COLLABORATIVE DESIGN OF SCAFFOLDING TOOLS FOR HIGH ENROLLMENT UNDERGRADUATE COURSES: HOW STRATEGY, POLITICS, CULTURE AND EMOTIONS IMPACT THE DESIGN, TEACHING AND ADMINISTRATION OF BIOLOGY 101

A Thesis

Presented in Partial Fulfillment of the Requirements for

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Graduate School of The Ohio State University

By

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The Ohio State University
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ABSTRACT

The goal of this research is to investigate the design, teaching and administration of large-population biology courses. A secondary purpose of this study is to understand how faculty interpret and accept the existing design of a visual syllabus learning tool for aiding guided discovery pedagogy in Biology 101. The design of the visual syllabus tool is intended to aid and reinforce the transition from a traditional lecture model to a guided discovery learning pedagogy.

To explore the nature of the instructional system, I have chosen a qualitative case studies approach relying on narrative interviews with faculty and staff. Data from these interviews are split into four categories — strategy, politics, culture and emotions. This led to a deeper understanding into the process of teaching large undergraduate non-majors science classes and how to better support the faculty, staff and ultimately the students through different design approaches and instructional tools.

I examined the goal alignments that occurred between multiple stakeholders in the system as a way to develop insight into the objectives and complexities they shared. Interviews with faculty and support staff were synthesized and compared along with document analysis of syllabi, and student evaluations.

Inquiry into the issues surrounding the visual syllabus tool took the form of a design critique. By making the guided discovery pedagogy observable, the visual
syllabus aims to allow students, staff, and faculty to better anticipate, understand, and coordinate within its framework. Faculty expressed their understanding of the tool, and reflected on how it interacted with their goals and expectations.
Dedicated to Justin and Turkey,
who are always up for a walk
and distract me in all the best ways.
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CHAPTER 1

INTRODUCTION

This thesis represents the culmination of six years of participating with higher education domain practitioners, researching and developing experimental learning technology tools meant to scaffold non-traditional science pedagogy. The nature of my work as an instructional designer has led me to assist faculty, staff and graduate teaching assistants (TAs) in finding solutions to the problems that come with teaching large undergraduate classes.

Six years ago, I began working for the Introductory Biology Program (IBP) at The Ohio State University (OSU). The IBP is the program that runs the large-population majors and non-majors sequences of biology classes. The program employs faculty and graduate teaching assistants (TAs) from nine departments within the College of Biological Sciences. The IBP has a permanent staff of 10 people and takes in over five million dollars a year in student credit-hour revenue for the college. Yearly, almost 9,000 students take an introductory biology course. The average course size of Biology 101 is around 700 students.
1.1. Motivation

As an instructional designer for the program, I wanted to investigate some of the problems that arose from issues surrounding such a large and complex system. This research originally germinated out of a project I was designing to better support the inquiry-based, non-major curriculum of introductory biology courses. I was working closely with then-director Steve Rissing to design a visual syllabus. This tool would illustrate the connection between the professor-taught lecture portion of a Biology 101 class and a combination lab/recitation section of the same course, usually taught by a graduate teaching associate. Because these classes are taught using an inquiry-based approach, the students attend their lab/recitation before they attend the lecture on the associated topic. The goal for delivery of this syllabus was to design something that would represent connections and relatedness between labs and lecture while taking advantage of the ability to hyperlink supplemental course material on the internet. Some examples of the supplemental materials found on the visual syllabus might be information not usually included on a normal syllabus, such as what K-12 Ohio science standards were covered in a particular topic, websites to go for remediation of class topics and why particular lectures were included in a General Education Course (GEC) — or another way of saying what relevancy did the class topics have to the GEC curriculum.

The visual syllabus was meant to illustrate the unusual relationship between lecture and lab, something students have found difficulty with because of its non-traditional nature. In the inquiry-driven course model, a student participates in a guided, hands-on lab to discover concepts for themselves before hearing those concepts confirmed in
lecture. This model can seem somewhat backwards to a student unfamiliar with discovery learning.

Figure 1.1. Prototype of the visual syllabus.

There are a number of challenges facing the visual syllabus project. Because there are six different instructors and a night instructor for the Biology 101 class (two instructors each quarter, Autumn, Winter and Spring) each instructor has a different idea of how this particular class should be taught and varying levels of commitment to
teaching with inquiry-style pedagogy. Even if the instructors are using the same basic topical syllabus, each instructor has different stylistic choices as to how that material is presented. The faculty also have varying levels of the time and technical skills it might take to try something new in a class of over 700 students.

I wanted to investigate how such an ambitious course-wide design project might succeed in the future and gain a better understanding of the role of an instructional designer working in such a complex system as the IBP.

1.2. Problem Statement

Through observations and student comments, a need to emphasize the relatedness between the lecture and lab components in Biology 101 was identified. One way to accomplish this was put forward in the form of a technology-based visual syllabus tool designed to make something abstract like the inquiry-based pedagogy of the class more apparent to the students. In order to be used by the six professors who teach this course, the tool would need to be adapted to their specific teaching needs and a certain amount of buy-in would have to be fostered among the faculty.

1.3. Research Questions

1.3.1. Design Phase Research Questions

Research Question #1: How can a learning tool—a visual syllabus designed to scaffold the relationship between large lectures and their corresponding inquiry-based labs—better support individual instructors that teach Biology 101?
1.3.2. **Implementation Phase Research Questions**

*Research Question #2:* How do strategy, politics, culture and emotions impact the design, teaching and administration of Biology 101?

*Research Question #3:* How can instructional designers better understand the needs of instructors and develop a participatory design process of course tools to scaffold curriculum?

To answer these questions, I chose a qualitative case studies approach relying on narrative interviews with faculty and staff to facilitate the exploratory nature of the study. This led to a deeper understanding into the culture of teaching large undergraduate non-majors science and how to better support the faculty, staff and ultimately the students with innovative technological learning tools. In-depth interviews were conducted with the teaching faculty of Biology 101 and categorized results were triangulated with staff interviews and document analysis of the instructor’s syllabi.

1.4. **Background and Roles**

Biology 101, a large, introductory survey course at OSU has an enrollment of over 700 students and is taught twice a quarter. With the exception of the smaller night sections, a tenured professor in the College of Biological Sciences teaches each class. Because the IBP is a program and not a department, there is not a natural core group of professors to draw from. Biology 101 draws its instructors from the nine departments within the College. Each professor teaches the class once a year, for several years at a time. The students in Biology 101 attend lecture twice a week for an hour and a half and meet in smaller groups of around 24 students for lab/recitation sections led by TAs. The
TAs, like the instructors, are sent to the program from all over the College to fulfill their teaching requirement and earn their fee waivers if they are not on a research fellowship. When a TA in this college starts at Ohio State, they work for the IBP first, if they are on teaching rotation. The IBP may get them the next quarter or their home department may pull them back in order to teach one of its own courses or to do full time research. Part of the responsibility the IBP has to the College of Biological Sciences graduate students is to give them the teaching experience they need in addition to the research experience they are getting in their labs to qualify them for multiple post-doctoral job opportunities.

A permanent IBP staff member with the title of Course Coordinator handles course details in an effort to reduce the amount of administrative strain that would normally fall on a professor teaching such a large course. Some of the responsibilities of the coordinator are to train, manage and mentor the TAs, lead weekly TA meetings, handle emails from students about absences, grade confusion, and manage all aspects of the 30 lab sections associated with each Biology 101 lecture.

Biology 101 is taught using a discovery or inquiry-based pedagogy often referred to as "The Learning Cycle." This means that the students have the opportunity to experience and form their own opinions about theirs labs before hearing their professor lecture about the same topic in class. The idea that students be allowed to explore the natural world around them before having their ideas confirmed or denied is integral to the learning cycle.

This approach also was very much in line with the current recommendations in undergraduate education reform, such as the Boyer Commission report (1998) and the National Academy’s Commission on Undergraduate Science Education (1997), both of
which charged that large, Research-I universities were not serving their undergraduate students very well and challenged them to put some of the vast resources of such large institutions towards that goal.

Biology 101 is meant to offer students tight integration between lecture content and lab experiences, but because of the large number of people associated with teaching this class, it is very hard to ensure that all students are getting the best teaching possible. New professors who come to teach for the IBP usually have either limited experience with inquiry in their upper-level courses or no experience teaching in that style. Professors arrive with their own set of expectations about how the class should be taught. Their sense of ownership of the pedagogy used is limited at best and they may be intimidated — especially at first — by the size of the class they have been asked to teach. TAs arrive with even less teaching experience and often have a background in the “hard sciences.” Their own undergraduate experience may have relied heavily on traditional classes or they may be from a foreign country where the education system is set up very differently from ours. It is natural for both professors and TAs to have the tendency to draw from their own experience as a teaching model, but if the only experience they have is in a classroom where knowledge is transmitted didactically from the teacher to the student in a lecture format, asking them to teach using inquiry may be comparable to asking them to teach biology in another language.

In an effort to strengthen the course by emphasizing the relatedness between laboratory sessions and lectures, the IBP began designing technological learning tools meant to "scaffold" some of the course concepts that may not be outwardly apparent to the students. This sort of pedagogical resilience is meant to compliment the ever-
increasing TA training the IBP is developing and the greater involvement in teaching support for the professors.

The structure of the program means that the course coordinators and all other IBP staff work with and accommodate the instructors teaching the course, but answer to the director of the program. In the past, it has been the director who has set the overall goals of the class as well as the lab design. Currently the program is in a state of acute change as there is an internal college search for a new director. Since August of 2005, the IBP has had an interim director who has been involved with the IBP in the past and is very familiar with the way the program works. The changes that have transpired during the past year have impacted and somewhat altered the course of this research.

1.5. Thesis Organization

In this thesis I start by explaining the unique environment in which I work, because understanding the scale and complexity of the Introductory Biology Program’s roles and responsibilities is integral to understanding the complexity of the problem. Next, I look at the role of the instructional designer and what elements a designer must take into particular account when designing to support a course, curriculum and all of the different members of the IBP teaching system and their goals. I then explain how I went about gathering detailed accounts of what it is like to teach large introductory biology classes and what concerns and needs the professors share. I examine their accounts for accuracy and emergent patterns and try to formulate an explanatory framework for their expectations and needs from a course-scaffolding tool that can then be used in the next
iterative design of the visual syllabus and also as a guide to better understanding the complexity of designing for such a large and diverse learning audience.
CHAPTER 2

THE ROLES AND RESPONSIBILITIES OF AN INSTRUCTIONAL DESIGNER

2.1. Introduction

The role of the instructional designer or learning technology staff is still being defined in higher education. At smaller institutions and in some departments at large universities, professors are expected to design and implement new tools and technology themselves. In places like these, resources in terms of time or training might be scarce. In the IBP, the emphasis for the past five years has been for professors to bring their ideas and goals to a coordinator or staff member for further development and implementation. This frees the professor to concentrate on their research program and leave some of the details about course administration and development to the permanent staff. This is usually a good thing, as often the development of new course materials takes longer than a single quarter, but it has its drawbacks when there is confusion about how much influence or autonomy the instructional designer might have in regards to course development. The expectations for how much of the course development a professor might do and how much responsibility for the course a staff member might take varies across the board. The usual method for writing a literature review might be to situate the research in a field of well-established literature, but though the role of instructional designer has been around for over 20 years, when put into the context of the long
standing traditions associated with university culture, it is a relative newcomer to the scene.

In this chapter I will talk about some of the calls for change in the way universities teach their undergraduates. I will then talk about the role of an Instructional Designer as a facilitator of those changes and lay out some of the most common concerns and processes an instructional designer must take into account when working with professors and designing for large classes, such as Biology 101. I believe that having a better understanding of the role instructional designers play in higher education will allow for a more meaningful discussion as to the appropriateness of role and responsibilities as well aid in understanding the different design considerations when creating something for the instructional environment.

2.2. Calls for Education Reform

2.2.1. Reforming Science Education tables

In 1996, the National Science Foundation declared that all of America's undergraduates must attain a higher level of competence in science. In Science for All Americans, The American Association for the Advancement of Science says:

Science, mathematics, and technology are defined as much by what they do and how they do it as they are by the results they achieve. To understand them as ways of thinking and doing, as well as bodies of knowledge, requires that students have some experience with the kinds of thought and action that are typical of those fields (1989, ¶ 11).
Results from the Third International Mathematics and Science Study led a commission headed up by John Glenn to declare that science education in the US was nearing a low that was akin to the pre-sputnik era of U.S. history (Glenn, 2000). In 1996, the National Assessment of Educational Progress (NAEP), often referred to as the nation’s report card, reported that less than one-third of all U.S. students in grades 4, 8, and 12 performed at the “Proficient” level in mathematics and science (1996). The most recent NAEP report card, published in 2005, showed modest gains for grade 4 students, grade 8 remained unchanged, and grade 12 students showed additional decline in science achievement since 1996 (2005). These 12th grade students are appearing in college-level Biology 101 classes not long after they take these proficiency tests. One might argue that higher education not doing much to make up for what they are not learning in high school (Glenn, 2000).

One of the major charges against how we approach science education in the US is that it rarely gives young people a chance to test their potential abilities as future scientists by allowing them to explore the world in the way that working scientists do (Alberts, 2005). One reason that these opportunities do not seem to exist for undergraduates — particularly undergraduates who are not science majors — is that the large topical survey courses, modeled on courses of the same type taught at large, prestigious universities, focus on the quantity of scientific information a professor can fit into the course, rather than the depth of understanding it would take to make that scientific knowledge meaningful to students (National Research Council, 2002). The call in recent years for undergraduate science to be taught, not as a discipline, but as a way of knowing (Moore, 1993) has intensified:
Problems with this approach have been exacerbated by the explosion of scientific information. Faculty members, wishing to cover the latest results and ideas but reluctant to discard classical material, rush to cover more and more information in the same amount of time. Those who have studied the learning of science have concluded that students learn best if they are engaged in active learning, if they are forced to deal with observations and concepts before terms and facts, and if they have the sense that they are part of a community of learners in a classroom environment that is very supportive of their learning.” (Science Teaching Reconsidered, 1997, p. 4).

2.2.2. Reforming Undergraduate Education

Just as there have been calls to reform science teaching, the undergraduate educational reform movement of the 1990s and 2000s has also been influential in how The Ohio State University teaches their undergraduate biology classes. The Boyer Commission on Educating Undergraduates in the Research University asserts that large research universities are advancing research at the expense of providing a solid education to their undergraduate students (1998). Among their recommendations that the IBP practices are that undergraduates spend more time in classes taught by tenured professors rather than TAs and that those professors bring examples of their research into the classes they teach when appropriate (1998). The Boyer Commission also recommends constructing an inquiry-based Freshman year. While the IBP cannot control the rank of
students who take Biology 101, student surveys have shown the largest representative rank of students taking the course are Sophomores with Freshman close behind.

When Steve Rissing took over the program in 1999, his first priority was to change how the non-majors courses were taught. This was considered a somewhat unusual focus. Often colleges are most concerned with getting students who believe they will major in a biological field through their introductory level courses. This makes sense in the standpoint that a college’s top priorities should include taking care of their own majors and from an economic standpoint in that students who major in the biological sciences will have to take the majority of their courses and credit hours through that college. Rissing’s reasoning for targeting science education for non-majors, or students who were taking biology to satisfy a liberal arts science requirement was that the one biology class was likely to constitute their entire exposure to the biological sciences in their college career. In order to further the goal of creating scientifically literate citizens, the IBP had to make the most of a ten-week quarter when teaching this non-majors audience. Because most of the students were only taking Biology 101 to fulfill a General Education Curriculum (GEC) requirement, the students often come across as an audience that is both uncommitted and disengaged.

It was at this time that the Biology 101 labs were re-worked and modeled after labs that Rissing had been involved in some degree of authorship with colleagues at Arizona State University. It was a big change for the IBP. In the words of one IBP staff member who was involved in the first quarter of the new Biology 101 labs, “For 10 years, we did exactly the same thing.”
Public universities teach more undergraduates than anywhere else (Boyer Commission on Educating Undergraduates in the Research University, 1998). "The country’s 125 research universities make up only 3 per cent of the total number of institutions of higher learning, yet they confer 32 per cent of the baccalaureate degrees, and 56 per cent of the baccalaureates earned by recent recipients of science and engineering doctorates" (p.5). In the pursuit of creating scientifically literate citizens, Rissing had an ideal platform as director of the IBP. OSU is the largest institution of higher education in the state and one of the largest in the country. According to his calculations, no one taught biology to a larger population of Ohio citizens than OSU. If the IBP could reform the way science was taught in its non-majors courses, the program could significantly alter the level of science education of its graduates.

2.2.3. Inquiry as a Mechanism for Change

According to The Boyer Commission Report on Undergraduate Education, "The ecology of the university depends on a deep and abiding understanding that inquiry, investigation and discovery are the heart of the enterprise" (1998, p. 9). Rather than run laboratory sections of science classes that resemble cooking lessons where students are merely following recipes of learning, students should be exposed to the aspects of science closely related to discovery (Alberts, 2005). The IBP refers to this as "hands on" or "hands dirty" biology. The analogy that discovery learning is a natural part of childhood that unnaturally grinds to a halt when that child becomes a student and enters the educational system is reinforced with a booklet published by the National Academies entitled Every Child is a Scientist (1998). Labs that are set up with inquiry pedagogy
have the ability to teach students both content concepts important to the class, but also a more fundamental lesson on how science is practiced. This practice of modeling scientists at work is in keeping with The Boyer Commission Report on Undergraduate Education's recommendations that large research universities "take advantage of the immense resources of their graduate and research programs to strengthen the quality of undergraduate education, rather than striving to replace the special environment of the liberal arts colleges" (1998, p. 7).

2.3. The Role of Instructional Designers

Given the calls for educational reform as laid out in the previous section, there seems to be no role more suited to act as an instrument of change than that of instructional designer. Banathy (1988) says that fundamental change is systemic, meaning that if one aspect of the educational system is to be changed, to be successful, change will likely have to occur in other areas of the educational system as well. This means widespread change is areas such as "human resources (e.g., the roles of administrators, teachers, assistants, and students), material resources (e.g., space, classrooms, instructional materials, and advanced technology), and time (e.g., grade levels, periods in the day, hours of operation, and days of operation)" (Reigeluth, 1993, p. 117-118). Reigeluth (1993) goes on to say that these changes are greatly complicated by the different constituencies that must buy in before these changes can be considered successful.
2.3.1. *What is Instructional Design?*

Reigeluth says that the discipline of Instructional Design is both a systems design model for managing the instructional development process and a collection of theories that specify what high-quality instruction should look like (1983, 1987). In the past 20 years, ID practitioners have moved from schools and higher education into business, military and industrial training, taking with them models and principles for effective instruction (Wilson, Jonassen & Cole, 1993). Morrison, Ross and Kemp (2004) say that the primary responsibility of an instructional designer is to ensure that instruction is designed, developed and produced in a systematic manner that will consistently produce efficient and effective learning. Instructional designers accomplish this by following an instructional design model, though they do this in a flexible manner rather than rigidly follow a prescribed solution (Morrison, Ross & Kemp, 2004). Some elements of an instructional design model might include factors such as time frame, nature of delivery and resources available (Morrison, Ross & Kemp, 2004).

2.3.2. *Instructional Designers in Higher Education*

Many of the problems instructional designers face in everyday professional practice are problems of complexity. In terms of content and task, most problems instructional designers are asked to tackle are ill-structured problems — the kind of problems that have multiple solutions, do not have clear best solutions and tend not to be pre-defined but emergent (Jonassen, 2004). Keppell says “instructional designers tend to be process-oriented individuals as they can apply instructional design principles to a wide range of content areas,” (2001, ¶ 4). The working environment of the instructional designer is
complex as well. This is especially true in the higher education environment, where an instructional designer has many different roles to play. In higher education, the client of the instructional designer is most often the professor looking to insert some change in their course. Because the professor usually comes up with the problem and is the subject matter expert (SME), the professor usually maintains the leadership role in their relationship with the instructional designer (Morrison, Ross & Kemp, 2004). Any number of factors may alter the relationship. The professor may ask the instructional designer to act as a consultant or to take on a more pro-active designing role (Morrison, Ross & Kemp, 2004). If the client is not a professor but an administrator, this can also alter the role of the instructional designer. In the case of the IBP, the instructional designer has worked for the director designing on behalf of the teaching faculty. Where ownership of subject matter and course material is not clear, the relationship between client and instructional designer, such as those relationships within the IBP, can become complicated, even when both parties share similar goals.

2.3.3. Syllabus Design

One important aspect of course administration and ownership is the course syllabus. Syllabi are educational tools that often have more important functions than what commonly is acknowledged by administration, faculty, or students (Eberly, Newton & Wiggins, 2001). A syllabus will usually include the organization of topics into an outline of the course of study, readings, exercises, examinations and a grading scheme (Committee on Undergraduate Science Education, 1997). In Science Teaching Reconsidered, the National Research Council asserts “these things are important, but it is
equally important to identify the goals of the course (content, student responsibilities, and desired outcomes) and to work both forward (from the starting point of the students) and backward (from the desired outcome of student understanding) to develop your syllabus” (1997, p. 5-6). In the past few years, I have seen a variety of differently styled syllabi from professors teaching the same Biology 101 course. Some elements of biology syllabi have included the “rights and responsibilities” of both the student and instructor, learning outcomes, reasoning as to what constitutes the course in question as a part of the General Education Curriculum (GEC), and syllabi that have purported to be contracts with the students.

2.4. The Instructional Designer’s Toolbox

The first thing to consider when designing for any level of education is to consider the pedagogy being used (Watson, 2001). Any sort of designed product or new technology introduced into a course should act as a scaffold for the curriculum and should never be forced to support a pedagogy that it is a bad match for. “The best teachers and researchers should be thinking about how to design courses in which technology enriches teaching rather than substitutes for it,” (The Boyer Commission Report on Undergraduate Education, 1995, p. 26). I have had professors teaching traditional expository lecture classes come to me dismayed that less than 25% of their students were attending lecture. Their idea for how to win back their missing student audience was to “throw some technology at them.” I cannot think of an instance where something like this produced the intended outcome. As it turns out, today’s college student is surprisingly savvy at identifying smoke and mirrors in the classroom. In the
IBP technology is used to help scaffold the pedagogy and curriculum. A closer look at the pedagogy involved might help explain why this is an important aspect of an instructional designer’s job.

2.4.1. Inquiry Strategies in Biology 101

In his call for learners to be allowed to discover new rules and concepts rather than be required to memorize what the teacher says, Bruner (1961) said “discovery, like surprise, favors the well prepared mind” (p. 22). Our traditional definition of how a class is taught is an expository mode of instruction where the teacher controls what is presented and the students listens and absorbs (Mayer, 2003). This is the lecture model of classes. It creates a maximum efficiency in the use of teaching resources, as it allows one professor to stand in front of a very large audience of students and transmit their knowledge in a particular subject. Discovery learning and inquiry pedagogy are rooted in the hypothetical mode where “the student has some control over the pace and content of instruction and may take on an ‘as if’ attitude. The hypothetical mode allows the learner to discover new rules and ideas rather than simply memorize rules and ideas that the teacher presents,” (Mayer, 2003, p. 288).

Within the category of discovery learning, there are two distinct types. The first is pure discovery, where little assistance is given and a student is expected to find their way through a problem to a solution (Mayer, 2003). The second type of discovery learning is guided discovery. In guided discovery, “the student receives problems to solve, but the teacher provides hints and directions about how to solve the problem to keep the student
on track” (Mayer, 2003, p. 288). The IBP’s particular pedagogy of inquiry is rooted within the context of guided discovery.

The goal of using inquiry strategies is that by using a constructivist view of knowledge, students will learn the principles of the scientific method through active investigation rather than passively absorbing bullet points on a slide in lecture. These active investigations are meant to mimic how scientists participate in the discovery and refinement of different elements of their work through processes that may include laboratory investigations, comparing and contrasting of biological processes, looking at the relationship between function and structure, analyzing sets of data and discussing biological concepts with open-ended questioning (Uno, 1990). Inquiry learning in the science can also involve the incorporation of observation, testing, analysis, classroom discussion, and the application of knowledge in future investigations. Inquiry activities often occur within small classrooms with up to twenty-five students because the attention an instructor must give to the process of guiding each group through the processing of information (Uno 1990). Because students are not a homogenous group, different groups may require different amounts of guidance through the material to achieve similar results and this is the responsibility of the instructor to determine (Lawson, 1995).

The IBP uses a variation of inquiry known as the learning cycle in Biology 101. Lawson (1995) describes this as a three-stage process involving exploration, term introduction and concept application. In the exploration phase, students conduct an investigation that has limited direction from an instructor (Lawson, 1995). Students are introduced to terms in the next stage, which allows the students to link those terms to schemas completed during the exploration phase (Lawson, 1995). The final phase of the
learning cycle is concept application where students use their range of experiences to
develop meaning of the two previous phases (Lawson, 1995). Lawson (1995) says that
when the three phases are combined and repeated, the curriculum design of the learning
cycle is often represented as a spiral, with each successive repeat of the pattern building
upon itself, meant to be representative of the student moving through material and
concepts that build upon what they have previously learned.

To give an example of how this might ideally work in a Biology 101 classroom,
one only has to look as far as the very first laboratory experiment the students encounter.
This lab —officially titled “How do we categorize living things?” but often called the
Diversity Lab — has students leave the lab room and go to a setting like a small
university pond or green space and collect samples of what they consider to be diverse
organisms to be analyzed and categorized with their lab group in the classroom. Some
examples of what they might collect are acorns, buckeyes, earthworms, leaves and other
plant structure, insects, pinecones, water samples, etc. When students get back to the
classroom, they are given a set of tools including a microscope and told that they are to
construct their own system to classify what they have collected. They are asked to
provide some reasoning behind their classifications in their lab report. The questions they
are asked to answer are meant to get them to focus on the process they went through in
determining how to classify their organisms. After the entire class has gone through the
lab, the professor gives a lecture that would ideally start out something like “Last week in
lab you classified organisms into different groups according to characteristics that you
came up with. Here are some of the considerations that Carolus Linnaeus came up with
while creating the taxonomy of living things that we use today.” In this way the students
are asked to explore the concept before the introduction of terminology. Perhaps a week later they will see the information on a weekly quiz, where their knowledge of the concept will be tested.

2.4.2. Extending Inquiry into Other Content Areas

In Reinventing Undergraduate Education (1995), The Boyer Commission Report on Undergraduate Education says that students should have “opportunities to learn through inquiry rather than simple transmission of knowledge,” (p. 12) going so far as to call this and other suggestions “An Academic Bill of Rights.” One of the main reasons the IBP uses the learning cycle because the “individual model” of learning does not mirror the way knowledge is really made or learned. Discovery learning often mirrors working styles that are common outside the academy. The IBP has had meetings with the Fisher College of Business at OSU where it was communicated that the business college was specifically looking for GEC classes that would compliment what they were teaching their business majors. One of the areas identified as being important to the School of Business was the ability for students to work together in small teams. Because the learning cycle also favors this behavior, Biology 101 labs are already set up in this style. The IBP’s enrollment of business majors increased because the School of Business’s advisers knew that if they pushed their students towards taking Biology 101, they would get the added benefit of learning some of the fundamentals of working in teams. Because collaboration offers us a richer learning environment with more diverse perspectives, it teaches students what they know how to do, not just what they know.
2.4.3. **Stumbling Blocks to Using Inquiry Strategies**

One IBP staff member said that although they believed that inquiry was the best strategy to use in Biology 101, when inquiry was being taught poorly, it would be better for the students to learn the material another — more traditional — way. Not all instructors are able to adapt their teaching styles to an inquiry-based class. There are a number of ways to stumble when using this pedagogy. The difference between pure discovery learning and guided discovery learning may not be apparent to a TA. Mayer (2004) argues that some minimal level of guidance is often needed in order for any sort of discovery learning to take pace and says that the formula “constructivism = hands on activity” is a prescription for educational disaster. In addition to the nuances of the pedagogy, any sort of discovery learning can disrupt the traditional classroom hierarchy. This can be particularly daunting to an inexperienced TA struggling to control a group of students who may only be a couple of years younger.

Every quarter the IBP surveys the students enrolled to find out their rank and area of study. For the Biology 101 class, it has been determined that almost every quarter; about half of the students are sophomores. These figures mean that the majority of 101 students come to the class with only about a year of college classes behind them, usually most of those classes coming from fulfilling their GEC requirements. While this might seem a little daunting to the faculty member you are asking to teach over 700 young and restless undergraduates, it also seems like there is a unique opportunity to help shape the way these students think about science.
2.4.4. Metacognition

In the most simplified definition, metacognition could be defined as "thinking about thinking." Flavell (1976) codifies that by saying, "Metacognition refers to one's knowledge concerning one's own cognitive processes and products or anything related to them... Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects on which they bear, usually in the service of some concrete goal or objective" (p. 231).

Mayer (2003) says it is an important concept any time an instructor asks students to step outside their normal model of how knowledge is acquired. By providing a tool that can help explain the structure of a course using non-traditional pedagogy, a student is provided with a kind of scaffolding to bolster their learning. In Science Teaching and the Development of Thinking, Lawson details using the inquiry method to teach labs and describes the situation of lacking the adequate cognitive structures to handle situational information processing as disequilibrium.

The child's current mental structures are found inadequate and must be altered or replaced. Through continued investigation and guidance from others, the child alters or accommodates his or her inadequate mental structures. Once this is accomplished, he or she is then able to assimilate the new situation. The new structure that is constructed is then tried. If the structure guides behavior so that the child's efforts are rewarded, then the structure is also reinforced (Lawson, 1995, p.78).

I became interested in providing metacognitive support for students unfamiliar with inquiry-taught classes when new course coordinators began explaining the problem of
how students seemed confused in lab the first few weeks of the quarter. Through
observations of grading trends and students comments, I believe that students that are
new to inquiry-learning may take a significant amount of time to catch on to the way the
class is being taught and what they are supposed to learn in the time they spend there.
Flavell compares metacognition to a child pulling a problem solving trick or method out
of their repertoire of previous problems solved, and this seems a very accurate example
of what we are asking students in a Biology 101 lab to do (1976). In a university that
operates on a 10-week quarter system, it is imperative to the students’ success in the class
that they assimilate to the learning cycle as quickly as possible. One way to help achieve
this would be to make the structure and pedagogy of the class as visible as possible. This
was the goal of the visual syllabus.

2.4.5. Scaffolding

A constructivist approach to instructional design is based on the assumption that
learners generate knowledge structures in their own mind (Morrison, Ross & Kemp,
2004). In 1968, Ausubel introduced the idea of advance organizers as a tool for learning.
He defined advance organizers as “appropriately relevant and inclusive introductory
materials...introduced in advance of learning...and presented at a higher level of
abstraction, generality and inclusiveness” (p. 148). The function of an advance organizer
was to “provide ideational scaffolding for the stable incorporation and retention of the
more detailed and differentiated material that follows,” (Ausubel, 1968, p. 148). In the
case of the visual syllabus, the students are already familiar with the common course
construct of attending labs and lecture. Building on these familiar relationships, the visual
syllabus provides students with entry points and links to hook their new understanding onto familiar course constructs. This can help prepare them to work in the new context of inquiry learning.

Mayer says that in order for an organizer to be a useful scaffolding tool for students it must both provide an assimilative context and encourage the learner to actively integrate new information (1979).

The visual syllabus tool was built in the mold of an advance organizer for Biology 101. The circular structure of the tool mimics the learning cycle the students go through during the course or the academic quarter and visually shows the unusual order of information processing between lecture and labs. The visual syllabus is organized into weekly units for easy orienting within the course. Students who are confused by the prospect of discovering concepts in lab before they have received and information in lecture need only to consult the visual syllabus to find their place in the course material.

2.4.6. Peer Scaffolding

Along with possibly lacking the necessary cognitive structure for discovery learning, students might face a more self-identifiable problem in the laboratory—a lack of prior knowledge. In the context of teaching with inquiry, this is exactly what teachers may want from them but for the student unprepared for this class, this can be extremely frustrating. How can you do well on a test, when you feel unsure that you are on the right track in lab? There are a couple ways to help ensure that students are getting the background information in biology that they need for class. The first way is the most obvious; if a student is unsure of biological concepts that their classmates have learned in
high school, we tell them to use their textbook as a resource. Hardly any of the IBP’s non-majors classes require textbook reading on a weekly basis, but all of the syllabi are set up to include page numbers that correspond to the textbook for each subject covered. Students are encouraged to follow along, particularly if they are not clear on something. The “See it in class, Hear it in Lecture, and Read it at home” study approach we advise our students to practice closely resembles Weinstein and Mayer’s cognitive learning strategies: rehearsal, elaboration and organization (as cited in Hofer, Yu and Pintrich, 1998, p. 58).

The other major support for prior knowledge that the IBP builds into Biology 101 labs is the lab group. Students are not being asked to come up with hypothesis on their own, but with the help of three other students. In this way, working in a cooperative group provides the opportunity for a student to gain equal mental footing through the help of his peers’ prior knowledge and experience. Classmates may question each other’s beliefs on the road to establishing their hypothesis and experiencing the disequilibrium of having your ideas questioned in a small group may be less disturbing than having those beliefs called into question in front of the entire class.

2.4.7. Universal Design for Learning

Universal Design for Learning originally started in the discipline of architecture as a way of building in a conscious manner to support the most diverse set of users possible (Rose, p.70). The thought behind this was rather than tack on additions like ramps and elevators as an afterthought incorporate them into the design of a building before any of the walls go up. The classic example that I’ve heard repeatedly is the case for curb cuts
on sidewalk corners. When curb cut are placed in a sidewalk to accommodate those in wheelchairs, a whole host of other users such as people with strollers, wagons, shopping trolleys and those who are still ambulatory but perhaps not without some difficulty, also benefit.

The Boston-based Center for Applied Special Technology (CAST) has taken the lead to bring Universal Design for Learning into the classroom. They believe that because people learn and absorb information in different ways, by providing multiple ways into course material, you will not only help those students who have problems in certain modalities, but also students who may have modal preferences that are not usually supported in traditional classrooms. The idea behind this is that by creating multiple pathways into the course material, you lower the barrier to entry without lowering the standards of the course.

In Biology 101, the IBP has tried to incorporate many different learning styles and concepts into the course. Students who learn by doing activities will find a natural match in the hands-on aspect of the Biology 101 labs. Additionally, students are regularly asked in their lecture section to get together with their collaborative lab groups and answer questions about lecture or to come up with questions for the professor. One Biology 101 professor is actively trying to come up with new ways to present Biology course materials. This professor has commissioned dances about DNA and poetry about the human genome, all in the quest to present new and interesting paths through the Biology 101 course material.
2.4.8. Summary

In this chapter I looked at calls for science education reform in the larger context of undergraduate education reform. I discussed the role of the instructional designer as an agent of change in higher education and talked about some of the tools and techniques an instructional designer might employ when designing or redesigning course material. I also discussed the pedagogy of the IBP and why inquiry learning is a technique the IBP is employing in its introductory GEC biology courses. In the next chapter I will discuss the research methods I used to investigate the design of the visual syllabus and the needs of faculty teaching large undergraduate science courses.
3.1. Introduction

Christopher Jones defines design as "the initiation of change in manmade things" (1992, p. 5). I feel that this sentiment is important when explaining the need for instructional designers in higher education.

The purpose of this chapter is to describe the methods and procedures used in this study. In the first phase of this study, faculty were shown a conceptual design model of a digital learning tool, designed to help scaffold the inquiry-based pedagogy in Biology 101 by visually representing and reinforcing the relationship between labs and lectures. The faculty members interviewed were then asked to critique the tool. In the second phase, I asked faculty members who teach Biology 101 a number of questions designed to gauge how receptive they would be to trying a new technology tool, such as the one they had just critiqued, in the class that they taught. I examined their responses in four main areas of strategy, politics, culture, and emotions. As an additional component of this research, I believe these four areas of concentration will provide a greater insight into the experience of teaching and administering large, introductory, undergraduate classes at a major university.
3.2. **Methodology Selection**

I chose to use a design research or design exploration methodology for this study because I believe it provides the flexibility I needed to collect descriptive qualitative data about designing, administering and teaching large populations of undergraduates. In design-based research, practitioners and researchers work together to produce meaningful changes in the contexts of their practice. These collaborations mean that goals and design constraints are drawn from the local context as well as the researcher's agenda (Robinson, 1998). I chose a design research methodology because the end goal in design research is for the research to help inform the product or design (Jones, 1992). This methodology was selected to provide insight as to what degree of collaboration is needed for the design of a successful learning technology tool and what degree of flexibility a technology tool must possess and how the different needs of an instructor dictates that aspect of the design. The rich data gleaned from narrative interviews with faculty provided a detailed description of the roles and responsibilities of an instructional designer at a large university.

I have focused deliberately on qualitative data derived from descriptive interviews, in order to draw conclusions about factors that influence the faculty adoption of learning tools and issues that are associated with the collaboration of faculty and support staff while teaching large undergraduate courses. I focused on four broad-brushed categories — strategy, politics, culture and emotions — that helped to shape the organization of my results into the beginnings of a theoretical framework to discuss factors that influence instructor buy in when adopting new learning tools. These categories were selected
because I felt they gave me a flexible structure in which to organize my data while allowing me the freedom to focus on possible emerging categories.

In the original design of the visual syllabus learning tool, I worked primarily with the director of program to design a tool that was reflective of his goals for the class and his needs while teaching the course. It was assumed at the time that all other instructors to some degree shared these goals and needs. While many faculty members have based all or part of their syllabi on the former director’s syllabus, later observations and comments from faculty have led me to believe they perceive their own needs and pedagogy as being distinct and separate from his. This could be a critical flaw of the visual syllabus leading to a lack of enthusiasm to use it in the classroom for all but one member of the Biology 101 faculty. While there is room in design research for both qualitative and quantitative research methods (Purpura, 2003), I have purposefully chosen qualitative research as a means to explore the scope of what is possible for the future design of the visual syllabus.

3.2.1. Design-based Exploration

In order to facilitate the exploratory nature of this study, I split the interviews with faculty members who have taught Biology 101 into two parts. Rather than having a traditional research hypothesis that I set out to test, I used the design for the visual syllabus as a design hypothesis that could be critiqued and improved upon through further research. During the first part of the interview, I involved the subjects in a critique of the design of the digital syllabus based on a 12-part short presentation. In the second part of the interview, I asked them questions pertaining to four categories of reasons —
strategy, politics, culture and emotions—that can account for an individual or organization not adopting innovation (Loch, 2003). These categories matched the types of data I wanted to collect from narrative interviews with faculty. I feel that using a design research protocol, with its emphasis on users, combined with a case-studies approach would give me the detailed data needed to better understand the complexity involved in teaching, administering and designing for a large class like Biology 101 with its diverse student population.

3.3. Subject Selection

3.3.1. Faculty

The subject selection of teaching participants for this study was limited to faculty and adjunct faculty teaching or who have taught Biology 101 within the past 6 years for the IBP. An email invitation and letter of consent was sent to all who qualified (See Appendix A). The response from these invitations was overwhelmingly positive. All prospective participants who were contacted replied to the email. All but one faculty member contacted agreed to be interviewed for this study.

3.3.2. Staff

The selection of staff members to interview was a somewhat harder decision to make. Because of the nature of the Course Coordinator position in the IBP staff, coordinators that have very little to do with Biology 101 may have very similar experiences with the classes and faculty relationships. In some cases, faculty who teach Biology 101 might teach another course for the IBP in another quarter. Originally I
planned to interview the staff in much the same manner as I interviewed the faculty. Eventually, I decided to limit staff interviews to present and past coordinators who have had in-depth experience as the Biology 101 Coordinator because I believed they would be able to offer the most insight into the teaching and administration of the IBP’s large, non-majors Biology 101 course. Email invitations and letters of consent were sent out and all prospective participants agreed to be interviewed (see Appendix A).

I decided to limit the staff to shorter interviews on the feasibility of using tools like the digital syllabus as scaffolding in the Biology 101 course. Ethically, I felt they were at a greater risk of exposure, both because of the small sample size and because they are professional staff at a university and do not have tenure, as do all but one of the interviewed participants from the faculty group. I did not ask the staff to critique the visual syllabus tool as I did the faculty, although all staff members are familiar with the design to some extent. Because of their role as support staff, the decision about whether to use such a tool would most likely fall to the faculty teaching Biology 101, although the logistics of using the tool in class and as a training aid for TAs would most likely be a staff responsibility. I did ask staff participants questions about the likelihood that the Biology 101 faculty members would adopt or be receptive to trying such a tool in their teaching and what factors might influence that decision.

The most important resource the staff provided was as a check on the data collected from faculty interviews. By interviewing the staff I was able to triangulate the data that I collected between the interview subjects, my one knowledge and IBP staff members who often work more closely with the instructors than my own role as an instructional designer allows. In order to situate some of my conclusions, I also used staff and in some
cases, the faculty members I had interviewed as a way to member check those conclusions. Their insights into the IBP system and the problems associated with teaching large biology courses were very valuable in forming a conceptual framework around my results.

3.4. Procedures

3.4.1. Design Phase Critique of Tool

Although all of the faculty members interviewed had at one time or another seen and heard about the digital syllabus, their exposure to it varied by person. In order to ensure that everyone interviewed had some basic level of exposure to the digital syllabus, I created a presentation of the conceptual design and gave a brief 5-10 minutes summary at the beginning of each interview. Some of this material was based on a presentation I created and have been refining since Spring of 2004 called “Digital Syllabus Design: The Evolution of an Evolutionary Syllabus.” All of the presentation material remained within reach during the interview for easy reference. A slide of the prototype of the digital syllabus remained on the table in front of each faculty member while they were asked to critique the design.
3.4.2. Elements of a Conceptual Design

The most useful description of what elements are presented in a conceptual design came from BJ Fogg. He presents his 12-step presentation formula as a chapter in Design Research (2003). Fogg says that the order of the elements is an important aspect of the presentation and that after having “created and evaluated over 300 conceptual designs…found that when people change the order of ideas, they usually weaken their document” (2003, p. 211).
In order to create a short presentation for faculty at the beginning of our interview, I adapted this 12-step prototype into a shorter version focusing on how the design prototype of the visual syllabus evolved, features of the designs, user-centered scenarios of the design’s possible uses in Biology 101 and the potential futures uses of the visual syllabus. I went into some detail about the process and timeline of creating the visual syllabus because I wanted them to understand that I had spent some amount of time considering the needs a professor would have from such a tool as I understood them. I believe this helped to create a dialogue about the features both present and lacking in the design. Some of the elements of design that I focused on were time, material, visual structure, colors, organization, spatial relationship, ancillary materials, and how faculty, staff, TAs and students might use the visual syllabus. I also wanted to emphasize that the syllabus, though a functioning prototype was still considered to be a work in progress.

Slides from this presentation are included in Appendix A.
| User Description | • How might professors in the classroom use this tool?  
• Would you be likely to talk about this tool or allow students to explore it for themselves? |
|------------------|--------------------------------------------------|
| Prototype | • What are/were your immediate impressions of the prototype?  
• Do you think it is easy to understand?  
• Do you have any reactions to the interface?  
• Is a relationship between lab and lecture apparent in the prototype? |
| Features/functionality | • Which features do you think are the most valuable?  
• Are there any features you would add? Take away?  
• Do you think the information presented clearly? How do you feel about this tool’s ease of use?  
• Do you think these features would be useful to the students? |
| Shortcomings of design | • What are the strengths in this tool?  
• What are the weaknesses in this tool?  
• What aspects of the visual syllabus should be changed?  
• What aspects should be expanded or explored?  
• How hard would something like this be to use in the classroom?  
• Do you think this tool would integrate well with your current use of a course management system? |
| Expansion | • What else would you like to see included in this design?  
• How would you feel about using this tool to deliver current content to students?  
• How would you feel about a tool like this, replacing current textbooks in your class?  
• If you had greater control over delivering new and current content, would textbooks still play a role in your class? |

Table 3.1. Sample topics and interview questions for faculty on a critique of the digital syllabus for Biology 101.
3.4.3. **Implementation Phase: Feasibility Study**

The second part of the interview was focused on the feasibility of using such a technology tool in the classroom. Questions related to either the digital syllabus or — if the faculty member was not receptive to the design — a more idealized, hypothetical version, of the digital syllabus tool. Questions were organized around four topics that represent possibly barriers to adoption of new tools and techniques in the classroom. These four topics are strategy, politics, culture and emotions. Questions were also be posed to provide context about process, or how a particular faculty or staff person’s class operates, such as “How do you write your syllabus?” A sample list of topics and questions is provided below.

3.5. **Data Screening and Category Selection**

According to Merriam, categories should be selected because they reflect the purpose of the research, because “they are the answers to your research questions” (p. 183). I chose to use Four Categories that Christoph Loch uses in his essay “Moving your idea through an organization.” These categories, strategy, politics, culture and emotions are described as the four levels of influences on the acceptance of an idea in an organization. I chose to use these categories in my research because they seemed broad enough to accommodate the anticipated findings, while not restricting the responses of faculty members into categories that were too narrow with no applicability outside of the context of teaching Biology 101 at a large research university. According to Glaser and Strauss, working with barrowed categories can be difficult as “they are harder to find, fewer in number, and not as rich since in the long run they may not be relevant, and are
not exactly designed for the purpose” (1967, p. 37). In order to account for these possibilities, I allowed room for emergent categories in the analysis, and in choosing these four broad categories; I allowed space to pull out specific pieces data that seems especially relevant and poignant to the research. In most cases, data included information that did fall into one of the four broad categories, but was repeated by the faculty in interviews so often that I felt it merited additional consideration. Because of the broadness of the categories, at times the may seem to overlap, but I have tried to explain them as clearly as possible, while still leaving room for emergent categories and themes.

3.5.1. Strategy

In this context, strategy means how well a learning tool fits with the overall goals of the instructor for their class. Hopefully, but not always, these goals mirror the overall goals of the program and are shared with the other instructors who are teaching Biology 101. Loch says that strategic priorities “always involve judgment calls,” and “reasonable people can disagree about what strategy really requires,” (Loch, p.215). In the case of a classroom, strategy must not only meet the goals of the instructor, but also mesh with the structure they have chosen for their class and the style in which they will teach. For my faculty interviews, I asked them several questions about how their class is structured, how they choose to present material and the process of planning to teach for the quarter. I also tried to establish what methods faculty use in their classroom to connect lecture to lab, whether they think that connection is important and what would make that connection easier. I solicited their assessment of the discovery-learning pedagogy and its appropriateness for Biology 101.
3.5.2. Politics

Politics mainly deals with the interests of the decision makers, according to Loch (2003). In the university environment, there are a wide array of people and priorities that can influence whether a learning tool is adopted or a new design is tried out. Though a tenured faculty member has a great deal of autonomy, they must still answer to their department Chairs, Deans and university upper administration. They must balance the demands on their time these actors may place on them. It seems the most common demand on their time is the demand to produce new research in their field of study. The phrase “No one ever got fired for doing research,” has become a joke refrain in the IBP. Loch maintains that “every organization is a coalition of partially conflicting interests,” (pg. 216) and only functions in complete unity when threatened with an existential crisis.

In interviews, I talked with faculty about their network of relationships and influences. I asked them questions about the similarities and differences in their syllabus as compared to their colleagues’ syllabi and how they constructed their syllabus when they taught. I talked with them about the Learning Objectives for Biology 101 and who controls the curriculum and pedagogy in their class. I asked them about the level of support they received from the IBP staff, their home department, and the university. I also asked them about sharing their content with their colleagues also teaching Biology 101.

3.5.3. Culture

University culture is a unique and self-referencing microcosm. It defines appropriateness and legitimacy or “how things are done around here,” (Loch, 2003, p. 42)
Of the four categories, culture has the possibility of being the most entrenched. The danger lies in the tendency of an insular group to take their culture for granted. When cultural norms and traditions are no longer questioned, they run the risk of becoming outdated. Additionally, outside conditions may change but an institutional culture might be slow to notice or adapt.

In my interviews with faculty, I asked how well they feel their students comprehend the material covered in their syllabus and if these perceptions have changed during their teaching experience. We talked about the culture of professors and teaching and we also discussed the culture of their students. I also asked what the faculty think could be done in order to better support them in classroom and how they feel about trying new tools, approaches and material in their class. We also discussed the culture of sharing teaching material and tips with their colleagues who teach the same class.

3.5.4. Emotions

Loch maintains that people commonly exhibit three emotional needs that should be taken into account when trying to implement a new design: friendship and reciprocity, group identification and ego (2003, p. 218). Friendship and reciprocity simply means that it is easier to get buy-in for a new design if you are on good terms with the intended users. Loch says that this “can open possibilities, but it also constrains you in order to keep the relationship positive,” (p. 219). Group Identification is the feeling of solidarity or loyalty. It is in this context that how a faculty member’s colleagues choose to teach or new technology they decide to use might affect the adoption rate of others. The third element of the emotional aspect of teaching is ego. Ego deals with how the faculty
members perceives themselves, perceives their role in front of their students and their relationship to their colleagues and university staff. Faculty members teaching classes of over 700 students are taking a significant risk in standing up and teaching in front of so many people. The idea that new tools or technology could quit on them is a fear that came up time after time. It turns out that ego is very important in the adoption decisions of professors.

During interviews with faculty, I talked with them about the experience of teaching large classes — how they feel when something (material or technology) isn’t working, how affected they feel by students comments, both positive and negative and if that impacts the way they teach the same material next year. I asked them about the personal investment they feel they put into each class and what they feel is at stake.

Originally I planned for emotions to be its own category, but I believe that it makes more sense to view emotions as a category that runs through the other three categories. Some of the most emotional reactions to questions came from discussing elements that I had previously consider to be strategic or political.
| Strategy | How is time a factor in the management of your classroom?  
|          | How connected do you think lab and lecture are?  
|          | How do you plan your syllabus?  
|          | How often does your syllabus change?  
|          | How do you use discovery learning in the classroom?  
|          | How important is metacognition in the classroom?  
|          | How do you know if something is working in your classroom?  
|          | Do you feel the pedagogy is appropriate for Biology 101?  |
| Politics | What are the learning objectives of Biology 101?  
|          | Do you think other faculty and staff would find this tool valuable?  
|          | Do you think students would find this tool helpful?  
|          | What barriers to entry exist in using this tool?  
|          | Would you be more likely to use this tool if you felt that you had adequate support for your teaching?  
|          | What do you consider adequate support?  |
| Culture  | Who do you think is responsible for understanding the material?  
|          | What could be done to make the adoption of a tool like this easier for faculty and staff?  
|          | Would you be more likely to use this tool if other faculty/staff were using to teach?  
|          | What do you think your students care most about?  |
| Emotions | How do you feel about student feedback?  
|          | Would you be more likely to use this tool if you could customize it to your specific needs and interests?  
|          | How much buy-in do you feel towards discovery learning in Biology 101?  |

Table 3.2. Sample topics and feasibility study interview questions for faculty.

### 3.6. Mode of Analysis Planned

#### 3.6.1. Design Phase Analysis

Phase I of this study deals with a very specific problem of how to improve the digital syllabus and what the faculty member might want from the design if they were to use it in their Biology 101 classroom. Phase I also deals with some of the issue of
whether instructors are or are not connecting lab to their lectures and their knowledge of what students do in lab.

3.6.2. Implementation Phase Analysis

In case studies, the goal of data analysis is communicating and understanding (Merriam, 1998). On my first pass through, I split data into categories. I looked for patterns, recurrent themes and emergent categories. I then took that data to staff member and proceeded to interview them about their experience teaching and administering Biology 101. Merriam defines triangulation as “using multiple investigators, multiple sources of data, or multiple methods to confirm the emerging findings,” (1998, p. 204). I used interviews with IBP staff members as a way to triangulate the data I had collected from faculty interviews. I also engaged with them in member-checking where I took data and tentative interpretations (Merriam, 1998) to the staff members who I encouraged to tell me what they thought of the conclusions I was drawing. I analyzed the instructors’ syllabi for accuracy in their narrative interviews as well as my own recollections of the courses they taught. This was especially helpful when analyzing how the faculty chose to incorporate or not incorporate inquiry pedagogy in their courses. Finally, I start to build theoretical framework for working and designing with faculty in complex situations in mind.

3.7. Trustworthiness and Authenticity

Connelly and Clandinin write that research involving narrative inquiry “relies on criteria other than validity, reliability and generalizability” (1990, p. 7). In their view, these criteria are still under development, but note that it is up to the researcher to do all
they can to ensure the quality of their results (1990). Because of my dual role as both a researcher and a staff member in the program I was researching, I have had six years to observe the style and methodology of our instructors as well as the problems they have encountered as they teach Biology 101 once a year. I have also seen their classroom performances where they convey material to students and have a basic understanding of how each faculty member is likely to react to the challenges and demands of teaching such a large course with so many different actors (staff members, office staff, graduate students) helping to support the faculty member. The narrative interviews I conducted with the faculty members were my opportunity to ask them about their experiences and also gave me a chance to compare their performances to how they perceived and represented themselves. Because of the small number of people interviewed, I feel that using the staff interviews as a check on both the memory and perception of the faculty members and my own memory and perceptions served to keep my research grounded in as much objectivity as possible.

3.7.1. *Triangulation*

Current and former IBP staff members were asked to interpret the accurateness of my findings and in some cases for additional framing. The staff that I interviewed had all worked more closely as course coordinators with the instructors than I had as an instructional designer. In many cases staff were able to provide context for further interpretation of faculty comments.
| Strategy                          | What kind of training do you give TAs in connecting lab to lecture?  
|                                  | How connected do you think lab and lecture are?  
|                                  | What is your role in planning the syllabus?  
|                                  | How often does the syllabus change?  
|                                  | How do you use discovery learning in the classroom?  
|                                  | How do you know if something is working in your classroom?  
|                                  | How receptive to change do you feel?  
| Politics                         | What are the learning objectives of Biology 101?  
|                                  | Do you think other faculty and staff would find this tool valuable?  
|                                  | Do you think students would find this tool helpful?  
|                                  | What barriers to entry exist in using this tool?  
|                                  | What involvement in content creation do you play?  
| Culture                          | Who do you think is responsible for understanding the material?  
|                                  | What could be done to make the adoption of a tool like this easier for faculty and staff?  
|                                  | Do you feel you adequately understand the pressures of teaching this course?  
|                                  | How well do you believe your instructors understand the Biology 101 audience?  
| Emotions                         | How do you feel about student feedback?  
|                                  | What level of ownership do you feel with the course?  
|                                  | What are some of the biggest challenges for faculty and staff involved with Biology 101?  
|                                  | How much buy-in do you feel towards discovery learning in Biology 101?  

Table 3.3. Sample topics and feasibility study interview questions for staff.

3.7.2. Document Analysis

Documents can be a non-intrusive source of data when they were produced independent of the research study (Merriam, 1998). Fluency in the syllabus of each instructor was a great help in formulating and asking interview questions and often framed how I interpreted their answers. The foundations for their stylistic teaching choices are laid in the syllabus. One example of the data gleaned from the document

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analysis of the syllabi, was that two of our instructors have very different systems of grouping content in Biology 101. This information was very helpful when discussing the strategic choices they had made for Biology 101 as well as gauging their response to using pedagogy inquiry. In my analysis of the syllabi, I grouped the lectures into the three major content areas of the visual syllabus. To make it easier to compare the syllabi side by side, I color-coded the lectures in the same ordinal color system the visual syllabus uses, where blue equals lectures centered around the topic of evolution, yellow means those lectures have to do with genetics and red denotes the subject matter of energetics (see Appendix A).

In addition to the stylistic choices of an instructor, reviewing the syllabi of the professors I interviewed allowed for some interesting changes in how I interpreted their reactions to the visual syllabus. The design for the visual syllabus had been predicated in part by the assertion of the former director of the IBP that most of the instructors were using a syllabus modeled after his own syllabus. This syllabus was the model for both the structure and flow of the IBP Biology 101 labs and for the design of the visual syllabus. While prototyping the visual syllabus for our instructors before autumn quarter of 2004, I met with some resistance from a professor whose syllabus obviously did not follow the pathway of the model syllabus. I subsequently realized that the instructor was following the normal pathway through the labs. This meant that the instructor, who was thought to have been happily teaching inquiry-based Biology 101, was teaching the lecture section of Biology 101 as if it were a separate class entirely from the lab portion of the class. I then looked at the other instructors’ lectures and found that out of five regular faculty instructors’ syllabi, three of them fit well with the established pattern of the model
syllabus, and two instructors’ syllabi seemed to follow their own particular pedagogical pattern with little regard for the pattern of the IBP labs.

3.8. Summary

In this chapter I discussed the design methodology I used to conduct my research. I talked about who my subjects were and how I went about collecting my data. I explained how the four categories I selected helped establish a framework for my results and I talked about how I would be analyzing my data. In the next chapter, I will discuss the data I collected from interviewing faculty and administrative staff connected to Biology 101.
CHAPTER 4

RESULTS

4.1. Introduction

A case study is "an intensive, holistic description and analysis of a single, bounded unit" (Merriam, 1998, p.193). Conveying an understanding of the case is the ultimate goal of any case study research (Merriam, 1998). In this chapter I will discuss the analysis of the data collected from faculty interviews and attempt to begin a conceptual framework for working and designing learning tools collaboratively with faculty. In the results, I refer to all of the professors I interviewed as male to help disguise their identity.

4.2. Design Phase Results

4.2.1. Perceptions of the Relatedness of Lecture and Lab

All of the instructors expressed various levels of curiosity towards using the visual syllabus. This observation should be qualified because of their knowledge that they were talking with someone who they knew to be involved in the design. All of the faculty said that they could clearly see the relationship between lecture and lab and most thought it would be a helpful tool to use when explaining the class structure to their students. One instructor said that the traditional way to approach 101 doesn’t communicate what he has
gone through to create the course or what he wants his students to get out of it because the inquiry nature of the class in not apparent to students. About half of the faculty interviewed said that when they teach Biology 101, they routinely get emails from students complaining that lab doesn’t have anything to do with lecture. Of the visual syllabus — “Something like this can communicate common goals and why we’re asking them to do what we’re asking them to do is designed right into it.” He said “any faculty member who cares about their course has something like this in their brain.” All of them expressed doubt as to whether it would be right for their teaching, and I believe based on their answers to questions about the strategies they employ when teaching that this is an artifact of their beliefs about the inquiry pedagogy of the class and their perceptions of the relatedness of lab and lecture in the first place.

One independent indication of their involvement with the Biology 101 labs might be how many instructors attend or involve themselves in weekly TA meetings where the course coordinators go over the weekly lab and recitation and veteran TAs offer suggestions to new TAs about how to improve upcoming labs. During interviews, some faculty members revealed that they did not always know which lab their class was working on. If an instructor chooses or is available to attend the TA meetings, one can conclude it is more likely that the instructor will know which labs the students are working on in a given week. Some instructors come to the TA meetings and are allotted however much time they ask for at the beginning of the meeting from the course coordinators. These instructors reported leaving the meeting before the discussion about the upcoming lab occurs. The faculty members I interviewed run the gamut from attending and staying through every TA meeting to attending the first meeting of the
quarter and none thereafter. To be fair, it seems that almost every instructor would like to attend his or her TA meetings, but time was not always available. The instructors also cited confidence in the IBP staff to run the meetings and train the TAs as a reason they felt they could miss TA meetings when they needed to.

4.2.2. *Perceptions of Individualism*

One assumption that had been made during the design of the visual syllabus was that all of our instructors taught the same syllabus with a few minor variations in the order of their lectures. In the process of document analysis, I found that this was not always the case (see Appendix A). There is a core group of four instructors that have similar syllabi and seem to go in relatively the same order as each other. These are the faculty whose syllabi follow the evolution, genetics, energetics path of the visual syllabus through the quarter. There are two faculty members whose syllabi are vastly different. One of those instructors divides his syllabus into three groupings consisting of diversity, evolution and ecology. Another faculty member does not appear to have a distinctive system of category groupings but teaches topics in an order that makes sense to him and allows for flexible scheduling of additional guest speakers for lecture.

In addition to actual similarities and dissimilarities in the syllabi of the faculty, something that might be important to take into account when designing a tool to be used by multiple faculty members is that they do not perceive their classes as resembling each other. Even if they are teaching the same material in the same order as their peers, they view their stylistic choices and the delivery of that material to be highly individualized. I believe this leads to extreme doubt on the part of the faculty member as to whether a
learning tool like the visual syllabus could ever be successfully adapted to suit their particular needs if it was not created specifically for them.

4.2.3. Design Recommendations

The faculty did not have many suggestions for further visual refinement of the design. Multiple instructors said that it seemed likely that more syllabi would move towards a more visual, electronic format similar to that of the visual syllabus we were discussing. All but one faculty member expressed positive views towards the design. The one faculty member who did not admitted that most of his criticism had to do with what he thought of as the learning cycle. He said that because of the circular design of the visual syllabus, it appears as if the student ends up right back where they start. A different instructor was particularly concerned that he might not be able to post things like course notes or lecture slides as fast as he might like to. This instructor mentioned that because he has that ability now, going back to an older-style model of having to send his notes to a staff member to be posted would be a step backwards.

4.3. Implementation Phase Results

What the faculty members chose to focus on during interviews was almost as telling as what they said. Some faculty members seemed inclined to focus primarily on their strategy of teaching, while other clearly viewed the problems that they faced when teaching through an emotional lens. Because all of the faculty interviewed have had some interactions with me in the past six years, this may have been reflective of how comfortable they felt dealing with me or it may have just been due to their individual personalities and perceptions about teaching. Whatever the reason, some faculty members
were more emotional than others and these were the faculty members that did not just feel disappointed that their students did not appear to be “getting it,” but seemed at times to this perceived failure very personally. One instructor, who revealed that he was not motivating the number of students he wanted to, said that he would be happy if 90% of his students “got something out of it.” The instructors who self-identified themselves to as innovative teachers took these feelings of failure particularly hard— one faculty member said that in his mind, “almost all of his lectures from a previous quarter were failures.” Professors who freely admitted that their research came first, seemed somewhat less bothered by negative student feedback and placed the responsibility for success or failure in the course on the students rather than their own performance as an instructor. “It feels like they’re listening, I wish we could find out what they really thought,” one faculty member commented.

4.4. Strategy

Strategy is the term that defines the choices, tactics and tools a faculty member employs when making decisions about how to teach their class. In the context of discussing the visual syllabus, I also used strategy to frame how well the learning tool fit with the overall goals of the instructor for their class.

4.4.1. Syllabus Planning

The faculty members each had their own unique approach to writing their syllabus every year. Most agreed that after they had written it once, it was a matter of refining that syllabus from year to year. One instructor could give actual estimates of how much his syllabus had changed from year to year. He estimated that the first year he taught Biology
101, he borrowed at least half of his syllabus from two other instructors (with their encouragement and permission). The second time he taught the class, the borrowed portion of his syllabus was reduced to 25%. The third time he taught the class, the borrowed portions of the syllabus had been reduced to 10% of his syllabus. He estimated that is where it is likely to stay for the remainder of the time he teaches the class. This was especially interesting when the former assertion that most of our faculty were using the same or a very similar syllabus. Perhaps at one time, they were, but as they’ve taught the course they have adapted that syllabus to something that is more personalized to their teaching style, delivery choices and content expertise.

Some syllabus choices were centered on particular topics they felt needed to be emphasized, such as evolution. Many faculty members mentioned that they felt they should pay greater attention to their evolution teaching as result of the controversy surrounding various group attempts to include creationism and intelligent design into state and local science standards — a particularly hot topic in Ohio in 2005 and 2006. Looking towards the class they will teach in the coming academic year, they are planning to allow themselves room to rework bits of their syllabus to fit in a topic, such as teaching evolution, that they feel passionate about.

4.4.2 Stylistic Choices and Delivery of Material

Some of the faculty I interviewed were particularly sensitive about this topic. The general feeling is that someone (perhaps the director, it was never a clearly defined authority) has the right to tell them what topics to cover, but that they have earned the privilege of teaching those topics — and whatever other topics they feel is necessary —
to achieve an introductory-level understanding of biology in their students. One professor said that "It’s likely to elicit and aggressive response if someone tells me how to teach."

It seems that the professors often view their own role as the content expert to be the most important aspect of the class. "They can download all of the content of a course or a textbook on a device as small as their phone, so my job isn’t just to stand there and deliver content but to provide meaning." This idea of placing information in a context that would be relative for a student took on a great deal of importance for more than one faculty member and was viewed as one of the hardest aspects of teaching an introductory class.

4.5. Politics

Politics mainly deals with the interests of the decision makers, and networks of influence (Loch, 2003). In the university environment, there are a wide array of people and priorities that can influence whether a learning tool is adopted or a new design is tried out. I also use politics to frame the discussion in terms of perceived support by the instructor as decisions about how much support a teaching faculty member is provided is a decision that has political overtones.

4.5.1. Perceived Technology Support and Perceived Teaching Support

Across the board, faculty agreed that they received excellent teaching and technology support from the IBP, but that data must be looked at with the knowledge that the interviewer is member of the IBP staff. One faculty member said that his students benefited from the course coordinators ability to take care of the administrative tasks of the class for him in such a timely fashion and that "it’s a richer experience for the
students because I can go to the course coordinator and delegate.” Opinions were mixed as to whether they received support for their teaching at the university level. Some faculty insisted that they were not given enough time away from their teaching responsibilities to develop their courses the way they would like too.

Opinions were mixed on technology support from the university. One instructor felt that OSU “was way behind” in technology — that OSU did very little in the way of providing access to technology, no funding or money for time off and course redesign. When asked to explore this, the instructor cited some examples of how a more forward-thinking university might reward faculty who made an attempt to develop technological resources for their courses. In one example from the University of Nebraska, professors are asked to develop online resources for their classes with the incentive that if the university is making money from the tuition of distance-learning courses, the professors who created the material get a share of the profits. The professor also offered that if the university really wanted to get professors involved in creating technological learning tools for their classes, OSU should highlight examples where these tools have been a success as a model for other instructors. “People hear these horror stories, but no positive outcomes,” he said. The faculty member who offered these suggestions had no knowledge of whether instructional designers had been used at the University of Nebraska or in the other “good examples” she cited.

One professor said that the IBP gives better support than other departments that he’s been in. He said that often when a department hires technical support, it’s for research. Only in the IBP does he feel like he gets that level of support for his teaching.
4.5.2. Appropriateness of Pedagogy in Biology 101

The faculty that I interviewed seemed to have varying levels of commitment to inquiry-based pedagogy. The former director of the program planned the inquiry pedagogy of Biology 101 and the labs to support that pedagogy. The view shared by most was that if the pedagogy didn’t get in the way of what or how they wanted to teach, it was fine. If the pedagogy complimented what or how they wanted to teach, so much the better. There was some misunderstanding among the faculty on this point. It seems that most faculty thought that the inquiry-pedagogy referred to the lab portion of the class and that the lecture, which they controlled and created, remained separate and was not necessarily subjected to being considered part of the inquiry pedagogy. Most instructors said that they thought the IBP course coordinators did a great job running the labs and training the TAs. A few said that they felt like it would be “insulting” to demand any kind of change from the staff because “the coordinators obviously know what they’re doing and have give the labs a lot of thought.” When asked what they thought of using inquiry in the class, one instructor said that he hoped that by presenting information in new ways, the students might connect and respond better. While it did speak to the professor’s commitment to continual general improvement of their course this did not lead me to believe that the professor shared a deep commitment to extending inquiry pedagogy into their lecture sections.

There were some professors that felt that inquiry-based pedagogy should not be the preferred method for teaching Biology 101 at all. The professors with this view said that they held nothing against inquiry teaching, but that it should be reserved for higher level courses, and “students who wanted to be there.” Even a professor who thinks that inquiry
teaching is an important aspect to Biology 101 said that the students struggle with it because they are not used to it, “they like to go into lab having some background and what we’re doing is different. I don’t know if they get it by the end.”

The professor who was the most vocal against teaching Biology 101 using inquiry believed that students are more savvy to inquiry pedagogy than we think and that they have figured out how to manipulate the system so that they end up doing relatively little work for class. One example of this had to do with cooperative lab groups that the Biology 101 students work in. The professor said that if one smart person in a 4-person group is doing all of the work, and that is happening class-wide, then you are only grading the top quarter of all 101 students. Students who are scoring very high on their labs may do poorly on midterms and finals where their individual knowledge of the class is tested. He is also doubtful the students are learning anything, “In Spanish, wouldn’t students have to learn the Spanish vocabulary? There’s no faking it. On the piano, only one note is C. In the sciences, we’re embracing new methods to become better teachers, but if students don’t know the concepts, then the whole thing is pointless.” This data becomes more interesting with the observation that the professor espousing these views is widely acknowledged by IBP staff and other faculty peers to be one of the most popular professors teaching this course. It should also be noted that of all the faculty interviewed, he seemed to have the most realistic view of student culture at OSU — that is what his students wanted from a 101-level course and how much they were willing to give of themselves in a GEC class.
4.6. Culture

The term culture refers to a particular way of organizing life. It can refer to a set of learned beliefs, values and behaviors shared by the members of a group. University culture is itself a unique way of organizing life and often is set apart from what might be called “the real world.” Within university culture there are distinct subcultures of faculty, staff, and students. Culture defines appropriateness and legitimacy or “how things are done around here,” (Loch, 2003, p. 217).

4.6.1. Understanding Faculty Culture

To be a faculty member at a large research university is to be pulled in many different directions at once. The faculty I interviewed unanimously felt pressure to produce research and compete for grant money. Most agreed that those research responsibilities had to come before course development and teaching responsibilities. Boyer (1990) said that the current model of the research university has a tendency to polarize the research and teaching roles of faculty with research holding top status, teaching a secondary priority and service a distant third priority. Some of the faculty interviewed expressed regret that this was the case, but most agreed that it was a system that was not likely to change in the near future. Boyer (1990) suggests an alternate model that breaks down into the four categories of the scholarship of discovery, the scholarship of integration, the scholarship of application and the scholarship of teaching. There have been many calls in recent years to integrate a professor’s research into their teaching (Paulsen, 2001) (The Boyer Commission Report on Undergraduate Education, 1998), but perhaps what matters most in the faculty member’s own assessment of their time is how
they perceive the importance of teaching in their own academic unit. One professor said that he relied heavily on the IBP staff because “I have to submit all of my time in spent 101 to a cost-benefit analysis and the results are that I just can’t take time out from my grants and my research to work on 101 very much.”

4.6.2. Understanding Student Culture

College is never the same experience for the adults who run it as for the mostly late-adolescents who make up the largest portion of its undergraduate population (Moffatt, 1991). Classroom education makes up only a portion of what most undergraduates consider the college experience (Moffatt, 1991). With this in mind, it hardly seems surprising that the area where instructors seemed most confused was in how to relate to and interpret their students.

One of the premises on which the visual syllabus is based is that it allows instructors to communicate extra material that extends and supplements the concepts learned in lecture to the students. How receptive are students to this extra material and how much time are they willing to devote to a GEC course? Rebekah Nathan — a pseudonym for Cathy Small, an anthropology professor at Northern Arizona University— wrote a book on her experience enrolling as a Freshman student at her own university. Some of her complaints at the beginning of the book sound very similar to the sentiments expressed by the faculty I interviewed. “Why don’t undergraduates ever drop by for my office hours unless they are in dire trouble in a course? Why don’t they respond to my (generous) invitations to do out-of-class research under my guidance? How could some of my students never take a note in my big lecture class?” (Nathan,
More than one faculty member I interviewed seemed horrified at the number of students who slept during lectures. Students’ unwillingness to reach beyond the testable material of the course led one faculty member to conclude that he is “boring the people who do understand, and the people who don’t understand when they come in, don’t understand when they leave.” Nathan learned about the time management strategies of college students by going through the experience of being one again:

Going to school, I found, was a time management nightmare; student life required much more and a very different kind of juggling than my life as a professor, even with its diverse service, teaching, and research demands. As a student, I was quick to learn, you serve many masters, each with his or her own quirks, schedules and predilections (Nathan, 2005, p.111).

The faculty member who seemed to have the most realistic picture of his students’ goals when it came to course material was that same professor who did not think highly of the use of inquiry in the course and who regularly does well on his Student Evaluation of Instruction (SEIs) forms. He believes that a student’s success in his course depends largely on their motivation. Most of his exam questions are available from material he posts to his online course site directly after lecture. He agreed that it was conceivable that a student could download the course material, never go to lecture and still get an A in his class. He did not think that happened with any frequency though because “they only ones who get As are the students who are already motivated and are more likely to attend lecture. The students who are unmotivated don’t even bother to download the notes.”
This professor’s major criticism of the visual syllabus also centered around the issue of how much material a student was likely to consume for a GEC course. He said that he believed that the external links on the diagram to supplemental material were a waste of time. He was very adamant that “students don’t want more information — they are busy trying to figure out what they can ignore or skip.” He said that he does sometimes post extra links to topics he has lectured on, but believes they are very rarely followed. “They just want to learn what will be on the test. They have Spanish and all of these other things to study for. It’s because we like it that we do it, but it doesn’t relate to them.” He said that he thought links and supplemental material are great ideas, but are better suited to a higher-level class, such as a 400-level class because the audience of a 400-level class would be made up of students who have selected biology as a major, and “Biology 101 students don’t want to grow up to be scientists.”

4.7. Emotions

Loch maintains that people commonly exhibit three emotional needs that should be taken into account when trying to implement a new design: friendship and reciprocity, group identification and ego (2003, p. 218). Initially, I viewed emotions as a distinct and separate category. In reviewing my data, I feel that it makes more sense to consider emotions a category with undercurrents that run through different aspects of strategic, political and cultural attitudes and decisions of the faculty. In fact some faculty seemed most emotional about the strategic decisions they’d made regarding the course. When asked what it took to teach 101, one professor said, “The vast majority of people have no idea what it takes to walk into the room and give a performance like that twice a week.
You must be immune to criticism and immune to childish behavior.” Another professor says that while it takes a lot out of him to get onstage, “you can’t go in with a big ego — they’ll be so bored with your defensiveness and they won’t learn anything.”

4.7.1 Feedback Loops and Feelings of Failure

In interviews, faculty members said that one of the most valuable aspects of teaching Biology 101 was the feedback they received from students. This referred to positive feedback. It was clear that instructors of large classes are receiving feedback from two polar opposite ends of their students — those who feel that the course enriched their lives in some way and those who felt dissatisfied with their experience in the class and vent their true feelings at the end of the quarter in anonymous teaching evaluations.

Disappointment over negative feedback was an emotional thread that ran through every faculty interview. Most instructors judge their success for the quarter in how many students were actively participating and asking questions. “Class involvement is the key thing for me,” one professor said. The same instructor said that the biggest reason he teaches Biology 101 is to get his students talking and sharing anecdotes about how biology has impacted their lives.

While all of the instructors enjoyed the sort of positive student feedback that might be categorized as participation, perceptions of SEIs at the end of the quarter were in almost every case disheartening. In the past year, instructor evaluations have been online rather than a form filled out in the last class. In the online version of these evaluations, students judge their teachers in a variety of areas using a Likert Scale where 1 = poor and 5 = excellent. There is also a box for student comments. It is this box that has resulted in
the most disappointment for instructors. One IBP staff member believes that because the students perceive their instructors from a distance, they feel particularly brazen in leaving harshly critical comments. The timber of these widely varying comments have led at least one instructors to disregard all SEIs, "The comments range from 'It's great' to 'It's stupid.'" He said that he found neither sentiment particularly useful to his teaching.

4.8. Summary and Unanticipated Results

One theme that became recurrent was that the term pedagogy held different meanings for people. Pedagogy is a term that implies that more than just the act of transferring knowledge and skills, that there is a methodology and reasoning for teaching a particular subject a particular way. One of the best definitions of pedagogy I’ve heard came from a recent movie review in The New York Times. A.O. Scott writes that Al Gore’s movie — which is really just a powerpoint presentation on global warming and scientific literacy to a very, very, large audience — “as unsettling as it can be, it is also intellectually exhilarating, and, like any good piece of pedagogy, whets the appetite for further study” (p.78, Scott, A.O. 2006).

In this study, almost all the faculty interviewed had varying levels of commitment to inquiry pedagogy as it is used in the Biology 101 labs, but in most cases, that commitment did not extend to lecture. Faculty tended to view any suggestion of a more pro-active use of inquiry pedagogy in their lectures as “telling them how to teach their own class,” and approached such suggestions negatively. Pedagogy seemed to take on a negative connotation because to them it meant that some level of authority was forcing them to teach a particular way. Even the faculty who felt more positive about using
inquiry pedagogy and who had made some attempts to tie their lectures to the labs student were working on felt that issues of timing and scale often kept them from using the pedagogy effectively. One professor said that inquiry is hard to do with the current set up because it takes one week for all of the students to cycle through a lab, but because of the way quarters are set up, those weeks don’t necessarily start on Mondays. Lectures are held twice a week and he said that he never is quite sure if everyone has been to lab yet, and it is very easy to get out of sync, so that occasionally he is either a week ahead of them or a week behind them and timing his lectures to be consistent with the inquiry nature of labs is sometimes difficult, “Sometimes I’m ready to lecture on a topic and they haven’t had it yet.”
CHAPTER 5

DISCUSSION

The primary purpose of this study was to investigate the design, teaching and administration of large-population biology courses. A secondary purpose of this study was to generate insight into how faculty understand and accept the existing design of a visual syllabus learning tool for Biology 101.

5.1. Findings

5.1.1. Design Phase Findings

Researching the design of the visual syllabus, I hoped to collect useful information on how its design might be used to support multiple professors teaching Biology 101. Faculty were positive in their critique of the design, but my position as both a stakeholder in the design and the interviewer may have impacted the candor of their critique. Faculty did seem to clearly see the relationship between lab and lecture that the visual syllabus was designed to emphasize. Vocalizing that relationship in their lectures did not seem to be a priority for the faculty. In fact I believe that some may have been looking at the visual syllabus as a tool that would accomplish that for them. Because the instructors are not in the lab room, their connections with lab are often tenuous. While they may have intentions of bringing aspects of the lab experience into their lectures, it is rarely done.
There are a couple of plausible explanations for this disconnect. One would be that teaching a lecture section of over 700 students is such a large scale operation that emphasizing the relatedness of lab in lecture is just not something that is in the front of their minds when they teach the course. I also believe that the way the lab schedule operates does not lend itself to an easy deduction of which lab the students are working on. When split into lab sections of 24 students, a 700-student lecture class takes one week for everyone to cycle through. Add to that an instructor who does not have time to attend weekly TA meetings, and it is almost guaranteed the instructor will not always know which lab is being covered.

There was also plenty of doubt among faculty that the design of the visual syllabus could ever be adapted for each individual instructor. I believe that each instructor would have to see a prototype matched to his or her particular syllabus before a change in that perception will happen. The major design recommendations from the faculty are that the visual syllabus would have to be tailored to each individual instructor’s Biology 101 course and that the function of the tool should be flexible enough to accommodate both, the most self-sufficient and the most techno-phobic or time-pressed professors with ease.

5.1.2. Implementation Phase Findings

One of the most significant findings of this study was developing an understanding of the attitudes that the faculty had towards the use of inquiry pedagogy in Biology 101 and how these attitudes might affect how the connected lab and lecture in their instruction. This finding could also be affecting their attitude towards trying new learning tools in the classroom or buy-in towards using the visual syllabus. This study also found a
cultural disconnect between faculty and students. The faculty seemed unaware of the goals and priorities of the current undergraduate student population and were unable to update or refresh their expectations and amount of course material accordingly. This may also be a design flaw to be addressed in the visual syllabus.

When I started investigating what faculty thought of the design for the visual syllabus, it had been assumed that the faculty felt very little connection to the technology used in the design and held doubts as to whether the technology would work in their class. I believe that while those perceptions about technology may have played a part in their lack of adoption of the tool, I now believe that the bigger obstacle is the disconnection they feel between their class and the prescribed inquiry pedagogy that the visual syllabus was designed to support.

5.2. Understanding Goal Conflicts and Resolutions

My recommendations for improving the process for designing instructional support systems focus on countering complexities in the system of teaching and administering large introductory courses. One example of such a complexity is in the area of goal conflicts. Bearing goal conflicts in mind when designing the system may improve the adoption rate of the instructional tool. Each population the instructional tool touches can have different goals. For example, faculty have the significant goal of conducting research, because they are largely rewarded for that aspect of their work. The faculty also have the goal of enabling learning in their students. Teaching is a time-consuming task with few formal rewards, so having students who enjoy the class and vocalize their enthusiasm becomes a reward for teaching.
Students taking Biology 101 have their own goals. Some want to get through a required GEC course by getting the highest grade possible for the lowest amount of effort. Most students do not seem opposed to learning something in the process, but that is not necessarily their primary goal.

Administrative staff have yet different goals. They want the course to run smoothly and for the faculty to have all of the support they need to teach. Staff want the students to respect the rules of the class and produce the work the class requires of them. They want the TAs to put forth effort to become good teachers for the students in their lab sections. Staff have the common goal of wanting to produce the best possible class experience for all of the other players involved with the least amount of time-consuming problems to overcome. This may induce a reluctance to try new tools or techniques if they are viewed as being possibly problematic.

The instructional designer’s goal is to navigate and align these different populations’ goals to create new ways to support the class. The areas that I researched—strategy, culture, politics and emotions—all interact with these goals. The realization that different populations have different goals may sound simple, but I believe that understanding goal conflicts and overlaps is the critical groundwork that must be laid before attempting to specify or change an instructional system. Instructional designers must look for ways these goals can be aligned in order to make progress in supporting a complex system like a large GEC class.
5.3. Recommendations for Aligning Goals

5.3.1. Strategy

Time seems to be a factor in a number of strategic choices faculty are forced to make. Time can affect everything from the decision to re-write troublesome lectures for the next year to the level of involvement with TAs to a faculty member’s interest to try new teaching methods — including scaffolding learning tools like the visual syllabus. Faculty used to a traditional system of reward and promotion based on research productivity often have to make difficult decisions about where to spend their limited resources. Paulsen (2001) suggests that one way to change perceptions about their time spent teaching would be to emphasize teaching as a scholarly aspect of research. By incorporating new assessments into their classes, faculty will be able to contribute to the field of teaching science as well as their own research fields. At this point in their careers, they have become specialists in the both areas. Research into the impact of using new learning tools in the class could have the positive effect of creating a system of design and refinement that both the instructional designer and the faculty member hold a significant stake in. Adoption of new learning tools and new models for old course elements, like the traditional syllabus, would be greater if faculty were more directly involved in the creation of those tools.

The IBP is lucky to have dynamic faculty lecturers. Faculty who possess this skill and are interested in improving teaching should be encouraged to do so as a model to the colleagues. According to The Boyer Commission Report on Undergraduate Education:

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Universities rightly assume that whoever appears in front of their classrooms can command the material that should be conveyed. Rare individuals can also captivate and stimulate student audiences, large and small, with their dynamic classroom presentations. Since it is likely that most universities will need to retain some large classes, those individuals capable of striking success in the classroom should be suitably rewarded.

(1pg. 32-33)

5.3.2. Politics

While the visual syllabus was being created, the IBP ran on a system where the director selected the pedagogy of the Biology 101 lab sections and encouraged the teaching faculty to extend that pedagogy into their lectures. Some of the faculty made attempts to do this with varying levels of commitment and success. Other faculty taught Biology 101 in a way that strayed from inquiry pedagogy, but trusted the IBP staff to run the labs using inquiry methods.

In interviews, there was a definite willingness to share classroom materials with colleagues teaching the course. However, the disconnect between professors’ different departments in a large college is apparent in the comments of one professor interviewed who said “I’ve used [Professor X]’s notes for the past two years, but I’ve never met [Professor X].” These two faculty members have never met, though they teach the same class and their offices are in buildings that are separated by about the length of a football field.
One suggestion for overcoming this is collaborative syllabus writing. The technique of collaborative syllabus writing is suggested in Science Teaching Reconsidered:

Often, multiple sections of an introductory course are taught by different faculty members. Some faculty members find it useful to meet with their colleagues to design a syllabus that optimizes the order and structure in which to present the course material. For example, if you are teaching atomic theory, is it best to start with basic terms and then build up to a model, or to start with a model and disassemble it piece by piece? The first step in collaborative syllabus design is to meet with fellow faculty members who teach the same course to identify basic concepts. Then, separately, each teacher does an analysis of the critical variables related to each concept. Finally, the colleagues reassemble to compare their lists, identify similarities and differences, and discuss the implications of their lists for instruction (pg. 4).

The first steps towards building a more collaborative system of teaching may have begun. In January, 2006, a meeting of the entire teaching staff of Biology 101 faculty was held to determine what the learning outcomes of the course were. All but one faculty member interviewed were present. During the meeting, four main content areas were identified as being important to all who were present. These areas were evolution, genetics, energetics and “biology in society.” These areas track very closely to the three major content areas (evolution, genetics, energetics) emphasized in the visual syllabus. Having identified these basic concepts as important goals of the course to everyone, the
next step could be to involve the faculty in a discussion about what instructional tools and techniques would be best suited to teach these concepts. Giving the faculty a stronger voice in pedagogical decisions at the program level would be the best choice to establish buy-in for new ideas and projects to improve the course.

5.3.3. Culture and Emotions

Faculty expressed great disappointment in the negative feedback they received from students. Most of the feedback stems from some basic disconnects that can be addressed with time and attention.

A strategy that one of the IBP’s most highly rated instructors employs is to attend every lab section once a quarter. IBP staff believes that this presence in the labs creates a humanizing image of their instructor for the students. Attending periodic lab sections also allows the instructor to follow the lab cycle the students are experiencing more closely, increasing the likelihood the labs will be mentioned in subsequent lectures. The opportunity for instructors to converse with their students in smaller groups of 24 students per lab section and even smaller groups of 4-6 students in cooperative lab groups would give instructors the opportunity to gain more insight into the cultural habits of college students. Chickering and Gamson (1987) identify encouraging contact between faculty and students to be at the top of their list in Seven Principles for Good Practice in Undergraduate Education. I believe the faculty I interviewed would see immediate benefit from this practice in the form of less vitriolic comments in their end of the quarter SEIs.
Instructional designers have a real need to understand the cultures of students and faculty better in order to create effective instructional tools. Faculty teaching Biology 101 have different needs based on the approach they take when teaching. Some professors prefer to delegate updating assignment listing and content found in the online course system that supplements the classroom. Some instructors like to upload their course notes themselves so they have greater flexibility in making small changes whenever they need to. These types of preferences have significant implications for a tool like the visual syllabus. Additionally, though we are past this point in terms of the computer skills of our students, it would be just as hard to create online course content for a student audience that felt uncomfortable accessing the material. In fact students may now prefer—and in some cases, expect—that course material be accessed electronically. Increasingly, course syllabi have moved to being electronic and updatable documents when once they were handed out the first day of class. The visual syllabus looked to extend that updatability into a system for delivering course information and course material in one place. A student culture that adapts rapidly to changes in new technology will continue to be a challenge for teams of faculty and instructional designers.

Though this sounds like an unlikely scenario, there is something to be said for reconsidering the model of having graduate students teach the inquiry-based labs. If lectures could be captured electronically or taught by graduate students looking to learn the art of lecturing to college audiences and faculty could teach the smaller lab sections, this would put faculty in direct contact with the students. Economics and the available time of faculty do not make this a viable approach, but if the lab is such an important component of the class, it is worth considering realigning resource allocation.
5.4. Limitations and Implications for Future Research

In this research, I chose to investigate the role of the instructional designer in part because that was more meaningful to my role at the university. In reality, it would have been very difficult to attempt a study involving large numbers of teaching assistants and students to evaluate classroom use of the visual syllabus. The coordination of these factors is something I felt would disrupt the course flow of Biology 101 and take some of the control of the course away from the professor teaching that quarter. In addition, the lack of a permanent director in the IBP left some potential projects, including the visual syllabus at an inconclusive state. The previous director was a stakeholder in the tool, as it was his syllabus and pedagogy the visual syllabus was created to support.

Obviously there is a need for further revisions of the visual syllabus if it is ever to be used for a Biology 101 class. While the faculty seemed positive in their critique of the design, all indicated that it would have to be changed to fit more seamlessly with their teaching style. The majority of those changes would be to accommodate the amount of inquiry teaching they include in their class and how comfortable they are emphasizing the relationship between lab and lecture. It seems far more likely that the visual syllabus will serve as a first iteration for a new model of online syllabus with content linked directly from it. Most faculty agree that they would like to emphasize the “biology in society” content area of Biology 101 as a way for their students to connect what they learn in class with how advances in science might impact their own lives. This means moving towards class material that includes current research and breaking science news and away from staid textbooks. The visual syllabus can serve as a model for new course content delivery by taking advantage of newsreader technologies and RSS feeds. These common content
delivery mechanisms could allow students to “subscribe” directly to their syllabus and have up-to-date course content delivered to the computer desktop.

Large classes are a part of life at research universities. They remain the most efficient — if not the most effective — way to teach undergraduates. Educational research on the demands of teaching and administering large courses could positively impact a huge number of students. I hope that this research speaks to the challenges of working with large-scale courses and the possibilities for future research.

5.4.1. The Future of the IBP

The IBP has been without a permanent director for the past year. October 1, 2006, this will change as Dr. Caroline Breitenberger takes over the director role. It appears that the IBP will be broadening its role in undergraduate education. Dr. Breitenberger’s first charge will be to expand the IBP to encompass not only introductory biology classes but also a three-class sequence for students at the Sophomore-level who have chosen biology as a major.

The IBP itself will soon become the Center for Life Sciences Education, and will expand its role in educational research. While a change in leadership may not equal change in pedagogy, it might mean that there is a bit more freedom for both instructors and coordinators to try new course designs in the lecture halls and laboratories. It is a goal of the program to incorporate the scholarship of teaching as an important aspect of educational science research that will involve both faculty instructors and IBP support staff. It is my hope that with the involvement of such a creative and eager group of
professionals, this research and design of innovative teaching tools will become a model for other complex teaching organizations within higher education.
APPENDICES

APPENDIX A

IRB PROTOCOL, CONCEPTUAL PROTOTYPE, AND DOCUMENT ANALYSIS
6.1. IRB Protocol and Solicitation Materials
APPLICATION FOR EXEMPTION
FROM REVIEW BY THE INSTITUTIONAL REVIEW BOARD
The Ohio State University, Columbus OH 43210

All research activities involving the use of human beings as research subjects must be reviewed and approved by an Ohio State University Institutional Review Board (IRB), unless the Office of Responsible Research Practices (ORRP) determines that the research falls into one or more of the categories of exemption established by federal regulation.

Exempt research is generally short term in nature. It usually is performed "as written," i.e. the investigators do not plan to make changes in the research design, the selection of subjects, the informed consent process, or the instrumentation during the course of the study.

A determination that research is exempt does not absolve the investigators from ensuring that the welfare of human subjects participating in research activities is protected, and that methods used and information provided to gain subject consent are appropriate to the activity. Investigators may not solicit subject participation or begin data collection until they have received approval from the appropriate Institutional Review Board OR written concurrence that research has been determined to be exempt.

All OSU investigators who participate in human subjects research must be appropriately trained in human subjects protection. See www.orrp.osu.edu/education for more details.

There is no deadline or timeline for submitting exempt applications for review. Applications are processed as received. Each application must include a research proposal. The proposal must include (at a minimum) the following items: the background literature review, the research question, a description of the research methods including sample size and data collection procedures, and a data analysis plan.

Please allow up to three weeks for processing.

If you have questions regarding the application process or the review of exempt protocols, please contact Janet Schutte, Office of Responsible Research Practices.
Phone: 688-0389 / Fax: 688-0366 / E-mail: schutte.58@osu.edu

A COMPLETE APPLICATION PACKET INCLUDES THE FOLLOWING MATERIALS:
☒ Title page (attached). Identifies the investigators. Lists the protocol title and the source of funding.
☒ Screening questions (attached). Identifies the categories of exemption and solicits responses to screening questions.
☒ Description of the proposed research (questions #1 through #9, attached). Includes responses to questions about the objective(s) of the research, the methodology that will be used to gain informed consent from the subjects, and the measures taken to protect the confidentiality of information obtained in research.
☒ Research proposal (see question #1).
Grant proposal. Must be included when externally-sponsored funding is being sought.
Letter(s) of support (see question #4).
 Copies of surveys, instruments, questionnaires, interview questions, focus group topics,
and/or data collection sheets (see question #5).
 Recruitment letter (see question #8).
 Consent form (see question #9).

SEND YOUR APPLICATION TO:
Office of Responsible Research Practices
300 Research Foundation Building
1960 Kenny Road
Columbus OH 43210-1063
Fax (614) 688-0366
# TITLE PAGE - APPLICATION FOR EXEMPTION
FROM REVIEW BY THE INSTITUTIONAL REVIEW BOARD
The Ohio State University, Columbus OH 43210

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<th>Name: Richard J. Voithofer</th>
<th>Phone: 614-247-7945</th>
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<tbody>
<tr>
<td>University Title:</td>
<td>Department or College:</td>
<td>E-mail: <a href="mailto:voithofer.2@osu.edu">voithofer.2@osu.edu</a></td>
</tr>
<tr>
<td>☒ Professor</td>
<td>School of Educational Policy</td>
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<tr>
<td>☒ Associate Professor</td>
<td>Leadership,</td>
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<td>☒ Assistant Professor</td>
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<td>☒ Instructor</td>
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<th>Name: Emily L. Jones</th>
<th>Phone: 614-888-5495</th>
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<tr>
<td>☐ Faculty</td>
<td>4034 Smith Laboratory</td>
<td></td>
</tr>
<tr>
<td>☒ Staff</td>
<td>174 W. 18th Ave.</td>
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<td>☒ Graduate Student</td>
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<td>☒ Undergraduate Student</td>
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<th>Research has been determined to be exempt under these categories:</th>
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<td>☑ Approved.</td>
<td>[Date of determination: ____________________________]. Research may begin as of the date of determination listed below.</td>
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<tr>
<td>☒ Disapproved.</td>
<td>The proposed research does not fall within the categories of exemption. Submit an application to the appropriate Institutional Review Board for review.</td>
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<th>Date of determination:</th>
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Office of Responsible Research Practices
The purpose of the Application for Exemption is two-fold: (a) to determine whether the proposed research qualifies for exemption from review and continuing oversight by an Institutional Review Board; and, if so, (b) to ensure that the informed consent process protects the rights and welfare of human subjects in research. Please respond to the following questions and provide the requested documentation.

Have all investigators completed the required web-based course in the protection of human research subjects? ☐ Yes ☐ No

If No, see www.orrp.osu.edu/humansubjects/citiecfm for more information.

EDUCATIONAL REQUIREMENTS MUST BE SATISFIED PRIOR TO SUBMITTING THE APPLICATION FOR IRB REVIEW.

Please check the categories of exemption for which you are applying. The list of categories is located at the end of this application. You may check more than one box.

**EXEMPT CATEGORY:**

☐ 1 ☐ 2  ☐ 3 ☐ 4 ☐ 5 ☐ 6

**SCREENING QUESTIONS:** If you check **YES** to any of the questions below, your research is not exempt. Do not complete the exempt application. Submit an application to the appropriate Institutional Review Board for review.

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<th>Question</th>
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<td>Does any part of the research require that subjects be deceived?</td>
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<tr>
<td>Will research expose human subjects to discomfort or harassment beyond levels encountered in daily life?</td>
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<tr>
<td>Could disclosure of the subjects’ responses outside the research reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects’ financial standing, employability, or reputation?</td>
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<td>Will fetuses, pregnant women, human in vitro fertilization, or individuals involuntarily confined or detained in penal institutions be subjects of the study?</td>
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<td>For research proposed under category 2, will research involve surveys, interview procedures, or observation of public behavior with individuals under the age of 18?</td>
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<td>For research proposed under category 4, will any of the data, documents, records, pathological specimens, or diagnostic specimens be collected or come into existence after the date you apply for exemption?</td>
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<tr>
<td>For research proposed under category 4, will any of the information obtained from data, documents, records, pathological specimens, or diagnostic specimens that come from private sources be recorded by the investigator in such a manner that subjects can be identified directly or through identifiers linked to the subjects?</td>
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IF YOU CHECKED YES TO ANY OF THE QUESTIONS ABOVE, YOUR RESEARCH IS NOT EXEMPT.

IF YOU HAVE CHECKED NO TO ALL OF THE QUESTIONS ABOVE, YOUR RESEARCH MAY BE EXEMPT. PLEASE CONTINUE WITH THE EXEMPT APPLICATION.

If you have questions about the application or review process, please contact Janet Schulte, Office of Responsible Research Practices. Phone: 688-0389 / Fax: 688-0366 / E-mail: schulte.58@osu.edu
For purposes of this application, "research" includes the recruitment of human subjects as well as data collection and analysis. None of these research activities may begin until the investigator has received a protocol number AND has received written concurrence that the proposed research is exempt. The "date of determination" on page one of this application is assigned by the Office of Responsible Research Practices; it indicates the date when research may begin.

Please describe your study clearly and completely, using a style of language that can easily be understood by someone who is not familiar with your research.

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<tr>
<th>GENERAL QUESTIONS REGARDING THE PROPOSED RESEARCH</th>
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<tr>
<td>1. <strong>Describe the purpose of the research activity to be undertaken. Describe how it involves human subjects. Respond in the space provided here, or attach a research proposal and/or grant proposal containing the requested information.</strong></td>
</tr>
<tr>
<td><strong>Description:</strong> The purpose of this research is to evaluate the design and feasibility of the use of an interactive visible syllabus for Biology 101 at the Ohio State University. This visual syllabus prototype was created with the intention of acting as a metacognitive scaffolding tool by making Biology 101's discovery-learning pedagogy and class structure more apparent and explainable to students. We would also like to collect data concerning faculty and staff's beliefs about issues of course ownership and using discovery learning pedagogy while administering and teaching a large undergraduate course such as Biology 101. Issues and beliefs about ownership and discovery learning are central to understanding the feasibility and design of the visual syllabus. Interviews will concentrate on two main foci — critiquing the design of the visual syllabus prototype and answering questions about the feasibility of using such instructional technology in the classroom. An important component of the feasibility study will be answers to a series of questions for faculty and staff about their experiences teaching and supporting large undergraduate classes. Participants involved in this research will include current and former faculty members who teach Biology 101 and current and former staff members who administer large Biology courses at OSU. All data will be confidential.</td>
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<td>2. <strong>Provide a brief description of the subjects you plan to recruit and the criteria used in the selection process. Indicate whether subjects are 18 years of age or older.</strong></td>
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<td><strong>Description:</strong> Participants will be recruited from the current and past Introductory Biology Program (IBP) teaching faculty and administrative staff. Specifically, participants will be recruited from faculty currently teaching and who have experience teaching for the IBP in the past. All participants will be 18 years of age or older, and they may choose whether or not to complete the interview. There will be no penalties for choosing not to participate. The expected number of participants is 18 or fewer. All data will be confidential.</td>
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<td>3. <strong>Describe how the proposed research meets the criteria for exemption from</strong></td>
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IRB review and oversight. (Refer to the criteria on the last page of this application that correspond to the category or categories you checked on the screening sheet.)

Description: It is believed that this research meets the criteria for exemption because it involves collecting interview response data in a routine educational setting regarding the effectiveness of the instructional and administrative strategies. All of the participants will be over the age of 18. Their participation will be voluntary and will be indicated by their signing informed consent. At the completion of the data collection, a master list of all names will be destroyed. Although the information gathered in this study may be published in scientific journals or presented at scientific meetings, the data will be reported in disguised form so that no individual responses will be identifiable.

4. Will your subjects be recruited through schools, employers, and/or community agencies or organizations, and/or are you required to obtain permission to access data that is not publicly available? If the answer is yes, provide a letter of support from the person authorized to give you access to the subjects or to the data in question. More than one letter may be required.

☐ Does not apply.
☐ Letter(s) attached.
☐ Comments: [delete]

5. Describe the means you will use to obtain data. Check all boxes that apply.

☐ Surveys or questionnaires distributed by mail or in person. I am attaching a copy of the instrument(s).
☐ Surveys distributed through the Internet, through listservs, or through E-mail. I am attaching a copy of the instrument(s). Provide the Internet address: [delete]
☐ Interviews. I am attaching a copy of the interview questions.
☐ Focus groups. I am attaching a copy of the questions that will shape the discussion.
☐ Observation of public behavior.
☐ Observation of activities in school classrooms.
☐ Audiotapes. I will obtain consent from the subjects to tape their responses.
☐ Videotapes. I will obtain consent from the subjects to tape their activities or responses.
☐ Review of existing records, including databases, medical records, school records, etc. I am attaching a copy of the data collection sheet. I am recording information in such a manner that subjects cannot be identified directly or through identifiers linked to the subjects. All of the information in the records to be reviewed exists as of the date of submission of this application.
☐ Tissue specimens. All of the specimens have already been collected and are “on the shelf.” I am recording information in such a manner that subjects cannot be identified directly or through identifiers linked to the subjects.
6. Indicate the date when you plan to begin research, and the date when you anticipate that data analysis will be complete.

Begin date: February 1, 2006  End date: September 30, 2006

CONFIDENTIALITY

- Investigators are required to protect the confidentiality of the information obtained during research, unless the subjects (a) explicitly agree to be identified or quoted, and/or (b) explicitly agree to the release of material captured on audiotapes or videotapes for use in presentations or conferences.

7. Provide a brief description of the measures you will take to protect confidentiality. Please describe how you will protect the identity of the subjects, their responses, and any data that you obtain from private records or capture on audiotape or videotape. Describe the disposition of the data and/or the tapes once the study has been completed.

Description: At the start of the interviews, the co-investigator will explain the purpose of the study and describe the interview process. We plan to emphasize the confidential nature of the data. Names will not appear on any of the interview notes. To further avoid identifying specific people by anything other than role, the naming convention of “Professor 1, Professor 2, etc” will be employed and gender will be disguised where appropriate. Prior to their participation in interviews and observations, participants will be asked to indicate their informed consent in writing. All tape recordings of interviews will be kept in a locked cabinet and destroyed at the end of the research period. Each tape will only be labeled only by the participant’s role and a number. Because the pool of faculty and staff is relatively small, identifying details, such as gender, will be disguised in the results reporting.

INFORMED CONSENT

- In most cases, investigators are required to obtain informed consent from their subjects before collecting data. Respond to questions #8 and #9 to indicate how you will inform your subjects about the research and how you will obtain and document their consent.
- Subjects must be told what they will be asked to do if they agree to participate in research, how long it will take, and how you will protect the confidentiality of the information they provide.
- Subjects must be told that their participation is voluntary, they can refuse to answer questions that they do not wish to answer, and they can refuse to participate or they can withdraw at any time without penalty or repercussion.
- With few exceptions, written consent of the child’s parent(s) or guardian(s) is required if subjects are under the age of 18. In addition,
children 14 years of age or older should be asked to give written assent (agreement) to participate. Children younger than 13 years of age should be asked to give verbal assent (agreement) to participate.

- Provide a means for subjects to contact the investigator(s) if they have questions or concerns about the research. Make it clear to the subjects that you are affiliated with The Ohio State University.

<table>
<thead>
<tr>
<th>8.</th>
<th>What information do you plan to give to your subjects before you ask for their consent? Use a style of language that simply and clearly explains the research to your subjects. Respond in the space provided here, or attach a copy of the information you plan to provide to your subjects and/or their parents or guardians. (Note: if you use more than one method of recruitment, you may check more than one box)</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Letter(s) attached. I will give each of the subjects a copy of this letter.</td>
<td></td>
</tr>
<tr>
<td>☒ I will be contacting subjects by phone or in person. I am attaching a script that contains the information I will give them.</td>
<td></td>
</tr>
<tr>
<td>☐ Does not apply. My data analysis is limited to existing records or tissue specimens.</td>
<td></td>
</tr>
<tr>
<td>☐ Response:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9.</th>
<th>How do you plan to document informed consent? Read all of the options before checking the appropriate boxes. (A sample consent form is attached to this application.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒ The subjects are 18 years of age or older. Before collecting data, I will ask them to sign a written consent form. I am attaching a copy of the consent form.</td>
<td></td>
</tr>
<tr>
<td>☐ The subjects are 18 years of age or older. Before collecting data, I will ask them to give verbal consent to participate in this research study.</td>
<td></td>
</tr>
<tr>
<td>☐ The subjects are 18 years of age or older. I am distributing a survey or questionnaire to the subjects. They can choose whether or not they want to respond. I am requesting a waiver of written consent.</td>
<td></td>
</tr>
<tr>
<td>☐ The subjects are under the age of 18. I am attaching a copy of the consent form that I will use to obtain consent from their parents or guardians and assent (agreement) from subjects who are 14 years of age or older.</td>
<td></td>
</tr>
<tr>
<td>☐ Some of the subjects are 18 years of age or older, and some are younger than 18. I have checked more than one box above to reflect the methods I will use to document informed consent.</td>
<td></td>
</tr>
<tr>
<td>☐ Does not apply. My data analysis is limited to existing records or tissue specimens.</td>
<td></td>
</tr>
<tr>
<td>☐ Other. Please explain and provide justification for your request.</td>
<td></td>
</tr>
<tr>
<td>☐ Comments:</td>
<td></td>
</tr>
</tbody>
</table>
SCRIPT FOR SOLICITING INFORMED CONSENT IN EDUCATIONAL RESEARCH

Protocol title: Critique and feasibility study of new learning tools to support discovery-based pedagogy in Biology 101

Protocol number: 2006E0060

Principal Investigator: Dr. Richard J. Voithofer, Educational Policy and Leadership
Co-Investigator: Emily L. Jones

With your consent, I am interested in interviewing you about your role in teaching and administering Biology 101.

The purpose of this study is to collect information about faculty and staff's beliefs about the teaching and administering of large undergraduate courses. Specifically, we would like to ask you to critique a visual syllabus based on the curriculum and discovery-based pedagogy of Biology 101. The interview will take about 60 minutes to complete and your answers will be confidential. The interviews may be tape-recorded. All tape-recordings will be secured with a locking mechanism and destroyed at the end of the research. In other words your name will not appear in published results. This information could be used to benefit future instructors who teach for the IBP. Please also understand Ms. Jones plans to use this data to support the completion of her Masters thesis.

Your responses will be confidential – your name will not appear anywhere in the research. Names will be changed to Professor A, Professor B, etc., and gender will be disguised when it makes a participant identifiable. Your participation is voluntary. You can refuse to answer questions that you do not wish to answer and if you choose not to participate in this research, you will not be penalized in any way.

If you have any more questions about the project or how the data will be used, you may contact me, Dr. Richard J. Voithofer at (614) 247-7945. If you have questions about your rights as a research participant, you can call the Office of Responsible Research Practices at (614) 688-4792. Please keep a copy of this form for your records.

Thank you.

Rick Voithofer & Emily Jones
CONSENT FOR PARTICIPATION IN SOCIAL AND BEHAVIORAL RESEARCH

Protocol title: Critique and feasibility study of new learning tools to support discovery-based pedagogy in Biology 101
Protocol number: 2006E0060

Principal Investigator: Dr. Richard J. Voithofer
Co-Investigator: Emily L. Jones

I consent to participation in research being conducted by Dr. Richard J. Voithofer of The Ohio State University and Emily L. Jones, Learning Technology Coordinator for the Introductory Biology Program.

I understand the purpose of this study is to collect information about faculty and staff's beliefs about teaching and administering large undergraduate courses, such as Biology 101. I understand the interview will take about 60 minutes to complete and that my answers will be confidential, in other words my name will not appear in published results. I understand that these interviews may be tape-recorded, and that the recordings will be destroyed at the end of the research. I also understand Ms. Jones plans to use this data to support the completion of her Masters thesis.

I know that I can choose not to participate without penalty and that I may withdraw at any time.

I have had a chance to ask questions and to obtain answers to my questions. If I have any more questions, I understand I can contact Dr. Voithofer at (614) 247-7945. If I have questions about my rights as a research participant, I can call the Office of Research Risks Protection at (614) 688-4792.

I have read this form or I have had it read to me. I sign it freely and voluntarily. A copy has been given to me.

<table>
<thead>
<tr>
<th>I consent to participate in this study of teaching and administering large undergraduate classes:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Date:</td>
</tr>
<tr>
<td>Signed:</td>
</tr>
<tr>
<td>(Principal Investigator)</td>
</tr>
</tbody>
</table>

| Signed:                                                                                             |
| (Co-Investigator)                                                                                   |

92
INFORMED CONSENT FOR PARTICIPATION IN EDUCATIONAL RESEARCH

Protocol title: Critique and feasibility study of new learning tools to support discovery-based pedagogy in Biology 101

Protocol number: 2006E0060

Principal Investigator: Dr. Richard J. Voithofer, Educational Policy and Leadership
Co-Investigator: Emily L. Jones

I want to thank you, again, for agreeing to be interviewed about your role in teaching and administering Biology 101.

The purpose of this study is to collect information about faculty and staff’s beliefs about the teaching and administering of large undergraduate courses. Specifically, we would like to ask you to critique a visual syllabus based on the curriculum and discovery-based pedagogy of Biology 101. The interview will take about 60 minutes to complete and your answers will be confidential, in other words your name will not appear in published results. The interviews may be tape-recorded, and all recordings will be destroyed at the end of the research. This information could be used to benefit future instructors who teach for the IBP. Please also understand Ms. Jones plans to use this data to support the completion of her Masters thesis.
Your responses will be confidential – your name will not appear anywhere on the survey.

If you have any more questions about the project or how the data will be used, you may contact me, Dr. Richard J. Voithofer at (614) 247-7945. If you have questions about your rights as a research participant, you can call the Office of Responsible Research Practices at (614) 688-4792. Please keep a copy of this form for your records.

Thank you.

Rick Voithofer & Emily Jones
## CATEGORIES OF RESEARCH ACTIVITIES EXEMPT FROM REVIEW BY OSU INSTITUTIONAL REVIEW BOARDS

These exemptions **DO NOT APPLY** when deception of human subjects may be an element of the research, when the activity might expose the human subjects to discomfort or harassment beyond levels encountered in daily life, or when fetuses, pregnant women, human in vitro fertilization, or individuals involuntarily confined or detained in penal institutions are subjects of the activity.

| CATEGORY #1: | Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as:  
|             | a. research on regular and special education instructional strategies,  
|             | b. research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods. |

| CATEGORY #2: | Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, **unless**:  
|             | a. information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; **AND**  
|             | b. any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation. |

**(NOTE: The exemption under Category 2 DOES NOT APPLY** to research involving survey or interview procedures or observation of public behavior when **individuals under the age of 18** are subjects of the activity **except** for research involving **observations** of public behavior when the investigator(s) do not participate in the activities being observed.)

| CATEGORY #3: | Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under Category 2, IF:  
|             | a. the human subjects are elected or appointed public officials or candidates for public office, **OR**  
|             | b. federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter. |

| CATEGORY #4: | Research, involving the collection or study of **existing** data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified directly or through identifiers linked to the subjects. |

| CATEGORY #5: | Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine:  
|             | a. public benefit or service programs;  
|             | b. procedures for obtaining benefits or services under those programs;  
|             | c. possible changes in or alternatives to those programs or procedures; or  
<p>|             | d. possible changes in methods or levels of payment for benefits or |</p>
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Taste and food quality evaluation and consumer acceptance studies,</th>
</tr>
</thead>
<tbody>
<tr>
<td>#6:</td>
<td>a. if wholesome foods without additives are consumed, or</td>
</tr>
<tr>
<td></td>
<td>b. if a food is consumed that contains a food ingredient at or below the</td>
</tr>
<tr>
<td></td>
<td>level and for a use found to be safe, or agricultural chemical or</td>
</tr>
<tr>
<td></td>
<td>environmental contaminant at or below the level found to be safe, by</td>
</tr>
<tr>
<td></td>
<td>the Food and Drug Administration or approved by the Environmental</td>
</tr>
<tr>
<td></td>
<td>Protection Agency or the Food Safety and Inspection Service of the</td>
</tr>
<tr>
<td></td>
<td>U.S. Department of Agriculture.</td>
</tr>
</tbody>
</table>
QUESTIONS FOR FACULTY AND STAFF INTERVIEWS

Protocol title: Critique and feasibility study of new learning tools to support discovery-based pedagogy in Biology 101

Protocol number: 2006E0060

Principal Investigator: Dr. Richard J. Voithefer, Educational Policy and Leadership
Co-Investigator: Emily L. Jones

All faculty and staff interviewed will be given copies of a 12-point prototype of the visual syllabus either prior to the interview, or at the start of the interview with time allotted for review and questions. The first part of the interview will center on a critique of the visual syllabus's design, and questions will be centered around these five categories.
Critique of a Conceptual Design

User Description

How might this tool be used by professors in the classroom?
Would you be likely to talk about this tool or allow students to explore it for themselves?

Prototype

What are/were your immediate impressions of the prototype?
Do you think it is easy to understand?
Do you have any reactions to the interface?
Is a relationship between lab and lecture apparent in the prototype?

Features/functionality

Which features do you think are the most valuable?
Are there any features you would add? Take away?
Do you think the information presented clearly? How do you feel about this tool’s ease of use?
Do you think these features would be useful to the students?

Shortcomings of design

What are the strengths in this tool?
What are the weaknesses in this tool?
What aspects of the visual syllabus should be changed?
What aspects should be expanded or explored?
How hard would something like this be to use in the classroom?
Do you think this tool would integrate well with your current use of a course management system?

Expansion — what else is possible
What else would you like to see included in this design?
How would you feel about using this tool to deliver current content to students?
How would you feel about a tool like this, replacing current textbooks in your class?
If you had greater control over delivering new and current content, would textbooks still play a role in your class?

Feasibility Study
The second half of the interview will be focused on the feasibility of using such a tool in the classroom. Questions will organized around four topics that represent possibly barriers to adoption of new tools and techniques in the classroom. These four topics are strategy, politics, culture and emotions. Questions may also be posed to provide context about how a particular faculty or staff person's class operates, such as "How do you write your syllabus?"

Strategy
Faculty - In this section, I would like to establish what methods faculty use in their classroom to connect lecture to lab, whether they think that connection is important and what would make that connection easier. I would like to hear their assessment of the discovery-learning pedagogy. I would also like to speak with them about what their considerations are when they create their syllabus.

Staff — I would like to hear about the training they give to graduate students teaching the labs to support a lab and lecture connection. I would like to hear about their experience supporting faculty teaching discovery-learning pedagogy and general trends in the syllabi of instructors.

How is time a factor in the management of your classroom?
How connected do you think lab and lecture are?
How do you use discovery learning in the classroom?
How important is metacognition in the classroom?

Politics
Faculty — I would like to talk with the faculty about the similarities and differences in their syllabus as compared to their colleagues syllabi. I would like to talk with them about the Learning Objectives for Biology 101 and who controls the curriculum.

Staff — I would like to talk with the staff about the curriculum and learning objectives of Biology 101 and what roles they play in both of those things. I would like to ask the staff if they are involved in content creation for the course and if so, to what extent. I would like to ask the staff for their impressions of who controls the curriculum and what sorts of learning tools might work in a large-scale class with many different instructors.

What are the learning objectives of Biology 101?
Do you think other faculty and staff would find this tool valuable?
Do you think students would find this tool helpful?
What barriers to entry exist in using this tool?

Culture
Faculty – I would like to talk with the faculty about how well they feel their students comprehend the material covered in their syllabus and if these perceptions have changed during their teaching experience. I would also like to know what the faculty think could be done in order to better support them in classroom and how they feel about trying new tools, approaches and material in their class. I would like to talk with the faculty about the culture of sharing teaching material and tips with their colleagues who teach the same class.

Staff – I would like to know the level of demand for supporting new tools, approaches and techniques in the classroom and whether they feel they are able to give an adequate amount of support to faculty and graduate students now. I would like to ask them if they feel that a new tool such as the visual syllabus would add to the amount of support they provide or lessen the amount of support they provide.

Who do you think is responsible for understanding the material?
What could be done to make the adoption of a tool like this easier for faculty and staff?
Would you be more likely to see this tool if other faculty/staff were using it to teach?
Would you be more likely to use this tool if you felt that you had adequate support for your teaching?
What do you consider adequate support?

Emotional needs
Faculty – I would like to talk with the faculty about the experience of teaching large classes — how they feel when something (material or technology) isn’t working, how affected they feel by students comments, both positive and negative and if that impacts the way they teach the same material next year. I would like to talk with them about the personal investment they feel they put into each class and what they feel is at stake.

Staff – I would like to talk with the staff about their role administering large classes. I would like to ask them about the role in mentoring graduate students, supporting the faculty and the intricacies of trying new ideas out in front of a large class. I would like to ask the staff about what personal investment they feel with a course and course content.

How do you feel about student feedback?
Would you be more likely to use this tool if you could customize it to your specific needs and interests?
6.2. Elements of a Conceptual Prototype Presentation

Digital Syllabus Design
The "Evolution" of an Evolutionary Syllabus in Biology 101

Making pedagogy visual

Emily L. Jones

Figure A.1. Introductory conceptual prototype presentation slide.

100
User Experience 1: A Teaching Tool

Teaching in lecture

Teaching in lab

As reinforcement and study aid of material taught in class

Figure A.2. Storyboard of user experience – slide 1.
User Experience 2: A Planning and Preparation Tool

Planning the syllabus

Preparing the GTAs to teach lab

Constructing feedback at the end of the quarter

Figure A.3. User experience slide 2: Using the visual syllabus as a planning and preparation tool.
What Is global warming? Why care?

Why do animals behave the way they do?

Lab 9: Introduction; "Prisoners of silence"

Lab 1: What is the nature of biological diversity around us?

Lab 2: How do organisms stay alive? (Photosynthesis and respiration)

Lab 7: How do molecules move in and out of cells? (Osmosis and diffusion)

Lab 8: How do insects navigate?

Lab 6: How do genes make proteins?

Lab 5: How does DNA replicate? How did we discover this?

Lab 3: How does the anatomy of invertebrates compare? (Annelids and arthropods)

Lab 4: How do multicellular organisms get bigger? (Mitosis)

What is the role of ethics in science?

How does the kidney form urine?

Why do we get sick (Evolutionary medicine)?

How does DNA code for protein; how does it replicate?

What is the molecular structure of a gene?

Where are the genes located in the cell?

How are characters inherited (Mendel’s 2nd Law)?

How are characteristics inherited (Mendel’s 1st Law)?

What is the evolutionary history of life on Earth?

How does the environment select for characteristics of organisms?

Why should we care about gene pools (conservation biology)?

What was the evolution of Darwin? What is the evolution of the animal body plan?

What is the origin of diversity?

What is the role of bias, misconceptions and ethics in science?

Figure A.4. Visual syllabus prototype slide.
Lab 5:
How does DNA replicate?
How did we discover this?

Associated Lectures with the Lab

How are characteristics inherited (Mendel’s 1st Law)?
How are characters inherited (Mendel’s 2nd Law)?

More lecture information, notes etc.

Don’t remember Dihybrid crosses from high-
school?
(Check here to go to a remedial tutorial)
http://www.biology.arizona.edu/mendelian_genetics/
problem_sets/dihybrid_cross/dihybrid_cross.html

Major Content Concepts: GENETICS

Science as a Way of Knowing

* History of Science
* Experimental Design
* Objectivity/bias
* Ethics

Background Readings:
Background Exercise:
Assigned Readings:
Assigned Exercise:
Further Readings:
Further Exercise:

OHIO K-12 Science Content Standards
covered in this lab:
1. (Link)
2. (Link)
3. (Link)

Figure A.5. Prototype for visual syllabus laboratory screen slide.
Figure A.6. Relationship between Biology 101 and Biology 102 in visual syllabus.

Expansion — what else is possible
Tell the story of the expansion of the design
Show relationship between sequential courses
Biology 101 covers a wide breadth of topics
Biology 102 covers a few topics in depth
The model for 101 is meant to help students discern the relatedness between Lab and Lecture in the Learning Cycle

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This is a model to remind faculty of that same pedagogical relatedness

Replace the textbook

Take advantage of RSS technology to both pull content into the visual syllabus and push new material out to students

6.3. Document Analysis of Syllabi
<table>
<thead>
<tr>
<th>Week No.; Lecture No.</th>
<th>Visual Syllabus Lecture Schedule</th>
<th>Week No.; Lecture No.</th>
<th>Professor 1's Lecture Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1; L1</td>
<td>What are the learning objectives of this course?; Introduction to Frontline video: &quot;Prisoners of Silence&quot;</td>
<td>W1; L1</td>
<td>Course Administravia; What is Science?; The two cultures; Start &quot;Prisoners of Silence&quot; video</td>
</tr>
<tr>
<td>W1; L2</td>
<td>&quot;Prisoners of Silence&quot; What is the difference between skepticism and cynicism in today's world?</td>
<td>W1; L2</td>
<td>Finish &quot;Prisoners of Silence&quot; - hypothesis vs. theory; scientific method; scientific theory</td>
</tr>
<tr>
<td>W2; L1</td>
<td>What is the role of bias, misconceptions and ethics in science? What is the origin of diversity?</td>
<td>W2; L1</td>
<td>Evolutionary history of planet earth; origin of life; what is life? biogenesis; life under a microscope, viruses, determinants of disease</td>
</tr>
<tr>
<td>W2; L2</td>
<td>What is the evolutionary history of life on Earth?</td>
<td>W2; L2</td>
<td>Evolution of complexity; Omne cellular e cellula; the complete cell; &quot;Wonderful life&quot;; prokaryotes and eukaryotes</td>
</tr>
<tr>
<td>W3; L1</td>
<td>How does the environment select for characteristics of organisms?</td>
<td>W3; L1</td>
<td>Systems of classification; what is a species?; evolutionary diversification and geological history</td>
</tr>
<tr>
<td>W3; L2</td>
<td>How does the environment select for characteristics of organisms? Why should we care about gene pools (conservation biology)?</td>
<td>W3; L2</td>
<td>Evolution of animal and plant body forms; the rise of mammals, the dawn of man; blueprint for an ant</td>
</tr>
<tr>
<td>W4; L1</td>
<td>What was the evolution of Darwin? What is the evolution of the animal body plan?</td>
<td>W4; L1</td>
<td>Oikos, the earth as &quot;house&quot;; fundamentals of ecology; energy flow</td>
</tr>
<tr>
<td>W4; L2</td>
<td>What is the evolution of the animal body plan? What is the evolution of the plant body plan?</td>
<td>W4; L2</td>
<td>How do organisms interact?; Competition, mutualism, parasitism and other peculiar habits</td>
</tr>
<tr>
<td>W5; L1</td>
<td>How are characteristics inherited (Mendel's 1st Law)?</td>
<td>W5; L1</td>
<td>Darwin; a solution to the question of organic diversity; natural selection, microevolution</td>
</tr>
<tr>
<td>W5; L2</td>
<td>How are characters inherited (Mendel's 2nd Law)?</td>
<td>W5; L2</td>
<td>Cellular energetics: respiration and photosynthesis</td>
</tr>
<tr>
<td>W6; L1</td>
<td>Where are genes located in the cell?</td>
<td>W6; L1</td>
<td>From peas to posterity; Gregor Mendel and the foundations of genetics</td>
</tr>
<tr>
<td>W6; L2</td>
<td>What is the molecular structure of a gene?</td>
<td>W6; L2</td>
<td>DNA: Identifying the hereditary material; three dimensional structure; fate's lottery</td>
</tr>
<tr>
<td>W7; L1</td>
<td>How does DNA code for a protein; how does it replicate?</td>
<td>W7; L1</td>
<td>Flow of information from DNA to protein; transcription and translation; genetic code</td>
</tr>
<tr>
<td>W7; L2</td>
<td>Why do we get sick (Evolutionary medicine)?</td>
<td>W7; L2</td>
<td>Why must you eat?; Milk, human genetics, geographical distribution of humans. Human reproduction; genetics of human disease, stem cells and cloning</td>
</tr>
<tr>
<td>W8; L1</td>
<td>How does the kidney form urine?</td>
<td>W8; L1</td>
<td>Why you've got rhythm but how and why?; Humans are genetically encoded to respond to and appreciate music.; But how and why is it possible?</td>
</tr>
<tr>
<td>W8; L2</td>
<td>What is the role of ethics in science?</td>
<td>W8; L2</td>
<td>Through the artist's eye; How your grandmothers invented art and begat society.</td>
</tr>
<tr>
<td>W9; L1</td>
<td>What happens when you burn a marshmallow (Energetics)?</td>
<td>W9; L1</td>
<td>Human reproduction; genetics of human disease, stem cells and cloning</td>
</tr>
<tr>
<td>W9; L2</td>
<td>How/why is there sugar (Photosynthesis/respiration)?</td>
<td>W9; L2</td>
<td>The capacity for genetic mistakes is encoded; You are not and it is a good thing!; The biology of cancer</td>
</tr>
<tr>
<td>W10; L1</td>
<td>What is global warming? Why care?</td>
<td>W10; L1</td>
<td>Pollution; adventures of Homo called sapiens; DDT</td>
</tr>
<tr>
<td>W10; L2</td>
<td>Why do animals behave the way they do?</td>
<td>W10; L2</td>
<td>You've got rhythm but how and why?; Humans are genetically encoded to respond to and appreciate music.; But how and why is it possible?</td>
</tr>
<tr>
<td>W11; L1</td>
<td></td>
<td>W11; L1</td>
<td>Through the artist's eye; How your grandmothers invented art and begat society.</td>
</tr>
<tr>
<td>W11; L2</td>
<td></td>
<td>W11; L2</td>
<td>Through the artist's eye; How your grandmothers invented art and begat society.</td>
</tr>
</tbody>
</table>

Figure A.7. Syllabus analysis of professor 1.
<table>
<thead>
<tr>
<th>Week No.; Lecture No.</th>
<th>Lecture Question</th>
<th>SP '03 Professor 2 &amp; 3 Lectures (21)</th>
<th>Week No.; Lecture No.</th>
<th>Lecture Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1; L1</td>
<td>What are the learning objectives of this course?</td>
<td>W1; L1</td>
<td>Science as a way of doing things &amp; the pitfalls of bias</td>
<td></td>
</tr>
<tr>
<td>W1; L2</td>
<td>&quot;Prisoners of Silence&quot; What is the difference between skepticism and cynicism in today's world?</td>
<td>W1; L2</td>
<td>Why and how to do science, and the relationship of science to society</td>
<td></td>
</tr>
<tr>
<td>W2; L1</td>
<td>What is the role of bias, misconceptions and ethics in science? What is the origin of diversity?</td>
<td>W2; L1</td>
<td>What do we know about how life originated?</td>
<td></td>
</tr>
<tr>
<td>W2; L2</td>
<td>What is the evolutionary history of life on Earth?</td>
<td>W2; L2</td>
<td>What is the evolutionary history of life on earth?</td>
<td></td>
</tr>
<tr>
<td>W3; L1</td>
<td>How does the environment select for characteristics of organisms?</td>
<td>W3; L1</td>
<td>What is natural selection and why should we care about gene pools?</td>
<td></td>
</tr>
<tr>
<td>W3; L2</td>
<td>How does the environment select for characteristics of organisms? Why should we care about gene pools (conservation biology)?</td>
<td>W3; L2</td>
<td>Where do species come from, why do they go extinct, and why should we care?</td>
<td></td>
</tr>
<tr>
<td>W4; L1</td>
<td>What was the evolution of Darwin? What is the evolution of the animal body plan?</td>
<td>W4; L1</td>
<td>What is the evolution of the animal body form?</td>
<td></td>
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<tr>
<td>W4; L2</td>
<td>What is the evolution of the animal body plan? What is the evolution of the plant body plan?</td>
<td>W4; L2</td>
<td>What is the evolution of the plant body form?</td>
<td></td>
</tr>
<tr>
<td>W5; L1</td>
<td>How are characteristics inherited (Mendel's 1st Law)?</td>
<td>W5; L1</td>
<td>How are characteristics inherited?</td>
<td></td>
</tr>
<tr>
<td>W5; L2</td>
<td>How are characters inherited (Mendel's 2nd Law)?</td>
<td>W5; L2</td>
<td>More about inheritance</td>
<td></td>
</tr>
<tr>
<td>W6; L1</td>
<td>Where are genes located in the cell?</td>
<td>W6; L1</td>
<td>Why do we get sick, and is it because of evolution?</td>
<td></td>
</tr>
<tr>
<td>W6; L2</td>
<td>What is the molecular structure of a gene?</td>
<td>W6; L2</td>
<td>The human genome and other boxes of Pandora</td>
<td></td>
</tr>
<tr>
<td>W7; L1</td>
<td>How does DNA code for a protein; how does it replicate?</td>
<td>W7; L1</td>
<td>Cells from cells, and when it goes wrong.</td>
<td></td>
</tr>
<tr>
<td>W7; L2</td>
<td>Why do we get sick (Evolutionary medicine)?</td>
<td>W7; L2</td>
<td>Breeding plants and Frankenfoods.</td>
<td></td>
</tr>
<tr>
<td>W8; L1</td>
<td>How does the kidney form urine?</td>
<td>W8; L1</td>
<td>If plants are such good food, why is the world still green?</td>
<td></td>
</tr>
<tr>
<td>W8; L2</td>
<td>What is the role of ethics in science?</td>
<td>W8; L2</td>
<td>Of energy, energetics, and ecosystems</td>
<td></td>
</tr>
<tr>
<td>W9; L1</td>
<td>What happens when you burn a marshmallow (Energetics)?</td>
<td>W9; L1</td>
<td>The world makes chemistry go round.</td>
<td></td>
</tr>
<tr>
<td>W9; L2</td>
<td>How/why is there sugar (Photosynthesis/respiration)?</td>
<td>W9; L2</td>
<td>You are what you eat, and other disturbing facts</td>
<td></td>
</tr>
<tr>
<td>W10; L1</td>
<td>What is global warming? Why care?</td>
<td>W10; L1</td>
<td>What is global climate change and who cares?</td>
<td></td>
</tr>
<tr>
<td>W10; L2</td>
<td>Why do animals behave the way they do?</td>
<td>W10; L2</td>
<td>Wrap up/ NYT</td>
<td></td>
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</tbody>
</table>

Figure A.8. Syllabus analysis of professors 2 and 3.
<table>
<thead>
<tr>
<th>Visual Syllabus Lectures (20)</th>
<th>Professor 4's Lectures (19)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week No.; Lecture No.</strong></td>
<td><strong>Week No.; Lecture No.</strong></td>
</tr>
<tr>
<td><strong>Lecture Question</strong></td>
<td><strong>Lecture Question</strong></td>
</tr>
<tr>
<td><strong>What are the learning objectives of this course?</strong></td>
<td><strong>W1; L1</strong> INTRODUCTION LIVING THINGS</td>
</tr>
<tr>
<td><strong>Introduction to Frontline video: &quot;Prisoners of Silence&quot;</strong></td>
<td><strong>W1; L2</strong> THE NATURE OF SCIENCE VIDEO – PRISONERS of SILENCE</td>
</tr>
<tr>
<td><strong>What is the role of bias, misconceptions and ethics in science? What is the origin of diversity?</strong></td>
<td><strong>W2; L1</strong> SCIENTIFIC METHOD</td>
</tr>
<tr>
<td><strong>What is the evolutionary history of life on Earth?</strong></td>
<td><strong>W2; L2</strong> BIODIVERSITY</td>
</tr>
<tr>
<td><strong>How does the environment select for characteristics of organisms?</strong></td>
<td><strong>W3; L1</strong> LIFE ON EARTH</td>
</tr>
<tr>
<td><strong>How does the environment select for characteristics of organisms? Why should we care about gene pools (conservation biology)?</strong></td>
<td><strong>W3; L2</strong> EVOLUTION</td>
</tr>
<tr>
<td><strong>What was the evolution of Darwin? What is the evolution of the animal body plan?</strong></td>
<td><strong>W4; L1</strong> POPULATION CHANGE</td>
</tr>
<tr>
<td><strong>What is the evolution of the animal body plan? What is the evolution of the plant body plan?</strong></td>
<td><strong>W4; L2</strong> CELL STRUCTURE and FUNCTION</td>
</tr>
<tr>
<td><strong>How are characteristics inherited (Mendel’s 1st Law)?</strong></td>
<td><strong>W5; L1</strong> CELLULAR REPRODUCTION</td>
</tr>
<tr>
<td><strong>How are characters inherited (Mendel’s 2nd Law)?</strong></td>
<td><strong>W5; L2</strong> CELLULAR REPRODUCTION</td>
</tr>
<tr>
<td><strong>Where are genes located in the cell?</strong></td>
<td><strong>W6; L1</strong> INHERITANCE</td>
</tr>
<tr>
<td><strong>What is the molecular structure of a gene?</strong></td>
<td><strong>W6; L2</strong> MOLECULAR BASIS OF INHERITANCE</td>
</tr>
<tr>
<td><strong>How does DNA code for a protein; how does it replicate?</strong></td>
<td><strong>W7; L1</strong> GENE EXPRESSION</td>
</tr>
<tr>
<td><strong>Why do we get sick (Evolutionary medicine)?</strong></td>
<td><strong>W7; L2</strong> CONTROL of GENE EXPRESSION</td>
</tr>
<tr>
<td><strong>How does the kidney form urine?</strong></td>
<td><strong>W8; L1</strong> BIOTECHNOLOGY</td>
</tr>
<tr>
<td><strong>What is the role of ethics in science?</strong></td>
<td><strong>W8; L2</strong> MEMBRANES</td>
</tr>
<tr>
<td><strong>What happens when you burn a marshmallow (Energetics)?</strong></td>
<td><strong>W9; L1</strong> FLOW OF ENERGY I</td>
</tr>
<tr>
<td><strong>How/why is there sugar (Photosynthesis/respiration)?</strong></td>
<td><strong>W9; L2</strong> FLOW OF ENERGY II</td>
</tr>
<tr>
<td><strong>What is global warming? Why care?</strong></td>
<td><strong>W10; L1</strong> ENERGY FLOW IN ECOSYSTEMS</td>
</tr>
<tr>
<td><strong>Why do animals behave the way they do?</strong></td>
<td><strong>W10; L2</strong> FINAL EXAMINATION</td>
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</table>

Figure A.9. Syllabus analysis of professors 4.
<table>
<thead>
<tr>
<th>Week No.; Lecture No.</th>
<th>Lecture Question</th>
<th>Week No.; Lecture No.</th>
<th>Lecture Question</th>
<th>Lab Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1; L1</td>
<td>What are the learning objectives of this course?</td>
<td>W1; L1</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>W1; L2</td>
<td>&quot;Prisoners of Science&quot; What is the difference between skepticism and cynicism in today's world?</td>
<td>W1; L2</td>
<td>Bacteria</td>
<td></td>
</tr>
<tr>
<td>W2; L1</td>
<td>What is the role of bias, misconceptions and ethics in science? What is the origin of diversity?</td>
<td>W1; L3</td>
<td>Eukaryotes, protista</td>
<td></td>
</tr>
<tr>
<td>W3; L2</td>
<td>What is the evolutionary history of life on Earth?</td>
<td>W2; L1</td>
<td>Terrestrial plants</td>
<td>What is the nature of biological diversity around us?</td>
</tr>
<tr>
<td>W3; L1</td>
<td>How does the environment select for characteristics of organisms?</td>
<td>W2; L2</td>
<td>Higher plants</td>
<td>How do molecules move in and out of cells? (Osmosis and diffusion)</td>
</tr>
<tr>
<td>W3; L2</td>
<td>How does the environment select for characteristics of organisms?</td>
<td>W2; L3</td>
<td>Fungi</td>
<td></td>
</tr>
<tr>
<td>W4; L1</td>
<td>What was the evolution of Darwin? What is the evolution of the animal body plan?</td>
<td>W3; L1</td>
<td>No Class</td>
<td></td>
</tr>
<tr>
<td>W4; L2</td>
<td>What is the evolution of the animal body plan?</td>
<td>W3; L2</td>
<td>Lower animals</td>
<td></td>
</tr>
<tr>
<td>W5; L1</td>
<td>How are characteristics inherited (Mendel's 1st Law)?</td>
<td>W4; L1</td>
<td>Vertebrates</td>
<td>How does the anatomy of invertebrates compare? (Annelids and arthropods)</td>
</tr>
<tr>
<td>W5; L2</td>
<td>How are characteristics inherited (Mendel's 2nd Law)?</td>
<td>W4; L2</td>
<td>Arthropods</td>
<td></td>
</tr>
<tr>
<td>W6; L1</td>
<td>Where are genes located in the cell?</td>
<td>W4; L3</td>
<td>Exam</td>
<td>How do insects navigate?</td>
</tr>
<tr>
<td>W6; L2</td>
<td>What is the molecular structure of a gene?</td>
<td>W5; L1</td>
<td>Environments</td>
<td></td>
</tr>
<tr>
<td>W7; L1</td>
<td>How does DNA code for a protein; how does it replicate?</td>
<td>W5; L2</td>
<td>Population ecology</td>
<td>How does the environment select for characteristics of organisms? (Natural selection and genetic drift)</td>
</tr>
<tr>
<td>W7; L2</td>
<td>Why do we get sick (Evolutionary medicine)?</td>
<td>W5; L3</td>
<td>Community ecology</td>
<td></td>
</tr>
<tr>
<td>W8; L1</td>
<td>How does the kidney form urine?</td>
<td>W6; L1</td>
<td>Evolution: Darwin</td>
<td>How do organisms stay alive? (Photosynthesis and respiration)</td>
</tr>
<tr>
<td>W8; L2</td>
<td>What is the role of ethics in science?</td>
<td>W6; L2</td>
<td>Natural selection</td>
<td></td>
</tr>
<tr>
<td>W9; L1</td>
<td>What happens when you burn a marshmallow (Energetics)?</td>
<td>W6; L3</td>
<td>Sexual selection</td>
<td></td>
</tr>
<tr>
<td>W9; L2</td>
<td>How is there sugar? (Photosynthesis/respiration)</td>
<td>W7; L1</td>
<td>Humans and sexual selection</td>
<td></td>
</tr>
<tr>
<td>W10; L1</td>
<td>What is global warming? Why care?</td>
<td>W7; L2</td>
<td>Photosynthesis and respiration</td>
<td></td>
</tr>
<tr>
<td>W10; L2</td>
<td>Why do animals behave the way they do?</td>
<td>W7; L3</td>
<td>Exam</td>
<td>How do multicellular organisms get bigger? (Mitosis)</td>
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<tr>
<td></td>
<td></td>
<td>W8; L1</td>
<td>Nervous &amp; endocrine systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>W8; L2</td>
<td>Cellular machinery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>W8; L3</td>
<td>Meiosis</td>
<td>How does DNA replicate? How did we discover this?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W9; L1</td>
<td>Mendelian variation</td>
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<td></td>
<td></td>
<td>W9; L2</td>
<td>Population genetics</td>
<td>How do genes make proteins?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W9; L3</td>
<td>DNA replication</td>
<td></td>
</tr>
<tr>
<td>W10; L1</td>
<td>Protein synthesis, enzymes</td>
<td>W10; L1</td>
<td>Proteins</td>
<td></td>
</tr>
<tr>
<td>W10; L2</td>
<td>Viruses</td>
<td>W10; L3</td>
<td>Summary overview</td>
<td></td>
</tr>
</tbody>
</table>

Figure A.10. Syllabus analysis of professor 5.
REFERENCES


