Integrating Statistics and General Biology I in a Learning Community

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Name of Institution	Collin College
Size	27,000 with three campuses in Collin County, Texas
Institution Type	Two-year college with core offerings for students transferring to a university, associates degrees, and certificates
Student Demographic	Core courses, required courses for students seeking associates degree in Nursing or in Physical Therapy
Department Structure	Separate Mathematics and Biology departments in the same division

Abstract

Community colleges can play an important role in integrating biology and mathematics at the freshman and sophomore level. Collin College uses a combination of introductory freshman and sophomore level courses and learning communities to show students the cross-disciplinary role of mathematics in biology.

Course Structure

- Weeks per term: 16-week semester
- Classes per week/type/length: two 2-hour, 30-minute lecture class meetings per week
- Labs per week/length: one three-hour lab each week
- Average class size: 24 students
- Enrollment requirements: students must assess into a college level mathematics course, or pass MATH 0310 – Intermediate Algebra for the statistics class, no requirement for the biology class
- Faculty/dept per class, TA's: Lecture section team taught by one math professor and one biology professor, lab section taught by one of the lab assistants or an associate faculty member in the biology department
- Next Course: after completing this biology course, students are eligible to take BIOL – 1407 – General Biology II
- Website: Only available during the semester the learning community is offered

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Introduction

Science teachers have emphasized statistics in various natural science disciplines. In biology, there is a need to effectively prepare the next generation of biological researchers for the tremendous opportunities ahead. Undergraduate biology students who use statistics from the start of their education will be better positioned to contribute to future discoveries in biomedical research. Unfortunately, for most biology students, statistics has been isolated from biology. One of the recommendations from *BIO2010: Transforming Undergraduate Education for Future Research Biologists* (2003) is "Connections between biology and other scientific disciplines need to be developed and reinforced so the interdisciplinary thinking and work become second nature." One way to facilitate interdisciplinary connections is with a learning community. At Collin College we created an interdisciplinary connection by combining two core courses in the learning community, *Chances in Life: A Quantitative Approach to Biology*.

Background

The Collin County Community College District was founded in 1986, and today Collin College has three campuses. The population of Collin County has increased by 42% since 2000, making it one of the fastest growing counties in Texas. The college's enrollment is also increasing, from 11,572 in Fall 1998 to 27,593 in Fall 2011.

Of Collin College students, 52% are between the ages of 18 and 22 and 80% plan on transferring to a university. Collin College offers associate of arts, science, and applied sciences degrees, and certificates and marketable skills achievement awards. Associate degrees are offered in traditional academic disciplines such as biology and mathematics, and in specialized health science areas, such as nursing and respiratory care. Collin College has dual enrollment agreements with nine universities and colleges in the state, including Texas A&M, Texas Tech, Southern Methodist University, the University of Texas at Dallas, and the University of North Texas.

Collin College began offering learning communities in the fall of 1994, and now provides learning community courses at all three of the campuses. In the fall of 2007, the district offered eighteen learning communities, including *Chances in Life: A Quantitative Approach to Biology*. A learning community consists of two or more classes that enroll a common group of students and are linked. At Collin College, we use an integrated model. Students are required to register for the statistics and biology classes, as well as a section of the biology lab. The lecture classes are scheduled consecutively, so students are in class for three hours, twice a week, with both instructors present and active. Longer class periods build a sense of community among the students and between the students and the faculty. The model allows the faculty and students time to explore the connections between the disciplines.

Process

The options for new or different courses that a community college in Texas can offer are limited. A community college can offer any course listed in the Academic Course Guide Manual (ACGM) (Texas Higher Education Coordinating Board, 2012). The best option for us was to create a learning community combining two courses, a statistics course and a biology course.

We wanted the learning community to reinforce interdisciplinary thinking in the uses of statistics in biological research, to help students learn how statistics plays an important part in biology and show topics in biology that are integrated with the principles of statistics. Students might not see connections in separate biology and statistics courses. We concentrated on

- Experimental design
- Evolutionary principles
- Data collection and interpretation
- Genetic principles
- Bioinformatics: relationship among gene, and protein sequences

The laboratory for biology was not initially included with the lecture; students had to sign up for a separate lab section. To give *Chances in Life* the best chance of running the first time it was offered, no particular lab section was specified, so we could award one grade for both courses. It is department policy that the biology lab must count for 25% of the students' final course grade. We had to have the combined tests account for 75% of the grade for both statistics and biology. The other 25% of the biology grade was determined by the biology lab grade, while the other 25% of the statistics grade was determined by a statistics lab component, which has varied over the three years *Chances in Life* has been offered. In the first year, it consisted of eight quiz grades and a five to seven page critique that examined a medical study (Greco et al 1996). In the second year, it consisted of several labs using either the graphing calculator or EXCEL, and the critique. For the third year, it consisted of designing a statistical study, which students would write up as an eight to eleven page paper and present as a five minute PowerPoint presentation.

Discussion

We faced challenges in integrating the two courses, and the development of this learning community has been ongoing. It is difficult to find good examples that integrate the two subjects for use in class. We are continually looking for biological and medical studies that are accessible to our students. We have used several of the studies mentioned in the biology text. In our discussion of statistical studies and the scientific method, we examined two research articles (Bromhall et al 2000; Davidson et al 2001) that were discussed in the biology textbook (Purves et al 2004). Another good source has been the sessions on biomathematics at the Joint Mathematics Meetings and MathFest. Professor Ardis attended the short course *Implementing Biology across the Mathematics Curriculum*, which was held prior to MathFest in 2007, and he came away with the idea to use the paper (Luria and Delbruck 1943) to introduce the chapter on probability distributions. We have used one or two of the experiments from the biology lab. Early in the semester, students performed a hypothesis test in the lab before that topic is covered in the statistics class. In the biology lab, the lab instructors assume students have not had statistics, so the hypothesis test was little more than a black box procedure. We have the students use the data from the experiment to use in class when we cover hypothesis

testing. This gives us an opportunity to discuss experimental design, formulation of the hypothesis, and hypothesis testing.

Because *Chances in Life* consists of two courses, its content is no different from the content of the individual courses. Consistency is important, since many of our students plan on transferring to a four-year institution. For both courses, it is difficult to change the order in which material is presented. In some cases, topics match, enabling discussion by both professors, as when we discuss the scientific method and statistical studies using the two studies noted above. In other instances, one of the professors might have to return to a topic covered earlier. For instance, while evolution is covered early on in the biology course, we returned to it when discussing the Luria and Delbruck (1943) paper as part of the introduction to probability distributions. So, while the schedule in which material was presented did not change, we worked together to determine topics that would tie the biology into the statistics lecture, or statistics into the biology lecture.

Not all of the cross-disciplinary examples are planned. One of the advantages of having both professors in the class at the same time is the opportunity for spontaneous input during the lecture. Several of the statistics examples come from the health field, and the biology professor was able to provide more background information than in the problem. Often this was the result of a student's inquiry.

Chances in Life was offered again in Fall 2008 and Fall 2009. In both instances, we required that students sign up for a particular section of the biology lab. We had hoped this would allow us to integrate statistics into the lab, and thus allow us to integrate the course grade completely. Unfortunately, the learning community was cancelled both times due to low enrollment.

Over the five years that *Chances in Life* has been offered, the largest group of students taking the course has been pre-nursing majors. To obtain an associates degree in nursing at Collin College, students must take MATH 1342, Statistics. BIOL 1406, General Biology I, is not specifically required for nursing majors, but it is a prerequisite for BIOL

2401, Anatomy and Physiology I, which is required. Since many of the pre-nursing students needed BIOL 1406 in order to take BIOL 2401, *Chances in Life* provided an opportunity for students to satisfy both requirements with the same course. We have also attracted the occasional respiratory care student; both courses are required for an Associates degree in this area. Unfortunately, we have not been able to attract many biology majors; only one or two over the past three years have enrolled in the class. In the future we will have to be more aggressive in recruiting students for the learning community. The biggest obstacle is students' lack of awareness of the program. The most effective approach is to heavily recruit students for the course. The learning community faculty need to visit other classes (and not just prerequisite mathematics classes) to explain the learning community concept and promote their biology and statistics learning community.

Suggestions

We recommend that schools without a learning community program investigate the possibility of starting one. It is important to gain the support of the administration and involve as many disciplines as possible. Because of the time and work involved in developing a learning community, we recommend that the administration consider extra compensation for teaching in one. Since Collin College uses the integrated model for learning communities, both faculty members are compensated for teaching both courses, and this encourages their development. Of course this requires an additional financial commitment from the administration. Learning communities are a form of professional development, so the information gained by faculty participants can also be used in stand alone courses. For schools that have a learning community program, we recommend that the institution encourage mathematics and science faculty to develop courses like *Chances in Life*. At Collin College, the learning community faculty members provide a professional development workshop each semester for other faculty members who might consider creating a learning community.

If a learning community program is not possible, there is an alternative. Some schools use a linked-course model, in which students co-enroll in two courses that meet separately.

While the instructors might not participate in the teaching of the other class, they work together to integrate the material into both courses. This model can be used as a starting point to encourage your college or university to consider a learning community program. It requires the support of the administration to encourage faculty to develop pairs of linked courses.

In any case, we recommend that faculty members attend at least one conference for the other discipline. This provides the faculty member with a view into the other discipline's world. Dr. Subramanian attended the Joint Mathematics Meeting in January 2007 because it included several sessions on biomathematics. This helped her get more examples and resources for integrating the two subjects and she felt it was enlightening to get a mathematical perspective on biological phenomena.

Another recommendation is to make sure students are aware of what a learning community is when they enroll, and make them aware of what is expected in class. One point of confusion we try to correct with students is that while this is one learning community, it consists of two classes. Students sometimes think that they will have less work to do in a learning community. It is important to stress that the learning community consists of two classes, with corresponding work loads.

Conclusion

The college has been supportive of the learning community program. Dr. Tracey McKenzie, Director of Learning Communities at Collin College, commented about *Chances in Life*:

> The integration of mathematics and biology was an important expansion of our Learning Communities program that had been dominated by social sciences and humanities. This course was the first Learning Community taught that included biology, and it has been an especially attractive course option for our nursing students.

The Dean of Mathematics and Natural Sciences, was happy to approve our Learning Community when it was proposed. He has also been supportive of the learning community program, encouraging his faculty to develop learning communities that include a mathematics or science course.

The Learning Communities program at Collin College operates on the principle that learning in context provides a deeper, more durable type of learning. Courses like *Chances in Life* provide students an opportunity to place both biological and mathematical information into context. Since both courses are in the field of study curriculum for nursing, students can see that the curriculum elements have a purpose, and that purpose can be exemplified through practical examples.

The logistical problems in setting up a learning community deal with space and time, but also with assuring that the instructors are compatible and willing to be participants in learning about the other discipline. Certainly, with these two faculty there were no issues about that cooperation. There is also the practical consideration that the course needs to make in order to justify the time spent in preparing for it. Faculty have to be encouraged to recruit students, but a significant part of that recruiting hinges on them showing to their students that they are still active learners who will work hard to create a well-integrated course. Again, for this course that was not an issue.

Learning communities such as *Chances in Life* are ideally suited for two-year institutions where there is little ability to create new courses. We strongly feel that this type of approach to interdisciplinary thinking is beneficial to both faculty and students. Learning communities certainly give an edge to students in achieving excellences in their pursuit of knowledge.

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