12-1-2010

# The Gel Documentation System: A Cornerstone to the Implementation of the Introduction to Biotechnology and Introduction to Bioinformatics Cross-Disciplinary Course Series (FINAL REPORT)

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# The Provost's Grants for the *Thinkfinity* Initiative for Innovative Teaching, Technology and Research Final Report

**Title of Project: The Gel Documentation System: A Cornerstone to the Implementation of the Introduction to Biotechnology and Introduction to Bioinformatics Cross-Disciplinary Course Series.**

**Cornererstone #: 3, Interdisciplinary Informatics**

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**Date: December 15, 2010**

## A. Original Goal:

Our original goal was to offer Pace undergraduate students opportunities to be introduced to both Biotechnology and Computer Science as it relates to Bioinformatics. We proposed a two course series, offered to both computer science and biology students that will increase both biological and computer science literacy of our students. The two courses are Introduction to Biotechnology (BIO 372) and Introduction to Bioinformatics. Because technology is a major component of both courses it is imperative that we offer our students the opportunity to utilize technologies that are current with industry standards. To that end we asked for and received funds to purchase a Digital Imaging System (henceforth referred to as a **GelDoc System**) that would be utilized in both courses. The system allowed us to implement technology that meets current Research and Industrial standards while also giving us the ability to upgrade the technology in the future.

To assess the impact of the **GelDoc System** on student learning in the two courses, we proposed using the following outcomes and assessment tools:

**Table 1.**

| Outcome | Assessment Tool |
|---|---|
| Ensure proficiency in the mechanisms and software used by molecular and systems biologists to access, manipulate, and interpret vast amounts of data (including the **GelDoc System**). | 1. Develop pre-test and post-test open ended questions that evaluate the students' knowledge, experience, and confidence with the data analysis software in the course. These questions will be distributed to the students prior to and following usage of the of the data analysis software. The answers to the pre- and post- test questions will be analyzed using statistics.<br>2. Develop a Student Assessment of Learning Gains (SALG) survey to determine the perceptions the students have about their proficiency with respect to the data analysis software in the course. |
| Ensure that the students realize that computer generated predictions of biological behaviors must be validated experimentally using tools such as the **GelDoc System**. | 1. Observe and question students while they work with the **GelDoc System** to ensure that they realize the connections between their computer generated predictions and the biological behaviors they are observing using the **GelDoc System**. |
| Enhance the students' ability to conceptualize bioinformatics techniques by providing the students with experimental tools such as the **GelDoc System**. | 1. Develop open ended exam questions that require the students to apply the knowledge that they have gained from the **GelDoc System** to new bioinformatics scenarios. |
| Increase cross-disciplinary literacy in bioinformatics to enhance communication and collaboration between biologists and computer scientists. | 1. Require that the students perform their experiments and data analysis in groups in the laboratory. Observe the interactions between the students during their group-work.<br>2. Require that the students present and discuss their findings regularly in lecture and laboratory. |

**B. Progress to date:**

We offered the Introduction to Biotechnology (BIO 372) course during the Spring 2010 semester on the Pleasantville campus. The course was developed and taught by Dr. Gregory Lampard, one of the PI's for this Thinkfinity grant. Twelve Pleasantville Biology and Health Sciences majors and one New York City Biology and Health Sciences major enrolled in the course.

The laboratory component of the course was designed to walk the students through the production of a transgenic plant following a series of laboratory exercises. In the completing this task, the students first learned how to produce proteins using microbial bioreactors. In order to assess the quality of their protein purification, the students analyzed and documented their results using gel separation technology, which was assessed using the Coomassie Brilliant Blue staining/white light imaging capabilities of the **GelDoc System**. These exercises were followed up with functional tests of the purified protein which were interpreted by analyzing the end-products of the procedure. This relied on viewing, assessing, and quantifying fluorescently labeled DNA molecules using the DNA intercalating agent/UV light imaging capabilities of the **GelDoc System**.

The **GelDoc System** was also utilized by students enrolled in the laboratory component of BIO 372 to assist them in the generation of trangenes. Transgenes are genes that will be, or have been transferred from one organism to another. In order to create the specific transgenes, the students spliced two or more pieces of DNA together. While there are multiple techniques that are available to visualize the successful attachment of two pieces of DNA together, each technique is contingent upon being able to visualize DNA, which as previously described requires a **GelDoc System**.

Finally, the students were required to learn about the processes involved in making transgenic bioreactors in the BIO 372 laboratory. The process of making transgenic bioreactors is relatively inefficient. This is due to many factors, but this fact necessitates the implementation of early diagnostic tests to screen for A) the insertion of foreign DNA into the host organism and B) the subsequent functionality of this newly inserted DNA. The students examined mock expression data that would come from these two classes of tests. The mock expression data analysis required not only the visualization of DNA on gels, but also required quantification of the amount of DNA present in each gel. This could only be conducted using the image analysis software that is associated and supplied with the **GelDoc System**.

From the above description of the experiments the students performed in the BIO 372 Laboratory, it is clear that the **GelDoc System** was widely utilized throughout the semester. The central nature of this piece of equipment in the course clearly illustrates why it is necessary that out students develop a practical understanding of this technology.

To assess whether or not the students gained a practical understanding of the **GelDoc** technology, we designed a pedagogical study involving the outcomes/assessment measures listed in Table 1, above. We applied for and received Pace University IRB approval for this study in January 2010 (IRB approval # 10-03) and initiated the study with the Spring 2010 BIO 372 students. We have prepared a manuscript describing the results of our study and will be submitting it to the peer reviewed pedagogical journal, *CBE Life Sciences Education* by the end of December, 2010. A copy of the manuscript in preparation is attached.

We have had two meetings with Dean Constance Knapp and Professor Richard Kline from the Seidenberg School of Computer Science and Information Systems in order to develop a Biology/Computer Science Bioinformatics Learning Community (CIS 101/BIO 1XX). We have a candidate syllabus for this course and plan to obtain Dyson Curriculum Committee approval to run the course as a Learning Community beginning in Spring 2012. If we obtain positive enrollment numbers for

the Learning Community and positive feedback from students, we plan to use the Learning Community as a springboard to develop a Bioinformatics minor. We have included the development of the Bioinformatics Learning Community and minor in the 2010-2015 Strategic Plan for the Department of Biology and Health Sciences.

**C. Activities that have been completed thus far to contribute to meeting/progressing toward these goals:**

We have completed the following tasks:

1. Developed and offered BIO 372 (Introduction to Molecular Biotechnology) in Spring 2010 on the Pleasantville campus. The **GelDoc System** was utilized as the main teaching tool during the laboratory component of this course.
2. Performed a pedagogical study and prepared a manuscript on the impact of the **GelDoc System** on student learning in BIO 372. The manuscript will be submitted by the end of this month to the peer reviewed pedagogical research journal, *CBE Life Sciences Education*. The manuscript in preparation is attached.
3. Began discussions with members of the Seidenberg School of Computer Science and Information Systems to develop a Bioinformatics Learning Community (to be offered in Spring 2012) and a Bioinformatics minor for Biology and Computer Science majors.

**D. Activities that have not been completed:**

We have not yet offered the second course in the proposed course series – Introduction to Bioinformatics. We had originally planned to offer this course as an upper level course in Fall 2010 but, after discussing our plans with members of Seidenberg, it seemed more appropriate to first develop a lower division course for both Biology and Computer Science majors. Offering a lower division Bioinformatics course would ensure that both groups of students have enough background knowledge to succeed in an upper level course. We felt that the best way to do this was to develop a Learning Community for Biology and Computer Science majors. We also felt that enrollment in an upper level Bioinformatics course might be low if the students were not familiar with the discipline. Offering a lower division Learning Community to students enrolled in both majors would enable us to introduce the discipline to them and, hopefully, inspire some of the students to continue to pursue topics related to Bioinformatics. If we find that the Learning Community is successful, we plan to develop a Bioinformatics minor for both Biology and Computer Science majors.

**E. Outcomes obtained:**

A description of the outcomes obtained from the pedagogical study of the impact of the **GelDoc System** on student learning in the BIO 372 course can be reviewed in the attached manuscript.

In addition to the pedagogical study, a positive outcome from this initiative is the that faculty from Biology and Health Sciences and Seidenberg School of Computer Science and Information Systems are working closely together to develop the Bioinformatics Learning Community and a Bioinformatics minor.

These initiatives support the President's Strategic Plan because Bioinformatics is a unique, cross-disciplinary field.

**F. Impact of the project on students:**

This project most definitely impacted students. Please review the attached manuscript for a description of how the **GelDoc System** enhanced student learning.

The development of a Bioinformatics Learning Community and minor will also benefit the students. They will be exposed to topics that are at the cutting edge of current scientific disciplines.

**G. Impact of the project on faculty:**

Not only has this project benefitted the three PI's but, our current discussions concerning the development of the Bioinformatics Learning Community and minor have included several additional faculty members included Professor Richard Kline from the Seidenberg School of Computer Science and Information Systems, Dr. David Zuzga from the Department of Biology and Health Sciences, and Dr. Richard Schlesinger from the Dyson College of Arts and Sciences Dean's Office.

The discipline of Bioinformatics requires that biologists learn about the development of computer programs for data mining and that computer scientists learn about basic principles of biology. All faculty involved in this endeavor will gain new interdisciplinary knowledge.

Finally, the **GelDoc System** can be utilized in other courses offered to Biology students. We have already used the technology in the BIO 101 (General Biology 1) course and we intend to utilize it in our BIO 335 (Cellular and Molecular Biology) course this upcoming Spring. Our researchers in the Department use the **GelDoc System** regularly. Students enrolled in our research courses (BIO 292 and BIO 480) have gained much practical experience from the use of the **System.**

**H. Unintended outcomes:**

We did not anticipate that we would be working together to develop a Bioinformatics Learning Community. We view this as a positive unintended outcome because faculty from different Schools are working together on an interdisciplinary project and each of us will gain new knowledge through the course development process.

The development of a Biology/Computer Science Learning Community will benefit the Biology and Computer Science majors as well. First, the Learning Community will introduce both groups of students to a cutting edge interdisciplinary topic. In addition, because of the tight schedule required for Biology majors, developing a Learning Community for the majors would assist them in fitting the core requirement into their schedules. The Computer Science majors would also benefit from the development of this Learning Community because we would like to apply for Lab Science Foundation credit from the Dyson Curriculum Committee. Doing so would enable the Computer Science majors to fulfill both the

Foundation Lab Science and Learning Community requirements of the University Core by enrolling in one course.

**I. Conference presentations:**

We did not present the results of this work at any conferences.

**J. Do your outcomes reflect the change or benefit you were hoping to receive?**

Yes, the outcomes did indeed reflect the change/benefit we were hoping to receive. The pedagogical study demonstrated that the student's learning was enhanced as a result of the utilization of the **GelDoc System** in the BIO 372 course. In addition, the development of the Bioinformatics Learning Community and minor will benefit both the faculty involved and the students that will enroll in the course/minor.

**K. How has the project furthered the Thinkfinity Cornerstone you selected?**

The project has furthered Thinkfinity Cornerstone 3 because faculty and students from the Department of Biology and Health Sciences and the Seidenberg School of Computer Science and Information Systems are working together to develop courses and learn about the inter-disciplinary fields of Molecular Biotechnology and Bioinformatics.

**L. Future plans to sustain the project:**

We plan to continue to develop the Bioinformatics Learning Community so that we can offer it during the Spring 2012 semester. To do this, we will have to apply for Dyson Curriculum Committee approval for both Learning Community and Foundation Lab Science Core Status.

Once we offer the Bioinformatics Learning Community and asses student learning in the course through a pedagogical study, we will use the information we obtain to begin to develop a Bioinformatics minor for Biology and Computer Science majors.

Beyond this, we will continue to uses similar student surveys to assess the learning outcomes of students enrolled in BIO392 when it is offered in Spring 2012 on the NYC campus.