in development for three years by faculty members at six institutions in California under the auspices of the National Science Foundation[2]. This NSF-funded project features assignments for exploration and tasks referred to as applications, all of which are accessible on the Web[3]. However, these units are used as in-class activities in computer-equipped classrooms or as homework assignments to be completed outside

of class. Direct interaction still occurs between students and faculty members and among students within the classroom.

The activities forming the core of the presentation of information and the development of skills in the Lehigh project will be used in a completely different environment —the student working alone at a computer — and hence must be quite different from classroom-linked or -based activities. As an illustration of the type of activities that are intended--that engage the student and provide a context for the information to be learned--several Web sites produced by the National Geographic are an appropriate model. At *http://www.nationalgeographic.com/monterey/*, visitors go on a voyage through a kelp forest. The virtual voyage contains graphics and small portions of written material. It does not deliver the quantity of information in a textbook but rather puts facts already learned in context and gives a student, who, for example, may have just read about the different zones within the ocean that are populated by various species, the opportunity to apply that information or see it illustrated in a real-life example. Another site of similar character is *http://www.nationalgeographic.com/kingcobra/index-n.htm*.

Many excellent tools are available to augment the Web site for Chem. 21, and these will be appropriated as necessary. Molecular structure packages such as Isis, available as freeware and downloadable from the Internet, as well as existing databases and pictorial information will certainly be used to develop the units. However, the fundamental difference between this course and any course that has direction interaction with a faculty member via a classroom setting makes it necessary for us to develop many of our own materials.

## Economics I

**Course Description:** This course presents a survey of basic economic theory in the two main branches of economics: micro- and macro-economics. The micro half of the course covers consumer theory, cost and supply relationships, the short- and long-run behavior of competitive markets, the behavior of monopolistic markets and the peculiarities of public goods and goods with external costs and benefits. The macro half of the course covers the measurement of key economic indicators, the theory of aggregate demand and the business cycle, the impact of monetary and fiscal policy, the sources of long run economic growth and the rudiments of international trade and finance. This is a very ambitious set of topics, especially when the level of the course is taken into account. Most universities cover these topics at the level we approach in two semester long courses - one devoted to micro- and one covering macro-economics.

**Pedagogy:** The student in this course, as in all principles of economics courses, first must understand the logical basis for important economic relationships. This involves learning a particular vocabulary and distinguishing between assumptions and logical conclusions of the argument. This material is usually presented verbally, but numerical examples are often used to clarify definitions and mathematical equations are sometimes used to make arguments precise. Once the underlying logic behind a relationship like the “law of demand” is understood, the student needs to be able to represent that relationship by a graphical model. Since economic theory is most useful in predicting responses to changing circumstances, the student must also be able to explain why and show how changes in the economy affect the demand curve for a product, for example, using the graphical model.

The third task facing the student is to integrate economic relationships in a more complex graphical model. So to understand price determination using the simplest economic model of supply and demand the student must learn the logic behind the law of demand and the law of supply, learn how these laws are depicted in graphical models, learn how these relationships and the corresponding graphical representations are affected by changing economic situations, and learn how demand and supply changes interact to determine price. Thus from the very first course, students are expected to learn how to use fairly complex, abstract models of the behavior of firms, people and markets to answer questions, such as: how would a rise in the tax on cigarettes affect the price of cigarettes, the number sold and the revenue raised by the state from the tax?

**What others are doing/have done:** The summer 1999 issue of *The Journal of Economic Education* (Vol. 30 No. 3) contained papers presented at a conference on "Technology and the Teaching of Economics to Undergraduates," held at the University of Pittsburgh in the Spring of 1998. There are a number of ideas and findings presented in this volume that inform this proposal. The articles describe a number of uses of the internet and computers as supplements to classroom instruction. A few articles described experience with on-line courses like the ones we will develop. But there was very little evidence presented to evaluate the effectiveness of the course innovations. The organizers of the conference write in their introduction ( Arnold Katz and William E. Becker, "Technology and the Teaching

> We were disappointed at not receiving more proposals dealing with the evaluation and assessment of instructional software. Some of the evaluations reported at the conference had, moreover, to be edited out of the articles reprinted here for what the referees considered weaknesses in their methodology. With the exception of a few published pieces, such as that of Agarwal and Day (1998), we do not have much information on the effect of the internet on student outcome measures. (Page 198).

A couple of papers suggested hypotheses about the way the internet might affect student learning. The visual nature and interactive aspect of the media and the provision of immediate feedback on assignments and quizzes is thought to increase student engagement. By making communication easier and less intimidating, the technology might increase student-student and student-faculty interaction and enhance opportunities for collaborative learning. Web-based courses have the potential to be more flexible and adaptable to different learning styles. On the other hand, on-line courses with no face-to-face instruction appear to be significantly more challenging to students.

There are some examples of current and previous economics courses that are useful to note, as well. Roger McCain at Drexel offers online a question-led approach that looks mostly like an on-line workbook. Joseph Daniel at Delaware has interactive software available at his Web site that would allow a user to incorporate spreadsheets, statistical packages, graphical calculators, drawing programs, etc. into a Web-based course. Some of these utilities might be useful for an Economics I Web course, but they are designed for a more advanced course in microeconomics.

Michelle Albert Vachris, "Teaching Principles of Economics without 'Chalk and Talk': The Experience of CNU Online," described her experiences since 1993 in on-line courses at Christopher Newport University in Virginia. She found that on-line courses require more effort so they tend to attract more active and independent learners; that, on average, 18% of on-line students withdraw from courses versus 8% of on-campus students; that on-line students tend to give lower instructor evaluations, in part because of frustration with the technology, and that learning outcomes are similar for on-line and on-campus students.

In "The Impact of the Internet on Economic Education," *The Journal of Economic Education,* Vol. 29 No. 2, Spring 1998, pp. 99-110, Rajshree Agarwal and A. Edward Day, tried to test for the effect of internet use on various outcomes in two paired undergraduate microeconomics courses and two paired graduate macroeconomics courses, where one of each used the internet and the other did not. Internet use was for e-mail, discussion and data retrieval for class assignments as a supplement to on-campus courses at the University of Central Florida. Here are their main findings:

1. Controlling for race, sex, age, GPA, and whether or not the class was a graduate course, participation in the internet class was positively correlated with student performance on the multiple choice Test of Understanding College Economics, which was part of the final exam, and with the student's course grade.
2. Student evaluations of various aspects of instructor performance tended to be higher among those who attended the internet class.
3. Attending the internet class had mixed results on changes in student attitudes towards economics.

**Requirements of a Web-based Course:** To allow students to master the concepts covered in Eco 1 through a Web-based course, the course needs to have the following characteristics:

**1. The Web page must go beyond presenting definitions and explanations of terms and relationships with an on-line textbook.** In fact, a regular textbook will be assigned to on-line students since reading a book is a lot easier than reading text on a video screen. What the Web page would have to do is act like a lecturer and help the student grasp ideas by presenting examples, telling stories, and showing the students how to do things. The course will have to take advantage of the medium and use pictures, cartoons, audio and video to accomplish this. The Web-based economics courses offered by other universities that were evaluated used a common approach--the Web site served as a substitute for--rather than as a complement to--the text. One thing that the Web site can do more effectively than a lecturer is to provide the student with links to related material already covered, or to a glossary to remind students of definitions. An advantage of the Web-based course will be the possibility of presenting concepts in different ways in the same space. So if the Web page has an explanation of the law of demand in English, perhaps the student could click on a box and get the corresponding explanation in terms of a numerical example, or in a mathematical equation, or in a graphical model. This will be very useful in convincing students that math and English and graphs can say the same thing and in allowing students to learn concepts in the particular way they find most helpful. Clicking on another box might bring up some "real-world" examples to round out the explanation.

**2. The Web page must provide the student with the opportunity to practice using the graphic models developed in a textbook and amplified on the Web page.** The student will practice graphing on the Web in supervised manner, with the program guiding and correcting him or her. This will be far superior to the experience open to in-class students who must copy graphs in their notebooks while the lecture is going on, without any individual attention from the instructor. This graphing procedure is a must for the Web-based course to succeed.

**3. There must be a series of workbook and self-quizzing activities on the Web.** These replicate paper workbooks and study guides but have the advantage of providing immediate feedback to the student and, if visually appealing, might motivate students to actually take advantage of these aids to learning. Several existing Web courses in economics look mainly like on-line study guides, presenting the student with a continuous stream of questions and problems. While the feedback is immediate and does help the student learn the material, the approach seems less than motivating for student learning. Reading Cliff Notes, even on the Web, is not the same as reading the book.

## Engineering I

**Course Objectives:** The envisioned Web based course will have the same objectives as the traditional Engineering 1 course. These are: the introduction of computing software as it relates to engineering applications; teaching of the basic programming concepts, structures and algorithms; and the application of learned techniques to solve some scientific and engineering problems comprehensible by students having a general science background. The traditional course uses C++ to introduce students to programming, draws examples from various engineering applications, and utilizes spreadsheets for calculations and graphing. It also discusses several basic numerical techniques such as elementary statistics, linear interpolation, numerical solution of transcendental equations, numerical integration etc. and instructs the students in the additional high level language Fortran 90. Two PC-based compilers are used, C++ and ELF90. The proposed Web course will cover the same material.

**Administration issues:** It is our estimate that students will enter this course having varying degrees of the requisite experience with computer applications, computer programming, calculus and physics. Students requesting the engineering course will therefore be given a questionnaire to identify their initial level of expertise. We anticipate that students entering the course with high levels of requisite experience will require minimal guidance from our instructional staff, beyond the grading and feedback from assignments, quizzes and exams. However, those students with less experience, we assume, will require

additional assistance--via e-mail, discussion boards, chat rooms, and phone calls. We propose to monitor and measure the amount of interaction in order to have a better estimate of required communication and of the workload associated with the course. Extrapolation of such data will allow us to understand better the resources needed to address students of varied abilities who enroll in the course and address these needs in the most cost effective manner.

The Web-based course will have the same number of assignments as in the existing traditional course. Homework assignments will be submitted as word processor files uploaded via the course Web site. Programming assignments will be worked out on the software Borland C++ (which will be made available to the distance students). The source text files will be submitted via the Web site, as well. A teaching assistant will have the responsibility of archiving the incoming assignments, monitoring the grading, and returning the graded files to the students through each students 'digital dropbox' on the course Web site. As assignments come in, students will be permitted to enter secure areas of the Web site containing the solutions and discussions of assignments. The same TA, in collaboration with the faculty member, will be responsible for answering students' questions with associated reading referrals. Special care will be given to questions on the engineering science aspects of the course, directing them to the faculty member unless they are within the immediate area of the TA's expertise. Such questions will be encouraged throughout the course.

A grader under the close supervision of the faculty member will grade the assignments. Actual grades will be assigned to all work of the students. In addition to the assignments, students will take two programming exams, two quizzes and a comprehensive final examination. Some of these exams will be appropriately proctored. We propose to monitor the effectiveness of such proctoring and devise methods for improvement and/or simplification. The grading of the exams will be done in close collaboration with the TA and the faculty member.

**Proposed Web site features & requirements:** The course Web site will be a significantly improved, enhanced and modernized version of our existing Web site which can be found at http://www.lehigh.edu/~inengr1 One textbook will complement the Web site. The Web site will contain links to learning resources (Lehigh and others) , Engineering Professional Societies, Computer Language "markets", Bulletin boards, Automated Grade retrieval and other support materials. The focus of the Web site, however, will be the units of instruction and activities necessary for the mastery of the course subject.

The theme of each unit will be set by an introductory video clip of about 10 minutes which will focus on a particular engineering issue and a related programming assignment for the unit. Presentations-explanations will complement actual footage of existing engineering systems. The material of the unit will include:

a) reading assignments
b) complementary notes
c) solved examples
d) exercises and tasks to be completed
e) homework to be completed and submitted in addition to the main programming assignment.

For example, the third week of our current site contains reading about control structures and if statements. There are several examples in the book and, in addition, on the Web site. There are two scheduled programming activities (taking place during recitations-labs) A homework assignment that deals with the details of the issues in the reading assignment and our main programming assignment that deals with **Smog in LA.** The title of the assignment is linked to a California State Government site that provides 24-hour readings of the pollutants, which are the inputs to our student's programs. In addition, explanations well beyond the ones contained in the textbook are offered.

We will develop several files consisting of completed C++ source files with strategically embedded errors. As students click on them they will activate the compiler and they will have to **fail** before they look and find ways to correct the errors. In this course most of the learning takes place by **doing** for the majority of the students.

**Existing Web courses:** In our review, we found no available Web course that adequately addressed our purpose. There are several courses in C++ developed as tutorials for programmers experienced in other languages who want to move in this direction, for example see http://www.swcp.com/~dodrill/cppdoc/tcppmain.html There are also some that start from scratch for example: http://www.mhonlinelearning.com/syllabus/programminginc.html. However, none of these combine programming with the basic engineering skills-motivations-problem solving we stress in this course. Also, none of the courses augments computer programming with numerical solutions of problems.

## English I

Lehigh University prides itself on its commitment to writing as a tool for learning. *All* students -- arts and sciences, business, and engineering -- take two semesters of first-year writing at a time when almost no schools require this even of arts and sciences students. English 1 and English 2 are "the" core curriculum of the university. Almost no students are exempted from the requirement; few receive advanced placement. The Lehigh English Department prides itself on its commitment to the writing program. Though the department has a doctoral program and a faculty of publishing scholars, *every* available faculty member teaches in the writing program at least once a year. No other English department in the country with a doctoral program can make that statement.

These points provide the challenging context for the application and acceptance of online instruction in writing at Lehigh. Teaching writing here is not a matter of presenting grammatical rules to memorize or even rhetorical forms to imitate. It is not a matter of a teacher correcting a student's work. In a sense, then, there is no content in English 1 for students to master on their own, like some other courses. Instead, within a classroom community of diverse individuals, students practice cultivating the habits of mind that lead to developing rhetorical strategies and qualities of expression effective with "real" audiences in various situations for differing purposes. Classes are relatively small; the attendance requirement is firm; group interaction is constant; the audience for student writing is their peers. There is no template for what we do; energetic, engaged, and motivated people on both sides of the "desk" make the program work.

An examination of the program's six main goals immediately suggests the overarching question as we think about offering English 1 online. Can the technology replicate the "in your face" and "in your mind" experiences that foster **critical thinking** and **sensitivity to audience** that we provide, person-to-person, in the walled classroom? Our writing program aims: 1) to encourage students to probe beyond what everyone else in the class has said about a topic; 2) to make them aware that conventions of usage can help or hinder reception of their ideas by their own classmates; 3) to share information that increases the pool of knowledge available to everyone in the class; 4) to experience different interpretations of the same texts; 5) to establish the on-going social exchange that creates a community of learners; and 6) to collaborate at all stages of the writing process from invention to revision. An examination of the four principal strategies used to achieve these goals likewise immediately suggests the focus of our development activities. Can the technology lubricate the intensive teacher-student and student-student **interaction** that is at the heart of our program? Our four main strategies are: 1) teacher-student conferences; 2) discussion, invention, and brainstorming activities; 3) peer workshops; and 4) demonstration and analysis of models.

There are many commercially available course delivery packages on the market. We have some experience locally with three of them: WebCT, Blackboard's CourseInfo, and Web in a Box. Others that have some prominence in the writing field are eCollege, Convene, and Anlon. Each of these systems provides a similar generic array of tools for interaction: a discussion board, a chat program, a white board, student project space, and so forth. Our sense at this point is that we could settle for a commercially available course delivery system designed to facilitate satisfactorily most of our interaction needs in print medium. But, because of the high degree of emphasis placed on personal interaction in our program, we

would like to go beyond what we see readily marketed now to teachers of writing and investigate audio and visual interaction as well. Can online students hear my comments on their papers as they might in personal conference? Can online students talk to and/or see each other? Can I "see" my online students during "virtual" office hours? What further steps could we take to enhance virtual community? Our sense is that there are technologies like NetMeeting available that we in the English department know little about but should explore.

And, now, what about what we might call "mindware"? We have surveyed many of the existing online writing courses and have reached several conclusions that will inform our development activities. First, many of the existing online courses seem to have followed the mantra of "whatever you can do in a traditional classroom, you can do on the Web." The Web becomes simply a depository for pre-existing materials. These courses do not excite us much as models. Second, the audience for many existing online courses is adult, so-called nontraditional students needing precisely what our program doesn't provide -- **training** in grammatical rules and imitatable rhetorical forms. These courses, with all due respect, are not of much use to us as models either. Third, while there is talk, there is not much concrete action in the writing community about how the new tool opens new doors. But that potential is what we would like to investigate.

Writing courses necessarily deal just with print text. But, as Lehigh president Gregory C. Farrington points out in Dancing with the Devil (76), "within ten years inexpensive technology will allow each of us to send and receive video, audio, graphics, and text, synchronously or asynchronously, wherever we are in the world." This is a death knell for writing courses as we know them. What would we even call a document that contains text, image, video, and sound? A "paper"? An "essay"? A "theme"? In the very near future we will need new "grammars" and new "rhetorical forms." We will need new labels and language. We suspect that the students we will be working with in a totally online environment will be very bright, aggressive, and highly motivated young people, ***who are also technologically sophisticated***. What better place to begin teaching in this Brave New World.

## Mathematics 21

Students enrolled in the Web-based version will use the same textbook as the on-campus version of Math 21, and will have the same required structure of readings, homework, quizzes, and exams. This entails the following:

1. Assigned homework problems from the text, some using a computer-algebra program (accessible from the Web page) to do a portion of the computations and graphing. The majority of these problems, however, stress on-paper computations and techniques, and by-hand graphing will also be required. A mixture of drill exercises and more subtle problems are assigned to develop both skills mastery and critical analysis. These assignments can be uploaded via the course Web site and returned to the student in the same manner.

2. Longer assignments, more extensively using the computer-algebra program to address complex and realistic problems that would not otherwise be accessible to calculus students, will be provided on-line. These will be submitted electronically (as they often are for on-campus students), commented upon, and returned to the student.

3. Short quizzes on each topic will be provided on-line both to offer immediate reinforcement of the key concepts and to gauge each student's difficulties as they develop, allowing intervention by the instructor before the student becomes too lost.

4. Two major exams will be taken at specific points in a student's progress through the material. These will be proctored, written, essay type exams. These exams would be substantially the same as the on-campus mid-term exams, although the timing of their administration would be determined by the

student's pace through the material (subject to deadlines), rather than the rigid pace of the on-campus course.

5. When the student has completed the course (or reaches a predetermined deadline), a comprehensive final exam will be administered in the same manner as the major exams. Again, this exam will be of the same nature and scope as for the on-campus course.

The course presentation will be divided into discrete topics, as with the on-campus course. However, there will no longer be the need to shape each topic to be covered in a 50-minute presentation, so that the discussion of each topic can expand or contract as needed. Students will be instructed to first do the assigned reading, then to go through the on-line presentation accompanying that topic. This presentation will include a written lecture component highlighting the important points of the topic, audio/video (or audio alone) commentary on those points by the instructor, meant to be played at specific times while the student is going through the lecture material, along with examples that can be presented in various formats. Applied examples can be described through video presentations, with accompanying written modeling of the problem, perhaps using the computer algebra system to perform calculations and produce graphics. Drill and practice examples of the mathematical techniques can be best presented as a step-through textual presentation, with animated graphics as warranted, along with either textual or audio (or video) commentary as needed. Examples can also encourage students at key points to develop their ability to apply the proper technique.

Clearly, students can view these materials as often as necessary for them to understand the topic, which presents an advantage over in-class lectures. What is lacking in this presentation mode, however, is the interaction between the student and the instructor. Feedback and interaction, between the student and the instructor individually, among the students with or without the instructor's participation, and in a group discussion, all must be provided. Individual interaction between a student and the instructor will be provided primarily via exchanges of e-mail. Experience has shown that, although students occasionally have difficulty expressing mathematical topics though e-mail, forcing them to write their questions, thus completely expressing themselves, is beneficial. E-mail responses often accomplish the objective of steering a student towards the right path better than an office visit.

Group discussions among students will be achieved by use of a discussion group and/or a chat room, where students can post questions or observations, and follow-up on questions posed by other students. Students now are quite familiar with this mode of interaction through internet newsgroups. Although there are often heated exchanges in these forums, there is also considerable learning and exchange of information as well. The instructor will participate in this discussion forum, but not dominate it. The instructor could also intervene, if needed, to keep the discussion on-topic and to correct any misleading information that might be propagated. Both e-mail and discussion exchanges are not limited to text. Formatted mathematics, graphics, and even video clips can be attached where needed during the exchange. Group discussions will take place by establishing a chat room, with specific hours of operation. Visual as well as textual interaction will be facilitated by a blackboard accessible to all and simultaneously displayed on all participants' screens.

Additional material that students can explore as their interests lead them can very easily be provided. Links to historical information, more advanced topics, and more general mathematical discussions will be included in the material. More general mathematical discussion will be, as part of the course, provided in a question-and-answer format led by the instructor, where questions from students will be (selectively) discussed in a general mathematical setting, leading students to explore mathematics beyond the scope of the course material. The aim of this feature of the course is to replicate the general questions that occasionally arise, either during office hours or in a lecture, that provide opportunities to discuss topics that are not directly related to the course, but which come out of connections students make between course material and other subjects that interest them. The model for this format is Frank Morgan's "Math Chat", available on-line at the MAA's site, http://www.maa.org/news/columns.html . Similar forums are provided by Swarthmore's "Ask Dr. Math", http://forum.swarthmore.edu/dr.math/ .

**Currently-Available Web Resources:** In our review of the mathematical resources currently available on the Web, we found three general types of sites: Hypertext courses; Computer-algebra courses; and Web-based tutorial workbooks. The current proposal will combine the successful strategies of each.

**Hypertext Courses:** Many Web-based courses tend to provide only a hypertext interface to the usual calculus material, with perhaps some additional commentary. One site, http://www.bc.cc.ca.us/math6c/, which was supposed to be a Web course, offered a discussion groups similarly to what we plan. However, the discussion seemed to be canned, with each topic being started by a single student asking how to solve a particular question, with the response being a complete solution provided by the instructor, formatted to display mathematical notation. Other than that, they relied heavily on the required textbook, with very little additional material provided as lecture notes. Homework was taken exclusively from the text. Weekly quizzes fit within the format we propose, having a number of either multiple-choice or short-answer questions to provide students with instant feedback and, I presume, to provide instructors with a quick measure of student performance.

**Computer-Algebra Courses:** Other course sites are primarily distribution sites for worksheets of material, often files which needed to be loaded into a computer-algebra program to run. Such methods are quite restrictive. A number of experiments in teaching calculus on campus (now on the Web as well) using computer-algebra programs in lieu of textbook, lecture, and even instructors have taken place over the last several years. The foremost project is Calculus & Mathematica, run from the University of Illinois and Ohio State University by Jerry Uhl and others. Their site is http://netmath.math.uiuc.edu/home.html. This is a complete Web course offered for University credit to anyone wishing to enroll. Students do not have to be enrolled in UIUC to participate. Materials are exclusively Mathematica notebooks, in formats only for Mac or Windows computers. The interface does not provide a link to the software itself, only providing worksheets to download and run on local machines. There are several types of worksheets used, called "Basics," "Tutorials," "Literacy Sheets," and "Give it a Try." The first three worksheets are example calculations and problems with answers provided (which may need to be entered into Mathematica to display properly), with differing emphases indicated by their names. The "Give it a Try" worksheets are the primary learning tool for this program, where the student must provide the code to answer the questions, and then interpret those answers. Mathematica must be purchased, which for the full version is a $300-$500 expense. Student versions may or may not be available to off-campus students. Student interaction with the instructors for the course is provided through both a chat room and discussion board that is only accessible to students in the course. They can also receive homework assignments and take on-line quizzes. Instructors appear to be advanced undergraduate students (a classified ad for such instructors appears in the site). Primary lessons, mathematica worksheets, are currently available for download, but apparently will be changed over to a CD in the future.

Calculus & Mathematica was taught here at Lehigh several years ago, in an on-campus format. Even with the students being present, the focus of the material to the Mathematica program was too confining. Students missed many of the more subtle theoretical points of the subject; topics which were not adaptable to the computational program, such as rigorous discussion of limits and the theory of integration (including the Mean Value Theorem) were omitted. In general the focus is too much on computation, and graphical presentation, with insufficient attention paid to underlying ideas. Without additional presentations, which was eventually provided via lectures, the course was incomplete. The aims of that course are more computational than most calculus courses, and are not well-suited to the needs of our students.

**Web-based Workbook Courses:** Temple University has an extensive interactive workbook for calculus drill problems, at http://www.math.temple.edu/~cow/. It appears this is designed to be used in conjunction with their on-campus courses, since it does not provide sufficient material for a full course. The workbooks are broken down into minute steps, which the student is expected to provide responses for (such as computing a derivative to provide the slope of a line, for example). A few of these workbooks were tried, but quickly we found to be tedious. This format might be acceptable for a very elementary course, but proceeds very slowly.

**Resource Centers:** There are numerous Web sites which provide supporting documents for traditional courses (we have several here at Lehigh), or links to other support material. The University of Texas has a large site of this sort, http://www.utexas.edu/world/lecture/math/, which is mostly links to other sites with notes or other materials. These sites are not intended to replace traditional courses in any way.

## Design of the Courses

Each course will be designed as an online version of the on-campus course offered at Lehigh. This means the same content will be presented with the same expectations for success. This also means the faculty involved will *not* simply design materials to be placed on a Web site for students to pass through on their own. Instead, the same faculty member who designs the course will also be responsible for interacting with students enrolled in the Web-based versions. This interaction is an imperative component of these courses, and will be facilitated via a combination of discussion groups, chat rooms, email, video conferencing (if applicable), and other media. Each section of the five courses will be delivered three times throughout the term of the project. The sections will include: a "traditional" course (all students on-site, yet using some media elements), a Web-based course for high school students *only*, and a Web-based course for a *combination* of high school students and current first-year students on-campus. This combination allows the project staff to investigate the effectiveness of the courses, the materials, and the process with a high degree of control (this organization is discussed in greater detail in the *research design* section).

## Advisory Committee

To help the project to get off to a good start, the planning committee is recommending two external committees be created during the course of the project. The first is an advisory committee. The advisory committee will be comprised of individuals--one from each of the five disciplines, as well as one in academic computing--with previous experience in Web-based course creation and/or delivery in the particular disciplines. Each committee member would be solicited by the content expert within the Clipper Project, and would spend two days on-site work with and advising the content expert during the initial stages of the project. The intent is: to learn from what others have done; to not repeat any previous mistakes; and to gain an additional perspective from a peer. Each member of the planning committee was charged with contemplating the type of person he or she might enlist for this role. Among those noted: a physicist with experience in creating and utilizing Java applets in a college course, the director of a learning and technology assessment center, and a staff member from the National Science Foundation with experience in and knowledge of on-going projects in technology-based curriculum development in the sciences. These committee members would visit only once--at the beginning of the project--to assist the faculty involved in the Clipper Project in "ramping up" with their development.

## External Evaluation Committee

Additionally, the Clipper Project planning committee is recommending the creation of a second external committee--comprised of experts in the various disciplines--who would make two site visits during the course of the project. This committee would be enlisted to provide external evaluation of the project's progress, suggestions for continuation, suggestions for continued development, and recommendations for extension of the endeavor once the funding period has ended. Membership of this external committee would be different than that on the consultation committee. Each member of the planning committee was charged with contemplating the membership of this committee, as well. Among those suggested: the National Science Foundation education directorate in chemistry, the director of Academic computing from a major technical institute, and the Executive Director of a major educational professional organization. This committee would be convened on-site once toward the end of the second year of the project (mid-point of development cycle) and again at the end of the third year (end-point of development and delivery of courses). Each visit would be scheduled for two days.

## IMPLEMENTATION

There are two levels of implementation that require explication. The first is the *design and development* stage of the project. The second is the *delivery and support* stage.

### Design and Development

Design and development will be the first level of activity for the Clipper Project, and it will be the most personnel- and resource-intensive component of the project. Course development primarily will occur during the first two years of the project: two courses will be developed during the first year, and three more will be added the second year. Course interactions, materials, communication vehicles, and support mechanisms must be designed before students are engaged in the process. Thus, the design stage will require the instructors to interact with the technical staff, the administrative staff, and focus groups of students. There are two design and development components to describe--project-wide and course-specific:

**Project**

The project personnel will need to put in place the appropriate technologies and support for students and faculty to succeed. From a technological viewpoint, this will require that the technical staff secures and configures the hardware (servers, networks, workstations) and software (development and content) early in the process. The systems administrator and IT consultant will work with the project director to ensure that this base-level technology is in place quickly. This will require the purchase of appropriate hardware and licensing of requisite software within the first month of the project. Once the technological infrastructure is in place, design and development of the content will be enabled.

Some content and support mechanisms will be necessary for all students, regardless of the course in which they enroll. For example, some pre-requisite skills will be assumed for participation within the courses. These skills might include: using a Web-browser, using a word processor, posting/reading messages on a discussion group, among others. Students who are not able to perform these functions may not fair well in a Web-based course. Therefore, the project personnel will create instructional modules that teach these pre-requisite skills, and offer them from the project Web site for those students who need them. Once students are familiar with and able to use the tools, they will be ready for the courses.

**Courses**

The Web-based courses envisioned by each of the faculty members do not exist yet. They will need to be developed and tested before offered to students. This will require varying types of media development and involve varying levels of sophistication. Some courses will require interactive animations (Chemistry, for example), while others may require group "workspaces" for more in-depth and varied discussions of course materials (English, for one). The IT consultant, the systems administrator, and the video production personnel will work with other members of the Information Resources department at Lehigh--specifically, with the four other IT consultants currently in place--to form a technical design and support team that will facilitate the design and development of each course. The technical team will work as a functional team, drawing on the expertise of each member. Some team members are more technical, others are more instructional design-oriented. Having them function as a team, however, allows the project to draw upon the expertise of each, as appropriate, in the most cost-efficient and effective manner.

Each faculty member will be assigned a technical team member who will serve as the "point-of-contact" between the content and technical dimensions. However, the faculty member will work with the various members of the technical support team, as appropriate. The content experts will also be supported by a graduate student, who will be responsible for collecting and organizing materials, obtaining necessary clearances (for example, applicable copyright permissions for materials and readings), and for preliminary testing of course materials as they are developed. In addition, the content expert will identify particular software applications or other tools that will be necessary for the course--for example, the Engineering I

course will require students to utilize a particular C++ compiler. The design team will be responsible for securing the software and preparing any instructional modules deemed necessary to support novice students first engaging the software. We anticipate the majority of time and effort during the spring and summer of the first year will be dedicated to these activities. For some courses--particularly, chemistry and mathematics--development is likely to stretch into the Spring of 2001.

## Delivery and Support

The materials developed for the Web-based courses will be field-tested in the Fall 2000 semester within the traditional sections of each course. This will allow the project team to make initial edits to the materials before offering them to the first cohort of online students. The first two Web-based offerings (Math and Economics) will occur in the Spring and/or Summer of 2001. After the first iteration, it is likely that edits will be required. Therefore, the faculty content experts and the technical support staff will spend the next fall adjusting course materials and field-testing them again in the traditional sections. A second iteration of the Math and Economics courses along with three new courses (English, Chemistry, and Engineering) will be offered in the Spring/Summer of 2002. Adjustments to content and structure of all five courses will be made during the following fall. All five Web-based courses will be offered again during the Spring/Summer of 2003; however, only English, Chemistry, and Engineering will be offered during the Spring/Summer of 2004 (see Table A on page 31 for a representation of this schedule).

Each of three *instructional conditions* will be offered for each of the five courses over a twelve-month period. These conditions will be: traditional; Web-based high school only; and Web-based combination (high school and college). The reasoning behind the three conditions is detailed in the research design section below. Because of scheduling and demand, some Web-based courses will be offered in the spring, others in the summer. Initially, enrollment for each section will be capped at 20. For the third condition (high school/college combined), the distribution will be 10 high school students and 10 college students. Offering each Web-based section at least three times will provide three cohorts of students to follow through their academic careers at Lehigh.

Each course will follow a timeline similar to the semester schedule. Students enrolled in the Web-based courses will be expected to read sections for an assigned textbook, experience lectures taught by the faculty (delivered online), interact with multimedia-based instruction modules (where applicable), participate in both synchronous and asynchronous interactions, and complete all requisite assignments and assessments. The Web-based courses will be delivered from the Clipper Project Web site. Students in the Web-based courses will be expected to fulfill the same criteria for success as those in a traditional section, and will receive the appropriate level of Lehigh University course credit upon successful completion of the course. Faculty and teaching assistants will interact with students in the Web-based courses via participation in the discussion groups, chat rooms at designated times, email, and other media, when appropriate.

**Assessments and Labs**

Some assignments--such as homework and some project work--may require feedback and grading. For these, the students will utilize their "digital dropbox." Each student will have a "digital dropbox" that he or she may use to turn in assignments for grading and to pick up graded assignments. The dropbox is accessible via the course Web site using a Web browser. Other assignments--such as simple quizzes to check for understanding--will be offered via the course Web site and collected in a database on the project server. Finally, some assessments--for example, midterm and final examinations--will need to be proctored. In these cases, the exam will be offered via the Web site, but the results will be submitted via a proctor. If the Web-based student is on campus--that is, is a college student participating in the college/high school combined condition--the teaching assistant assigned to the content expert will proctor the exam locally. For the high school participants, external proctors will be necessary. Proctors will be solicited from the students' high school--most likely, they will be teachers or administrators. Each proctor will be compensated for his or her time.

For some of these courses, laboratories are traditionally offered at the same time as the lecture/recitation. This is typically the case for Chemistry, Engineering, and--to some degree--Mathematics. Regarding the Clipper Project, the Chemistry course is the only course affected. At Lehigh University, the Chemistry lecture and the Chemistry lab are considered independent of one another--that is, one does not necessarily have to take a laboratory and lecture concurrently to succeed in either. Therefore, the Chemistry lecture (Chem 21) will be offered Web-based, but the off-campus students will be expected to take the Chemistry laboratory (a one-credit course) once they arrive on-campus. Whereas the Web-based sections of Chemistry 21 will represent some of the concepts via animations and interactions, it will not be assumed that these are of equal value as an actual laboratory experience--for which the students will ultimately be responsible.

**Support**
Students enrolled in the Web-based courses will have access to all the support available to any student enrolled in a course at Lehigh. This includes Web-based resources as well as phone support from the Information Resources help desk. The IR help desk is available via phone until 10 p.m. each evening. Given the fact that the survey of first year students suggests that the vast majority of students will access the Web-based courses between 4-10pm, this should be ideal. For additional support, the IR staff will also grant access to the Web-based help system being implemented on campus. Finally, students enrolled in the Web-based courses will have access to all necessary plug-ins and other software requisite for each course, as well as the support from the IR help desk available to traditional students. The Clipper Project technical staff will work with others within IR to create instructional modules on how to download and install necessary plug-ins (e.g., Quicktime Video, Flash animation, RealVideo) and instructional software (e.g., Maple, C++, StarOffice) for successful participation in the Web-based courses.

## MARKETING AND DISSEMINATION

Information regarding the Clipper Project will be disseminated to prospective high school participants as part of the admissions process. Brochures describing the project will be mailed (or emailed) to students after they initiate contact with the admissions office regarding application information. Additional information will be provided at two critical points during the admissions process: confirmation of the admissions office receiving a student's completed application and at the point of a student's acceptance of admission to the university. Students who express interest in the project prior to their admission will be contacted periodically to keep them apprised of application deadlines for participation in the Web-based courses offered as part of the Clipper Project. (Only students who have accepted an offer of admission from Lehigh will be considered for participation in the project to allow for monitoring of long-term outcomes throughout their collegiate experience). Information about the Clipper Project will be distributed to first year students on Lehigh's campus through academic advisors, emails disseminated to all first year students, and advertising posted on bulletin boards and in the campus newspaper. In addition, the Clipper Project program staff will disseminate information about the project to appropriate list-servs and professional journals. Finally, the project staff will solicit the assistance our colleagues in university communications and media relations to help the project utilize their existing network via direct mail pieces and contacting other media relations departments.

**Dissemination**
In an effort to share our process--as well as our results--with as many as possible, the project will utilize various channels for dissemination. This will include:

**The Clipper Project Web site** -- The project will establish a Web site (tentatively, http://clipper.lehigh.edu) that will serve as the hub of communication and activity for the Clipper Project. From this site, visitors will be able to access updates, white papers, discussion groups, data, reports, and other news. In addition, students will be able to access the courses by logging on via the Clipper Project Web.

**Conferences** -- Faculty, staff, and students associated with the Clipper Project will attend local, national, and international conferences within the disciplines--as well as those dedicated to technology and learning, and higher education--to share various components of the project with peers.

**Papers** -- Faculty, staff, and students associated with the Clipper Project will write papers and submit them to appropriate journals and other publications. Publications with the disciplines as well as the fields of teaching, learning, technology, and higher education will be targeted.

**Annual reports** -- Each year, the project director will prepare an annual report of the activities and findings for the Clipper Project. Elements of this report will be made available on the Clipper Project Web site.

**Lehigh Intranet** -- Lehigh University will soon be unveiling a new Intranet, designed to facilitate communication and information-sharing within the confines of the university. In an effort to disseminate Clipper Project news and goings-on within the Lehigh University community, we will place a link on the Lehigh Intranet to the main Clipper Project Web site.

**University publications** -- Lehigh has several periodic publications that will serve as appropriate venues for disseminating project information to current students, community members, alumni, faculty and staff. We will solicit the assistance of the University Communications and Media Relations staff to actively represent project news in the student newspaper (The *Brown & White*) the university newspaper (*Lehigh Week*), and the alumni relations publication (*Alumni Bulletin*).

**Partnerships** -- During the planning process, the Clipper Project planning committee entertained a handful of education management organizations--that is, companies that specialize in creating and serving online courseware. As a result of these site visits, we have established a dialog between the project personnel and some of the industry leaders in the burgeoning field of educational technology and courseware development. We will continue inviting representatives of these companies to visit, continuously exploring reasonable opportunities to partner with those in industry, if appropriate, to extend the reach and impact of the Clipper Project model.

**Clipper conference** -- The project planning committee has suggested that, toward the end of the project timeline, we host a conference on-site. At this conference, we will highlight particular processes and lessons learned via the project and share what we have learned with invited colleagues in teaching, learning, technology, and higher education.

**Clipper book** -- At the Clipper conference, each of the faculty and staff members associated with the Clipper Project will present a paper detailing the process and results of their particular experiences. These papers will then be combined into a manuscript for publication. This book will detail the entire process of the Clipper Project--each content area represented, as well as insights from the Academic computing, research, curriculum planning and development, and overall impact levels.

## THE RESEARCH DESIGN

As outlined in the preliminary proposal submitted to the Mellon Foundation in May of 1999, the purpose of this project is twofold. The first objective is to develop a core set of introductory college courses to be delivered via the Web to high school students preparing for post-secondary education, and the second objective is to assess the experiences and outcomes associated with these courses for students and faculty. It is important to note that one significant change has occurred as a result of the planning grant. Based on the data from the survey we issued--and to advance a more wide-reaching model once completed--the Clipper Project planning committee suggests it is reasonable to open the project up to all early admission candidates, rather than just those applying to the engineering school, as first suggested. Five questions frame this study, and they are as follows.

1. What are the implementation considerations (e.g., institutional, practical) when offering college courses to high school students via the Web?

2. How do faculty transform "traditional" on-campus introductory courses from a variety of disciplines to effective Web-based courses?

3. What are the costs (including time and financial resources) associated with developing and implementing a Web-based introductory course for high school students?

4. What are the short and long-term outcomes for students who participate in Web-based courses?

5. What are the short and long-term outcomes for faculty who develop and teach Web-based courses?

## Method

Overview of Research Design and Data Analysis

The research design has been developed to allow for within and between-groups comparisons across time. In addition, the project uses replication to test for cohort effects. As such, three instructional conditions will be implemented within each of five academic courses (English I, Math 21, Engineering I, Chemistry 21, and Economics I), and each condition will be offered once during three consecutive academic years. Table A displays the schedule for offering each of the three instructional conditions. The first instructional condition reflects a "traditional" model of instructional delivery: on-campus, face-to-face instruction. The second and third instructional conditions provide opportunities to evaluate two plausible models for providing Web-based instruction to high school seniors. The second instructional condition is Web-based instruction for high school seniors only, and the third is Web-based instruction for a "class" comprised of equal numbers of high school seniors and first year students at Lehigh University. This latter condition provides an opportunity to assess Web-based instruction for students on-campus as well as evaluate an instructional delivery model likely to be implemented in practice (i.e., allowing high school students to participate in Web-based college courses for students on-campus.) This third instructional condition also allows for the exploration of possible academic and non-academic outcomes (e.g., adjustment to college) which may result from high school seniors having the opportunity to interact with actual college students.

These instructional conditions provide the opportunity for between-group comparisons of student achievement, satisfaction, learning behavior, and long-term outcomes (e.g., course of study, cumulative GPA, etc.) Also, because the same instructors will teach all three conditions within each content area, the design allows for the assessment of the impact of Web-based course development on instruction provided via the "traditional" method of face-to-face contact. Quantitative and qualitative methods will be used to analyze project data. Quantitative analyses will include repeated measures multivariate analysis of variance (MANOVA) using student's grades, questionnaire responses, learning behaviors, and course evaluations as dependent variables.

Qualitative methods will be used to analyze data collected via faculty journals, logs, classroom observations and transcripts from meetings. Grounded theory will be used to identify themes from the data, to produce rich descriptions, and to categorize concepts for theory that emerges from the data. In addition, a case study methodology will be used to explore emerging concepts and processes relevant to the study, and to assess the overall costs and benefits of each course individually and the Clipper Project as a whole.

### Timeline for Completion of Major Project Activities

The Clipper Project is proposed to commence in January 2000 and conclude in August 2005. Development and implementation of the Web-based courses will occur in two phases. Two courses (Math and Economics) will be developed and taught during the first year of the project. The three remaining

courses (English, Chemistry, and Engineering) will be developed and taught during the second year of the project. Each course will be taught for three consecutive academic years (see Table B for a timeline for completion of the major activities associated with the Clipper Project).

**Participants**

Participants in this project include students (current and prospective) as well as faculty at Lehigh University. Across the five years of the proposed project, we anticipate that 900 students will participate in one of the three instructional conditions (see Table C for a breakdown of participants by instructional condition and year of the project). Twenty students will participate in each instructional condition the first time it is offered; however, if instructors determine that it is feasible to expand enrollment for subsequent years, we will increase the number of participants in each condition. In addition to the student participants, five faculty (see brief biographies provided in the personnel section) will serve as instructors for the project. High school participants will be solicited through informational brochures sent to seniors who apply to Lehigh. Information describing the project also will be disseminated via a Web-site describing the project linked to Lehigh admissions homepage. Student participants on campus will be solicited through a variety of means including information shared with advisors, emails distributed to all first year students, and advertising posted on bulletin boards and in the campus newspaper.

Consent will be obtained from all participating students. For the high school participants, consent will be obtained from both the student and one of the student's parents (or legal guardians). For first-year students on Lehigh's campus, consent will be obtained from the student only. Participation will be voluntary and all participants will be treated in accord with the ethical principles of the American Psychological Association.

**Incentives**

To ensure that we will receive quality data throughout the five years of the project, we will utilize an incentive system to reward students for continued participation in the project. This incentive will take the form of a series of good-faith gestures (such as gift certificates to the student bookstore) and lotteries for larger items (gift certificates to local area stores, for example). Students will be eligible for incentives after returning completed longitudinal data.

**Measures**

A variety of measures and methods will be used to collect data related to the five research questions outlined in the introductory section of this proposal. These measures reflect the following domains: implementation considerations; costs and benefits associated with the development of Web-based introductory courses; and short- and long-term outcomes for both students and faculty.

**Implementation Considerations.** To identify practical issues encountered during the development and implementation of the five introductory Web-based courses, we have begun (and will continue, pending funding) audiotaping all meetings involving faculty and project staff from the Clipper Project. The purpose of these meetings is for the project team to discuss issues related to the design and implementation of the Clipper Project. Transcripts of audiotapes, handouts, meeting notes, and email communications will serve as data for identifying problems (as well as their solutions) related to the implementation of the courses. Some examples of implementation considerations already identified during the initial planning stages include: Web accessibility for high school students; student interest in taking college courses during high school; scheduling considerations (e.g., best time of day, time required for completion of activities); ensuring accurate assessment of student performance; and faculty concerns regarding administering courses via the Web.

In addition to learning about implementation considerations at the university level, we are interested in learning about considerations at the high school level as well. To explore these issues, we will conduct

focus groups with administrators, guidance counselors, and teachers from high schools that have high numbers of students who participate in courses offered through the Clipper Project. The primary purpose of these interviews will be to explore the feasibility of a senior earning high school credit for completing university Web-based courses. Earning high school credit may enable students to enroll in a greater number of Web-based courses because they could take these courses in lieu of required courses at their high school. This, in turn, would allow students to amass more credits toward completing their undergraduate degree *before* they arrive on campus.

**Costs Associated with Course Development and Implementation.** To assess the costs associated with the development (and implementation) of the five Web-based courses, three types of resources will be measured: time, money, and personnel. Faculty will complete a weekly log of activities related to course development and administration. As part of this log, they will record the amount of time devoted to each activity. In addition, technical support staff will maintain detailed records regarding time and activities allocated to course development and implementation. Financial resources expended for each course will be calculated based on salary for faculty and support staff as well as other expenses incurred with the development and support of the course (e.g., hardware, software, and instructional materials). Logs will be used to identify all personnel involved with the design and implementation of the Clipper Project. Cost information will be collected for each course across all three of the instructional conditions (on-campus, Web-based high school, Web-based combined). Separate cost values will be calculated for development and implementation of each course.

**Student Outcomes**. A variety of measures will be used to assess short- and long-term outcomes for students. To assess short-term outcomes, we have selected measures that reflect students' knowledge and skills regarding course content (i.e., English, Math, etc.) and the use of technology to facilitate learning. Measures to assess students' knowledge and skills in specific course content include final grades as well as grades on assignments, quizzes, and projects. For Web-based instructional conditions, we will collect additional direct measures of student behavior and participation. These measures include (but are not limited to) number of email communications, amount of time devoted to course-related activities, and participation in synchronous and asynchronous discussions. (Students participating in courses on campus will be asked to provide self-report data regarding these types of learning behaviors.) Questionnaires also will be designed to assess students' perceptions of instructional activities, use of technology, and the course as a whole. In addition, students will be asked to provide self-assessments of their own knowledge of course content and instructional technologies. In our review of the literature, we were unable to identify a reliable and valid measure that assessed student's knowledge, skills, and attitudes regarding educational technology as well as academic content. One instrument that is customizable and appears to have promise for the Clipper Project is the Current Student Inventory (CSI) currently available through the Flashlight Program. If the current proposal is funded, we will develop our own self-report measures using items created by the Clipper Project evaluation team along with items from the CSI item bank.

Long-term outcomes for students will be assessed via direct and indirect methods as well. Each year, we will collect grades for subsequent courses within the content area in which the student participated. Transcripts also will be analyzed to assess if students' participation in the Web-based courses prior to high school benefited their academic program. In addition, yearly follow-up questionnaires will be distributed to participants to assess their own perceptions of the long-term impact of participation in the Web-based courses.

**Faculty Outcomes.** The process of introducing technology into instruction has been hypothesized to yield outcomes for faculty as well (Ehrman, 1997). We previously described measures to assess costs for faculty incurred during the development and implementation of Web-based courses. In addition to such costs, there are positive outcomes for faculty that can result from utilization of instructional technology in their courses. A few of these outcomes include increased competence in the use of instructional technology, incorporation of technology-based instructional methods in other courses, and changes in faculty-student relationships. To assess outcomes such as these, faculty will complete a questionnaire at the beginning and conclusion of each course that they teach (Web-based and on-campus). Sections of the questionnaire will complement the questionnaires completed by students. As with the student

questionnaire, we were unable to locate a measure of faculty knowledge, skills, and attitudes sufficient for the purposes of the Clipper Project. The Flashlight Program, however, is in the process of developing an item bank for a faculty survey, and we have reached a tentative agreement with the program to serve as a beta tester for this item bank. We will develop a customized questionnaire using items generated by the research team as well as items from the Flashlight Program's item bank.

In addition to the faculty questionnaire, we will collect direct observation data to assess the impact of developing the Web-based courses on the pedagogical practices of faculty. Observational data will consist of videotaping on-campus sections of the courses taught by faculty participating in the project. Finally, faculty self-perceptions will be collected via a weekly journal that will include reflections on the impact of instructional technology on teaching and learning as well as the process of developing courses for the Web.

**Summary of data collection measures.** A variety of measures will be used to collect data related to the five research questions. Primary sources of data include:

- transcripts of discussions among faculty and project staff during the development and implementation of the Clipper Project;
- transcripts of focus groups with high school administrators, counselors, and teachers;
- journals and activity logs collected by participating faculty and support staff;
- direct measures of student performance (grades and transcripts);
- questionnaires of students and faculty (before, during, and after participation); and
- direct observations of instructional activities and student learning behaviors in on-campus and Web-based courses.

Table D displays these measures as they relate to the research questions proposed for this project.

## THE BUDGET

The proposed budget for this 5-year project assumes an overlapping 3-year cycle of design, development, and delivery of the Web-based courses--followed by an additional year of follow-up data collection. The budget reflects the fact that courses are introduced in two phases, with two courses designed and taught in year one and three additional courses designed and taught the following year. Included are the budget figures, as well as a budget narrative describing the components.

### *Budget Narrative*

**Project Director** -- The project director will oversee the administrative and budgetary aspects of carrying forward the Clipper Project. In addition to coordinating the activities of the faculty, staff, and students involved, the project director will be responsible for producing annual reports of project activity, as well as any other documentation deemed necessary from the Mellon Foundation or the university. Since project activity in years four and five will be limited primarily to data gathering and synthesis, compensation for the project director will be reduced in the final two years of the project.

**Faculty** -- A faculty member from each of the five designated content areas will serve as the expert for the design, development, and delivery of that particular course. The faculty that are currently on the planning committee will serve as the experts during the actual project. Each faculty member will be responsible for working with the project director, the technical staff, the students, and their department colleagues to produce a Web-based version of their course. Once the course is developed, each faculty member will also be responsible for teaching each section of the Web-based course each of the three years. Additionally, the faculty members will be responsible in years two and three for working with the technical support staff on any course material revisions deemed necessary. Compensation for the faculty

will be the equivalent of one month's summer salary--average of $8,000. Since neither development nor deliver is necessary in the final stage of the project, the faculty will not be supported in year five.

**Researchers** -- The research component of this project is paramount. Therefore, two full-time researchers will be employed--one as the co-principal investigator. The two researchers will be supported throughout the project, to design and carry out evaluation of the effects of this project over the course of five years.

**Instructional Technologist** -- An instructional technologist is one with expertise and training in instructional design, courseware development, learning theory, and technical systems. The project will hire an instructional technologist to work with the faculty and the graduate students in developing the Web-based courses. Since an instructional technologist generally has a macro-understanding of the process of courseware design, it will be important to have this person full-time with the project during the first four years. During year five, there will be little need for such a person, so that position will not be funded.

**Systems Administrator/Web Developer** -- The Clipper Project will need a dedicated systems administrator, particularly early in the process. The systems administrator will be responsible for installing and maintaining the servers and software employed during the creation and initial delivery of the Web-based courses. In addition, the systems administrator will assist faculty with Web site programming and design during the development of the Web-based courses. Additional responsibilities will include: working with the university's Information Resources staff to ensure a smooth interface between the project's technologies and those in place at the university level, backing up all servers and requisite data, and setting up student accounts. The systems administrator/web developer will play a critical role in this project and will be employed full-time for the first four years of the project. This position will be reduced to half time as the project concludes during the fifth year.

**Support Technician** – Due to the two-phase introduction of courses, the need for Web design and technical support will be the greatest during the second, third, and fourth years of the project. As a result, an additional developer/programmer will be hired to provide support for faculty during these critical years of the project.

**Video Production** -- Some Web-based digital video will be necessary to successfully implement the Web-based courses and support materials within the Clipper Project. Therefore, some video production resources are necessary. However, the planning committee did not feel the anticipated need warranted the hiring of a full-time videographer nor the acquisition of very expensive video production machinery. Instead, the Media Services division of Information Resources at Lehigh University has agreed to serve as the video production unit for the Clipper Project. Rather than spending the money to purchase a separate digital video production suite (often costing between $20,000-$60,000) and hiring personnel, the project will budget $28,500 to upgrade some existing production equipment and secure the assistance of the Media Services staff for project activities.

**Secretary** -- Coordinating a project such as this one will require some administrative assistance. We have budgeted for full-time secretarial help during the first three years of the project, then reduced to half-time and quarter-time help in years four and five respectively. The secretary will be responsible for helping the project coordinator with payroll, coordinating meetings, interfacing with the various departments and staff, overseeing space allocations, and other factors of daily operations. This will be an essential position if the project is to run smoothly and efficiently.

**Graduate Assistants--content** -- Each of the five content areas will need a graduate assistant to help in the development, and then in the delivery, of the courses. The student assistants will work as liaisons between the faculty content experts, the technical support team, the research team, and the project coordinator. Their responsibilities will range from development, to securing materials and permissions for course development, to interacting with students on discussion groups and chat rooms. The proposed budget provides half-time support for one student assistant for each of the content areas for the three years of the project in which the course will be taught. This will provide valuable assistance to the faculty

and technical support personnel, as well as valuable experience for the students, and will be necessary for the success of the project.

**Graduate Assistant--technical** -- An advanced graduate student in either educational technology or Technology-based Teacher Education will be necessary to coordinate the activities of the content assistants, as well as to provided overall technical assistance to the project. The technical assistant will work closely with the instructional technologist and the project coordinator. Therefore, this student assistant will work full-time throughout the first three years of the project. In years four and five, this position will not be necessary and therefore will not be funded.

**Graduate Assistant--research** -- An advanced graduate student in educational research will be necessary throughout the project. This student will work closely with the research team and will report directly to the lead researcher/co-principal investigator. Because of the importance of the research component--and the challenge of coordinating and gathering the various forms of data from the project participants over multiple years--this assistant will be funded full-time throughout the length of the project.

**Proctors** -- To ensure comparable rigor between the Web-based coursework and traditional coursework, the students in the Web-based sections will need to complete a mid-term and a final exam for each course. The faculty on the planning committee felt it would be reasonable to contract with teachers and/or administrators at the high schools from which the participant students were drawn to proctor these exams. The budget therefore reflects the allocation of $50 per proctor, per student, per exam, for each of the five courses offered.

**Advisory and Review Committee** -- The roles of the advisory and review committees are detailed in a previous section. Because the input of these committees is imperative to the success of the project, it is important that we budget accordingly. The proposed budget contains a $1,000 honorarium for serving on the committee, as well as money for transporting each member on-site, housing, and meals.

**Equipment/Software** -- With the heavy emphasis on technology in a project such as this, it is evident that some hardware and software will be necessary. The budget reflects the need to purchase a Web server for the courses, a video server for the animations and videos produced, workstations and development software for the technical support team on which to develop the courseware, and additional software licenses for the students enrolled in the courses. The majority of these are one-time acquisitions that can and will be purchased at the beginning of the project--with the exception of updated development software and the recurring costs of software licenses.

**Marketing** -- Money allocated for marketing will be used to solicit and retain participants for the project. This will be accomplished by implementing the marketing plan detailed previously. The funds will be used to pay for the creation and distribution of information about the project through the identified channels--for example, for creating, printing, and mailing flyers--via the Admissions Office--to students who inquire about and/or apply for early admissions.

## THE TEAM

**Alec Bodzin, Ph.D.** (North Carolina State Univ., 1999): Dr. Bodzin is Assistant Professor of Science Education in the Department of Education and Human Services' Technology-based Teacher Education program. He will serve as a qualitative researcher and assist in instructional course design for the Clipper Project. He is a science teacher educator with a biological background and has an interest in the improvement of science education. His research interests include telecommunications use with preservice teachers, use of visual instructional technologies in science curricular development, evaluation of Web-based instruction; and design issues for Web delivered inquiry-based learning. He has recently developed a variety of interactive multimedia projects, including a CD-ROM and World Wide Web site for exploring coastal issues in North Carolina.

**Stephen Bronack, Ph.D.** (University of Virginia, 1998): Dr. Bronack is Assistant Professor of Educational Technology and Technology-based Teacher Education in the Department of Education and Human Services. He will serve as the principal investigator and project coordinator for the Clipper Project. Dr. Bronack teaches courses in curriculum, instruction, computer-based training, and research on technology and teaching. His research interests include: Web-based learning environments, case-based teaching, teacher development, and instructional discourse. Dr. Bronack recently co-developed--with some colleagues at the University of Virginia--CaseNET, a suite of Web-based courses offered to preservice and inservice teachers in the United States, Canada, and Norway.

**James DiPerna**, **Ph.D.** (University of Wisconsin-Madison, 1999): Dr. DiPerna is Assistant Professor of School Psychology in the Department of Education and Human Services. He will serve as the research coordinator and co-principal investigator for the Clipper Project. Dr. DiPerna teaches courses on test development, assessment of intelligence, and professional issues in school psychology. His research interests include academic and emotional competence, school-based prevention programs, and the assessment of students with disabilities. Dr. DiPerna is preparing to publish the Academic Competence Evaluation Scales: a student rating scale designed to assess skills, attitudes, and behaviors that predict academic success. In addition, he currently serves as an evaluation consultant for two projects exploring the effectiveness of an instructional approach designed to promote prosocial behavior in schools.

**Tim Foley, Ed.D.** (Lehigh University, 1988): Dr. Foley is the Director of Client Services for Information Resources at Lehigh University. He will serve as coordinator of technology services for the Clipper Project. Dr. Foley has been at Lehigh for twenty years holding various educational, technical and administrative positions including technical consultant and associate director of computing. He has taught graduate courses in instructional programming as well as undergraduate courses in mathematics and computer science. His current position provides oversight responsibility for client services in a merged library, computing, and telecommunications environment. He has published and presented over 40 papers at national and international conferences on the problems and issues of developing, implementing and managing university information systems.

**Natalie Foster, Ph.D.** (Lehigh University, 1982): Dr. Foster is Associate Professor in the Department of Chemistry. She will serve as the content expert in Chemistry. A member of the Lehigh faculty since 1985, she has taught courses at the undergraduate level in Introductory Chemistry, the Organic Chemistry Laboratory, Technical Writing and in the Advanced Organic Analysis Laboratory and at the graduate level in Spectral Analysis and Medicinal Chemistry. Except for the laboratory courses, all have been taught in both traditional format and for Distance Education via satellite. She is currently working on a freshman chemistry textbook with David Lavallee, Provost at SUNY New Paltz. Her research interests include studies of intermolecular interactions relating to the development and analysis of candidate compounds for use as contrast enhancement agents for Magnetic Resonance Imaging.

**Ed Gallagher, Ph.D.** (Notre Dame, 1970): Dr. Gallagher is Professor of English, Department of English and will develop the first-year composition course in the Clipper program. Dr. Gallagher's area of specialization is American literature. He is the teaching page coordinator of the Web site for the Society of Early Americanists and editor of SiteScene, a monthly review of new Web sites in American Studies. At Lehigh, Dr. Gallagher has served as chair of the English Department and has received the Alfred Noble Robinson Award for Distinguished Service to the University and the R.R. and E.C. Hillman Award "for a person advancing the best interests of the university" (Lehigh's highest faculty award).

**Tom Hyclak, Ph.D.** (Notre Dame, 1976): Dr. Hyclak is Professor of Economics and Chair of the Economics Department. He will serve as the faculty content expert in Economics. A member of the Lehigh faculty since 1979, Dr. Hyclak has taught undergraduate courses in economic principles and intermediate micro- and macro-economic theory along with courses in urban economics and labor-management relations. He won the Bernard A Briody Jr. Award for distinguished teaching and advising of students in 1984--a Lehigh University distinguished faculty award--and was the Sue and Eugene Mercy Jr. Professor of business and economics from 1985 to 1988. Prior to his appointment as department Chair, Professor Hyclak was Associate Director of the Martindale Center for the Study of Private Enterprise and the Director of the Kalmbach Institute for the Study of Regional Political Economy. His

recent research has focused on the performance of urban labor markets with particular emphasis on the determinants of urban unemployment and changes in urban wage inequality.

**David Johnson, Ph.D.** (MIT, 1977): Dr. Johnson is Associate Professor of Mathematics in the Department of Mathematics. Faculty at Lehigh since 1984, Dr. Johnson will serve as faculty content expert for mathematics. Professor Johnson has taught courses ranging from basic algebra and precalculus, through calculus of various types, up through graduate courses in differential geometry and analysis. His research specialties are in differential geometry, analytic geometry, and geometric measure theory, and he has published approximately 20 papers on these subjects. Professor Johnson has led the efforts of the Lehigh Mathematics Department in various innovations in calculus instruction, including introduction of computer-algebra systems to the curriculum and various experiments in alternate modes of instruction.

**Jacob Kazakia, Ph.D.** (Lehigh University, 1972): Dr. Kazakia is Professor of Engineering Mathematics in the Department of Mechanical Engineering & Mechanics. He will serve as the faculty content expert in Engineering. Dr. Kazakia has taught courses ranging from Freshman Calculus to graduate level Numerical Methods, in both the department of Mathematics and the department of Mechanical Engineering. Dr. Kazakia's research interests lie in the interface of fluid mechanics and applied mathematics. He has written more than 20 scientific articles in various journals, and has developed software (using Visual Basic) for the sizing and pricing of axial compressors.

## References / Notes


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[2]A. A. Russell, O. L. Chapman, P. A. Wegner: “Molecular Science: Network-Deliverable Curricula,” J. Chem. Educ. **1998** (75), 578-579.

[3]See http://server2.nslc.ucla.edu/ms/index.htm

# Tables

**Table A.**

**Course schedule for each academic year during the Clipper Project**

| | 2000-2001 | | 2001-2002 | | 2002-2003 | | 2003-2004 | | 2004-2005 |
|---|---|---|---|---|---|---|---|---|---|
| | **First Semester** | **Second Semester** | **First Semester** | **Second Semester** | **First Semester** | **Second Semester** | **First Semester** | **Second Semester** | **First Semester** |
| **Instruction Condition** | | | | | | | | | |
| On-campus | **Economics Math** | | **Economics Math English Chemistry Engineer** | | **Economics Math English Chemistry Engineer** | | **English Chemistry Engineer** | | |
| Web: College & High School | | **Economics Math** | | **Economics Math English Chemistry Engineer** | | **Economics Math English Chemistry Engineer** | | **English Chemistry Engineer** | |
| Web: High school only | | **Economics Math** | | **Economics Math English Chemistry Engineer** | | **Economics Math English Chemistry Engineer** | | **English Chemistry Engineer** | |

**Note:** Some of the Web-based courses will be offered during summer instead of the second semester.

**Table B.**

**Timeline for completing major activities associated with the Clipper Project**

| | 1999-2000 | 2000-2001 | | 2001-2002 | | 2002-2003 | | 2003-2004 | | 2004-2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Second Semester | First Semester | Second Semester | First Semester | Second Semester | First Semester | Second Semester | First Semester | Second Semester | First Semester |
| **Activity** | | | | | | | | | | |
| Hire personnel | | | | | | | | | | |
| Design surveys & other measures for data collection | | | | | | | | | | |
| Develop instructional activities for Web courses | | | | | | | | | | |
| Recruit student participants | | | | | | | | | | |
| Teach Web-based and traditional courses | | | | | | | | | | |
| Collect student data | | | | | | | | | | |
| Collect faculty data | | | | | | | | | | |
| Collect follow-up data | | | | | | | | | | |
| Data analysis | | | | | | | | | | |
| Dissemination of results | | | | | | | | | | |

**Table C.**

**Number of participants by instructional condition during each academic year of the Clipper Project**

| | 2000-2001 | | 2001-2002 | | 2002-2003 | | 2003-2004 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Instruction Condition** | **First Semester** | **Second Semester** | **First Semester** | **Second Semester** | **First Semester** | **Second Semester** | **First Semester** | **Second Semester** | **Total** |
| On-campus | **40** | | **100** | | **100** | | **60** | | **300** |
| Web: College & High School | | **40** | | **100** | | **100** | | **60** | **300** |
| Web: High school only | | | | **100** | | **100** | | **60** | **300** |
| **Total** | **40** | **40** | **100** | **200** | **100** | **200** | **60** | **120** | **900** |

**Table D.**

**Data collection measures for each research question.**

| | Research Questions | | | | |
|---|---|---|---|---|---|
| **Measure** | Implementation considerations | Process of transforming on-campus course to Web-based | Costs associated with developing Web-based courses | Short- and long-term outcomes for students | Short- and long-term outcomes for faculty |
| Transcripts of project meetings | X | X | X | | X |
| Journals & activity logs of project staff | X | X | X | | X |
| Direct measures of student performance | | | | X | |
| Faculty questionnaires | X | X | X | X | X |
| Student questionnaires | X | | | X | X |
| Observations of instructional activities and student behavior | | | | X | X |

# Appendices

# Appendix A

## First-year Student Survey

**Incoming Student Computer Survey**
**Fall, 1999**

Lehigh University is exploring the possibility of offering several core academic courses via the Web to incoming first year students before they arrive on campus. In an effort to explore the feasibility of this project, we ask that you respond to this brief survey regarding your preferences and prior access to the Web. After completing the survey, please return it to your Gryphon. **All completed surveys will be entered in a drawing for one of twenty-five $10 gift certificates to the University Book Store.**

**Your Initials:** **Date of Birth:** **(mm/dd/yy)** **Gryphon's Name:** _____

Please ***CIRCLE*** the appropriate answer for each question.

**Sex:** Male Female **Age:** _____ **Location of High School:** Urban Suburban Rural

**College:** Arts & Sciences Business & Economics Engineering & Applied Science

1. Did you have access to the Web during your senior year of high school? Yes No

2. If so, from where did you access the Web? (Circle all that apply)

   School Home Other: _____ (Describe)

3. A. What time(s) during the day did you typically have access to this computer? (Circle all that apply)

   **AM:** 6-8 8-10 10-12

   **PM:** 12-2 2-4 4-6 6-8 8-10 10-12

   B. How long did you typically have access during these time periods?

   Half hour or less Half hour to one hour One hour or more

4. Would you have been able to use this computer during the summer? Yes No

5. What type of processor did this computer have?

   **PC:** 486 or lower Pentium Class

   **Mac:** PowerMac or lower IMAC/G3

6. How fast was the modem on this computer?

   14.4 28.8 56 ISDN or Cable Network (LAN) Not Sure

**OVER**

7. Did you take any Web-based courses during your senior year of high school? Yes No

If yes, please provide **a brief description** for each Web-based course in which you were enrolled, the **institution** that offered the course (e.g., your school, a corporation, college or university, etc.), and whether or not you **completed** the course.

| Description of Web-based Course | Institution | Completed? |
|---|---|---|
| 1. | | Yes No |
| 2. | | Yes No |
| 3. | | Yes No |
| 4. | | Yes No |

**Lehigh Web-based courses would be offered at no cost to incoming students, and successful completion of these courses would allow you to receive credit toward your degree.** With this in mind, please ***CIRCLE*** the number of Web-based courses you would have taken if they were offered at the following times during the previous year. (It is important to note that taking four Web-based courses would be equivalent to taking a full-time undergraduate schedule.)

| | Number of Web courses would have taken at this time | | | | |
|---|---|---|---|---|---|
| 1st semester of Senior year | 0 | 1 | 2 | 3 | 4 |
| 2nd semester of Senior year | 0 | 1 | 2 | 3 | 4 |
| Summer following high school graduation | 0 | 1 | 2 | 3 | 4 |

Please indicate which of the following Web-based courses you would have taken prior to arriving on campus for your first year. If there is more than one course that you would have taken, please **rank order** your priority (assign 1 to your first choice, 2 to your second choice, etc.) for enrollment. **Courses listed in BOLD are required for ALL first year Lehigh students.**

| | Would Enroll? | | Priority? |
|---|---|---|---|
| **Engl 1 (Composition and Literature)** | No | Yes | _____ |
| Eco 1 (Principles of Economics) | No | Yes | _____ |
| Math 21 ( Calculus I) | No | Yes | _____ |
| Engr 1 (Engineering Computations) | No | Yes | _____ |
| Chm 21 (Introductory Chemical Principles -- lab course) | No | Yes | _____ |
| Phy 11 (Introductory Physics I -- lab course) | No | Yes | _____ |

Would you enroll in a Web-based course offered by Lehigh before you were offered admission to Lehigh?
Yes No

Would you be more likely to enroll in a Web-based course if it enabled you to take an AP Exam?
Yes No

**Additional Comments:**

_____

_____

_____

**Thank you for taking the time to complete this survey.**