

Student Learning Assessment Report
BIOLOGY DEPARTMENT
Closing the loop Project (2)
Learning in the General Biology I (BIOL 3051) course

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SECTION I: Mission and Student Learning Outcomes

The Biology Department Mission The Biology Department will develop in each professor and student, critical thinking, enthusiasm, initiative and the necessary skills to become lifelong students of Biology. Emphasis will be placed on basic concepts and research, in an environment that promotes the development of professionals with social, cultural and humanistic sensibility as well as profound ethical values. In this way, the Department will contribute to the enrichment of science and society through the creation and dissemination of new knowledge through scientific research.

Biology Student Learning Outcomes

The Biology Department Programs aim to develop graduates with the following skills and values, as well as with proficiency in the following scientific concepts:

Skills and Values

- Critical thinking and problem solving skills through the scientific method
- Team working skills
- Communication skills in Spanish and English
- Computer literacy and its scientific applications
- Knowledge of up-to-date scientific tools and techniques
- Awareness of contemporary scientific issues
- Awareness of ethical implications in science
- Ability to learn by him/herself (lifelong learners)

Scientific concepts

- Cell structure and physiology
- Organismal biology (zoology, botany and microbiology) with emphasis in tropical environments.
- Genetics: classical, population and molecular
- Chemical, physical and mathematical applications to biology
- Ecology: Interrelationship among organisms and its environment, population, ecology, biodiversity and conservation biology
- Evolution as a unifying science

SECTION II: Biology Student Learning Assessment Project

Sub-section		Content
Focus of Assessment Project		Assess the learning of basic biology concepts and identify misconceptions in the first part of the General Biology course (BIOL 3051)
Justification		<ul style="list-style-type: none"> • This course is taken by all freshman biology majors • Course introduces important concepts that are necessary for advanced courses. • Many course topics are comprised within the Department learning outcomes • Same study was performed in the second part of the General Biology course (BIOL 3052) and misconceptions as well as difficult concepts were identified
POPULATION Student		<ul style="list-style-type: none"> • Project impact: Pre test - 279 students, Post test – 174 students, 2 faculty members
Faculty		<ul style="list-style-type: none"> • Overall impact: Course enrolls about 400 students per year and 4 faculty members
Assessment	Pre-intervention	<ul style="list-style-type: none"> • A diagnostic pretest on content was offered on the first day of class.
	Intervention	<ul style="list-style-type: none"> • Conventional lectures, laboratory exercises, small group diagnostic test discussion
	Post-intervention	<ul style="list-style-type: none"> • Post activity: Post test was offered near end of the semester (before semester ended to allow for taking action).
Results and discussion		<ul style="list-style-type: none"> • Students improved performance indicating the interventions helped most students clarify the chosen content. The test average increased from 33.78% in the pre-test to 62.90% in the post test (figure 1). • Incoming and persisting misconceptions as well as missed concepts were identified and further discussed with students before semester ended
Dissemination of Results		<ul style="list-style-type: none"> • Failed questions and the misconceptions were discussed with the course faculty. • Project was summarized at department meeting • Project was presented at Arts and Sciences activity to department assessment coordinators and College officials (Feb 07) • Publication (In progress)
Course of Action		<ul style="list-style-type: none"> • Course faculty was made aware of the misconceptions and the difficult concepts for them to emphasize with their students • Different approaches were used by different faculty to re-teach concepts such as small group test answering or entire group test discussion. In both activities an increment in student's scores was observed (figure 2) indicating these are effective re-teaching methods. • New course faculty will be made aware of the important concepts and misconceptions • Will recommend group discussion of diagnostic test as teaching tool • Faculty decided to prepare a listing of major concepts to emphasize with

	students and laboratory teaching assistants
<i>Next learning assessment closing the loop project</i>	<ul style="list-style-type: none"> • Ethics in science, communication and/or critical thinking
<i>Appendix</i>	<ul style="list-style-type: none"> • Diagnostic test is available upon request

Biology Student Learning Assessment Project

Focus of Assessment Project

The main focus of this study was to assess the learning of basic concepts and identify the misconceptions associated with these concepts in the first part of the General Biology course (BIOL 3051).

Justification

The General Biology I course is the first course taken by all freshman biology majors. This course is a prerequisite to all other biology courses and teaches the fundamental scientific concepts and skills needed in advanced courses. Furthermore, concepts and skills included in the General Biology I course are comprised within the Department expected student learning outcomes (e.g. cell structure and physiology, genetics, team work, etc.). Last year a similar study was performed in the General Biology II course (BIOL 3052) and misconceptions as well as difficult concepts were identified.

Population

The first part of the General Biology course enrolls about 400 students per year and is taught by at least 4 different faculty members. In this study the data was collected from groups of students of two faculty members (Pre test - 279 students, Post test – 174 students) and the results were shared with all the faculty that teaches the course.

Learning Assessment Loop

A. Pre-intervention Activity

For the pre-intervention activity, a diagnostic pretest on content developed by the faculty that teaches the course was offered on the first day of class. An earlier version of this test was created and offered a few years ago to assess student knowledge in the course, but was briefly analyzed. The diagnostic test used in this study consisted of 25 multiple choice questions from the following fundamental concepts discussed in the course: Chemistry of life (Inorganic and organic), Cell structure and metabolism (Photosynthesis and Cellular Respiration), Genetics and molecular biology (Mitosis, meiosis, DNA and basic genetics). Questions addressed general knowledge of the water molecule, chemical elements, organic compounds, nucleotide sequence in DNA and RNA, enzyme characteristics, biological organization, protein structure, ATP, functional groups in amino acids, cell organelles, eukaryote vs. prokaryote cells, criteria that distinguishes plants from animals, definition of cellular respiration, photosynthesis reaction, mitosis and meiosis process, genetic expression, transcription, genetic inheritance, kingdoms, histology and taxonomy.

B. Intervention

The intervention used to teach these concepts consisted of the conventional lectures, the laboratory exercises and group discussion of the diagnostic test.

C. Post-intervention

For the post intervention activity, the same pretest was offered as a post-test before the semester ended to allow for taking proper action. Some students first took the post-test individually and then answered it in small groups and the missed concepts were again discussed to the entire class as well as again assessed in the final exam. Thus, the diagnostic test was used as a teaching/ learning tool to improve student understanding of major concepts.

Results and Discussion (Figure 1)

The pre and post test scores were used not only to assess how much the lectures and laboratory assisted students in learning the concepts but to identify misconceptions. The incoming misconceptions (brought from high school) were identified in the pre-test as those questions were 40% of the students that failed them choose the same wrong answer. Misconceptions that persisted throughout the semester were identified in the post-test again as those questions that 40% of the students that failed them choose the same wrong answer. Those questions were then again discussed in groups and to the entire class before the final exam.

PRE-TEST: The pre-test was given to 279 students. In the pre-test the test score average was 33.78. Entering students had some knowledge on protein characteristics and on biological organization hierarchy. Twenty two of the 25 items were failed by over 50% of the students. Most failed questions, failed by 80% of the students, dealt with functional groups, cell organelles, metabolism, meiosis, kingdom characteristics and taxonomy.

Incoming misconceptions were identified in the pretest. These questions were answered incorrectly by more than 50% of the students and the same incorrect answer was chosen by more than 40% of those who failed them. The following misconceptions were identified in the pretest: Students identified an amino functional group as a hydroxyl group, cellular respiration as the process that oxygenates the blood, mitosis as the process that produces sperms in animals, cells of the same body as having different genetic information, mRNA as containing thymine and Homo in Homo sapiens as the species category and not the genus.

POST-TEST: The post-test was taken by 174 students. The test average increased from 33.78% in the pre-test to 62.90% in the post test (Figure 1). Student's improvement indicates that the lectures and laboratory offered throughout the semester assisted students in learning the concepts. An improvement was observed in 24 of the 25 questions. Most students (over 70%) answered correctly 14 questions. Still, 8 questions of the posttest were failed by many students of which 5 were answered correctly by less than 35% of the students. In the one

question where an improvement was not observed the students appear to confuse the terms protists and prokaryotes even after the semester ended. All questions where a major improvement was not observed were again discussed with students before the semester ended. The post-test showed that incoming misconceptions were clarified for most of the students. Still, in some students some misconceptions persisted or new ones were created. Thus, traditional teaching was not sufficient to correct all misconceptions in all students. Misconceptions in the post-test were identified as those questions that were failed by more than 25% of the students and that 40% of those that failed them choose the same wrong answer. Misconceptions that persisted throughout the semester in some students include that on identifying an amino functional group as a hydroxyl group, mitosis as the process of sperm production, mRNA as having thymine and the genus category question. New misconceptions identified in the post-test in some students include associating golgi with intracellular digestion functions, organic compounds as not being present in bacteria and confusing the terms protist and prokaryotes. Possible explanations for some of these misconceptions are that: students knew the term amino but could not identify it in the chemical diagram or did not know amino had nitrogen, that they confused DNA transcription with DNA duplication, that they associated golgi with intracellular digestion because the lysosomes are formed in golgi. The question on meiosis was missed by many probably due to a misleading diagram.

Dissemination of results: Those questions failed by many students as well as the misconceptions were discussed by the faculty teaching the course for them to take proper action. This study was also summarized and presented in a department meeting and to Arts and Sciences assessment coordinators and officials.

Course of Action

The students in this course are all department majors who will build upon the basic concepts in the advanced courses thus it is important all major concepts are well learned. Thus, most missed questions and the misconceptions were shared with the faculty teaching the course for them to be aware and further discuss with their students. Different approaches were taken to re-teach and clarify concepts:

- In some groups, those questions that were failed and those identified as misconceptions were again discussed by the students in small groups. In this activity students answered the pretest in groups of about 5 students' right after answering it individually. The group post-test was taken by 18 groups of students (total-89 students). Fourteen of the 18 groups obtained a perfect score, 2 groups failed one question, 1 group failed 2 questions and one group failed 3 questions. Thus, students clarified most of their doubts among themselves through the group exam. Still those questions that were failed in the groups were again discussed and clarified to the entire group. These were again asked in the final exam of one faculty members that had re-discussed them and the results showed an improvement. Seven of the 9 questions (amino group, movement in plants, DNA transcription to MRNA, same genes in cells, protists are not prokaryotes, the genus in nomenclature, meiosis

producing gametes in animals) were answered correctly by more than 75% of the students. Questions still failed by some include that associating golgi with intracellular digestion, not knowing that bacteria lack mitochondria and identifying covalent bonds instead of hydrogen bonds as uniting water molecules. Thus, small group discussion and entire group discussion are effective re-teaching methods.

- One faculty member, near the end of the semester, choose the 10 most failed questions (those that included misconceptions) and offered them first as pretest, then discussed them emphasizing the misconception to the entire student population and then ask the questions again in the final. An improvement was observed in all questions (Figure 2). Thus, this type of approach of discussion before the semester ends also helps clarify concepts.

Other actions to be taken include continuing sending misconceptions and failed questions to the new course faculty to keep them aware.

Course faculty also analyzed misconceptions and decided to prepare a listing of fundamental concepts for the course. These will be given to all course faculty for them to emphasize with their students and will be explained to laboratory teaching assistants. Faculty is also becoming aware of group discussion techniques to re-teach concepts.

Innovations in this study

Giving the post-test before the semester ended allowed for taking action before students left the course. Offering the diagnostic test individually and then in groups allowed for students to clarify concepts as well as review for the final exam. Also discussion of difficult questions before semester ended also proved to be an effective teaching technique.

Next learning assessment closing the loop project

Awareness of ethical implications in science, communication and/or critical thinking

Appendix

Pre and post-test-available upon request

Figure 1.

General Biology BIOL 3051

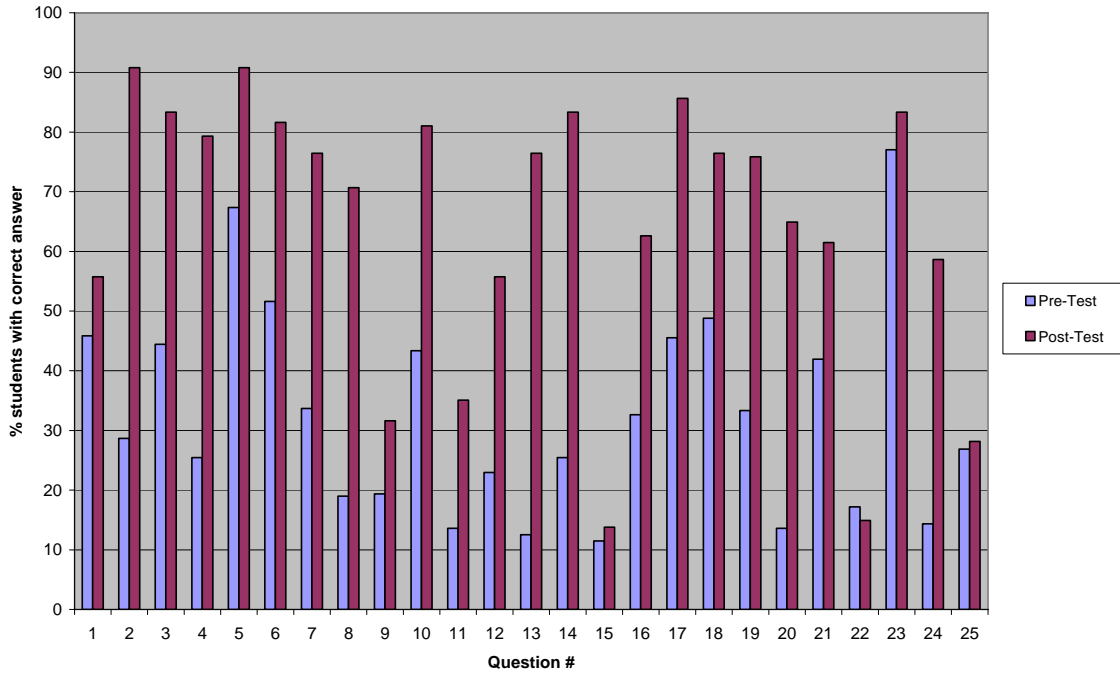


Figure 2

Action: Pre and Post-test activity near end of semester

