**Bio 204 Lecture Second Summer Report**

***Abstract***
Biology 204, the fourth and final core course for Biology majors, explores the relationship between organismal form and function using plant and animal systems as examples. The lecture section is designed to develop students' understanding of major concepts by posing questions and predictions and using data to evaluate possible outcomes. This goal has typically been addressed in a traditional lecture format with intermittent use of clickers, sometime as active learning. Historically, students have found Bio 204 challenging and a significant fraction repeat the course before succeeding. Recently, the lab and lecture portions have become separate co-requisite courses to streamline repeat attempts, but the impact of this change has not been assessed. In addition, a prior STEM Gateway course reform team has been working to improve the learning outcomes for the Bio 204 *lab* course and has had some positive feedback from students, teaching assistants, and instructors.

The prior positive STEM Gateway experience motivated our team to pursue reform of the Bio 204 *lecture*. Since all faculty teaching Bio 204 recently agreed on an outline of course outcomes and learning objectives, we decided to use methods from the STEM Gateway program to achieve the three major course outcomes and to develop more specific outcomes for each topic area in the course syllabus. In addition, we developed low stakes assessments to improve learning and additional student survey assessments to track the success of our reform efforts. We were able to implement these activities partially in the fall of last year, fully in the plant half with team member Hanson and partially in the animal half with Irene Salinas (not a team member). Last spring we were able to fully implement reforms for the entire term and both terms we continued with lab reform efforts developed the prior year. This coming year, team members Pockman and Litvak are teaching for the first time in the plant half since the reform efforts and they have agreed to continue with implementation. This fall, Eric Toolson (not a team member) is teaching the animal half and will be incorporating as many active learning elements as he can. In spring, team member Wolf will continue to refine his prior efforts.

Overall, we have had significant "buy-in" from all Bio 204 instructors, so no expansion is needed. We have begun sharing resources through Google Drive and UNM Learn as a way to increase the sustainability and we will continue active learning discussions with interested faculty throughout the coming year, expanding on meetings organized by Kelly Howe last year. Our challenges are: 1) to ensure that resource sharing functions as intended, 2) to increase our ability to assess the success of our outcomes through pre-post style questions, 3) to maintain datasets that can provide metrics for our successes, and 3) to increase the amount of effective active learning by growing the Biology learning community and increasing interactions with other departments.

***Project motivation and goals***

Biology 204 presents several challenges for students: 1) it is the last course in our core curriculum and thus the gateway to upper division courses, 2) it is often a student's first experience with answering exam questions in their own words rather than through multiple choice exams, and 3) the associated lab emphasizes data collection and analysis to test hypotheses. These challenges make 204 a stumbling block for some students, requiring more than one attempt for successful completion. This generates pressure to seek instructor overrides in order to maintain progress with their degree program, i.e. by taking upper division courses without completing 204. As a result, we see many students taking 204 in their final year at the same time that they are completing upper division requirements. Our efforts in 204 lecture and an ongoing STEM Gateway reform of the 204 lab program are intended to improve student learning outcomes and success in 204 so that fewer students repeat and instead get proper preparation for our upper division courses.

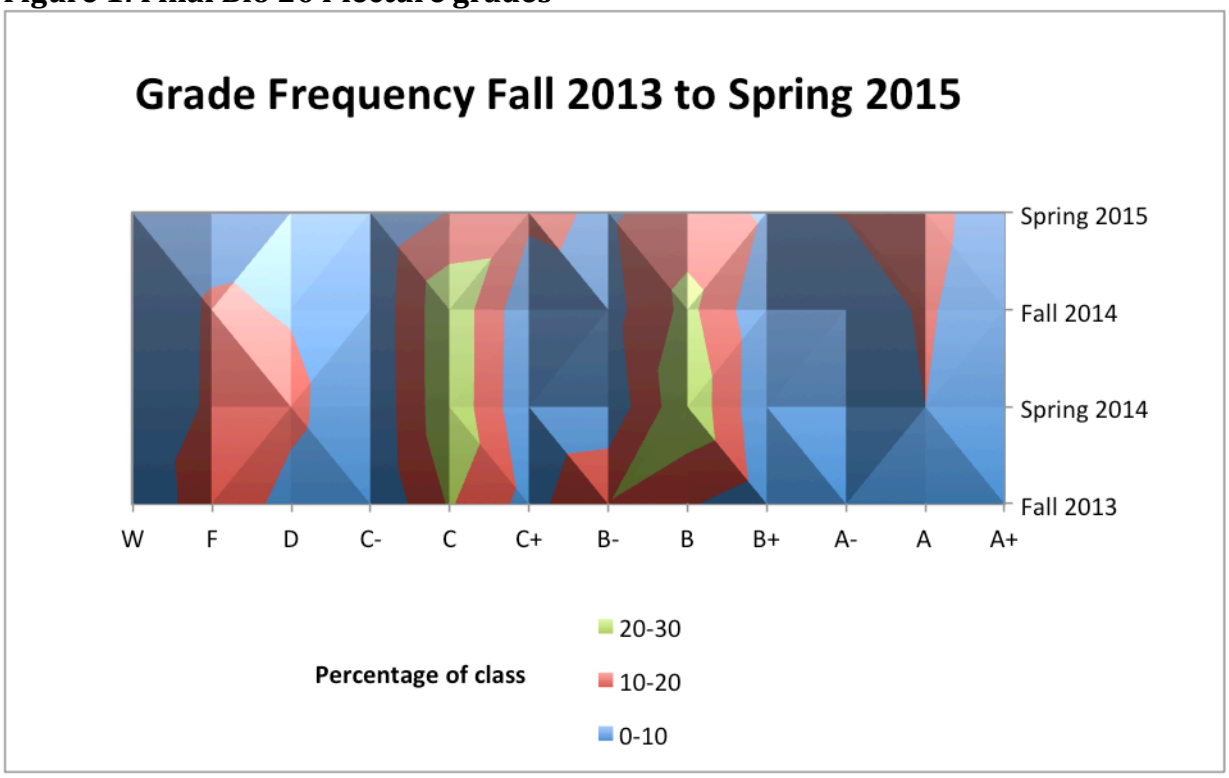
***Project Summary***

We created daily course outcomes and aligned them with new and existing course materials in class (demonstrations, videos, iclickers, learning catalytics, and other activities) and online (primarily via UNM Learn). We added formative assessments through the introduction of weekly muddy point questions and practice exam questions that included answers *with* grading rubrics. We expanded the pool of summative assessment quiz and test questions and aligned them with outcomes. However, we still need to select specific questions to track between semesters for assessing the effectiveness of our reform. Lastly, we implemented student opinion surveys regarding the effectiveness of our reforms for each half of the class. All survey questions used the Likert scale with a score of 1 being positive and 5 negative in order to facilitate numerical quantification of our progress. In addition to incorporating assessments into the redesign, we developed active learning modules that instructors implemented or modified as best fit their teaching style. Our future goal is to develop and test enough modules for a few instructors to transition to a flipped classroom approach taught in UNM's new studio classrooms.

***Assessment***

Ultimately, we aim to have student improvements in learning translate into improved course grades and fewer students repeating. To assess our progress toward this goal, we have compared Bio 204 final lecture grades from fall semester 2013 (where Bio 204 lab reforms were just beginning but lecture reform had not begun) through spring 2015 (where lab reforms were in their fourth semester and lecture reforms were in there second). Figure 1 is a topographic-style graph showing the percentage of the class in each grade category, low to high from left to right, starting with the oldest semesters on the bottom. It appears from this graph that the red (medium-high percentage) portions of the graph are disappearing from the W, F, D areas of the graph and more students are migrating into the A's in more recent semesters. This may represent a real upward trend in over-all student performance, though more data are needed to make a conclusive statement.

**Figure 1: Final Bio 204 lecture grades**




Student opinions of our efforts (Table 1) were assessed via an anonymous survey delivered through UNM learn for each half of the course (the animal half survey was created but accidentally not used). We used the Likert scale: 1 = strongly agree, 2 = agree, 3 = neither agree or disagree, 4 = disagree, and 5 = strongly disagree (except for the first two questions about grades where 1=A and 5=F). At the end of plant half of the course for both semesters last year the student opinions were generally positive with averages for most questions being above 3. In-class demonstrations, clickers, and readings had the most positive responses, whereas muddy-points and discussions boards were not seen to be as helpful. In my view, this directly correlates with the amount of effort and participation in each. Greater instructor use of muddy point responses and greater student use of discussion boards would increase their value. One possible solution to both is for instructors to post information about muddy points on the discussion board. Another positive outcome is that most students agree that exams reflect course material and their understanding of plant form and function increased. However, students are neutral on the connection between lab and lecture. All of these results need to be viewed with some caution as the standard deviation for most is about 1 point. Many scores are high enough suggest there is a positive rather than negative opinion about them across the class, but additional parsing will require more data.

After fall semester 2014, we noted in our reflection form that active learning activities requiring discussions among students were limited by the difficulty of making groups. This led us to try the Pearson product Learning Catalytics. It uses student mobile devices

## Table 1: Student Opinion Survey Plant Half and Prior Resources Survey

| Plant Survey Questions: | Fall 2014 Average | STDEV | Spring 2015 Average | STDEV |
|---|---|---|---|---|
| What grade would you **define as success** in the lecture? | 1.46 | 0.56 | 1.72 | 0.76 |
| What is your most **recent grade estimate** in lecture? | 2.40 | 0.95 | 2.59 | 0.85 |
| At the beginning of the semester, I was excited about the **plant portion of the lecture**. | 3.05 | 1.25 | 3.12 | 1.23 |
| Now, I am excited to learn more about **plants in other courses.** | 2.83 | 1.20 | 2.83 | 1.17 |
| I **learned** the material. | 2.03 | 0.62 | 2.10 | 0.66 |
| I **enjoyed** the material. | 2.46 | 1.07 | 2.62 | 1.05 |
| The lab **learning outcomes as presented** helped me understand what was expected on exams. | 3.09 | 1.24 | 3.18 | 1.19 |
| **Readings** prepared me to **understand lecutures**. | 1.92 | 0.87 | 2.37 | 1.00 |
| **Quizzes helped me** avoid cramming for the exam. | 2.74 | 1.21 | 2.89 | 1.23 |
| Multiple choice quizzes helped my grade. | | | 2.17 | 1.19 |
| **Instructor reviews of short answer quizzes** were helpful for preparing fo the exam. | 2.82 | 1.19 | | |
| Short answer quizzes were helpful for preparing fo the exam. | | | 1.99 | 0.96 |
| **Instructor reviews of muddy points** were helpful for preparing fo the exam. | 2.84 | 1.14 | | |
| Muddy points were helpful for preparing fo the exam. | | | 3.39 | 1.13 |
| I found the **blog/discussion board useful** to help me study for the exam. | 3.09 | 1.11 | 3.10 | 1.17 |
| The **in-class demonstrations** were helpful for learning the material. | 1.66 | 0.93 | 1.72 | 0.88 |
| The **in-class clicker questions** were helpful for learning the material. | 1.83 | 0.68 | 2.05 | 0.95 |
| The **in-class discussions around clicker questions** were helpful for learning the material. | 1.99 | 0.80 | 1.98 | 1.08 |
| The in-class Learning Catalytics questions were helpful for learning the material. | | | 2.18 | 1.32 |
| The in-class discussions around Learning Catalytics questions were helpful for learning the material. | | | 2.20 | 1.23 |
| The **exams** covered the material in lecture and the text | 1.93 | 0.89 | 2.09 | 1.02 |
| My **understanding of plant form and function** has increased over the semester. | 1.73 | 0.73 | 1.72 | 0.71 |

Note: S# refers to questions from spring 2015, F# to Fall 2014
1 = Strongly Agree; 2 = Agree more than disagree; etc

| Prior Resources Survey Spring 2015: | % responses TRUE |
|---|---|
| I had an access code for Pearson's Mastering Biology BEFORE signing up for Bio204. | 0.55319 |
| I had an iclicker BEFORE signing up for Bio 204 OR I need an iclicker for another class I am enrolled in this term. | 0.96454 |
| I have a mobile (wi-fi compatible) device (e.g. smart phone, tablet, laptop) that I can use in class. | 0.95035 |
| I am concerned about the expense of using my data plan on my mobile device if the wi-fi is overloaded. | 0.39716 |

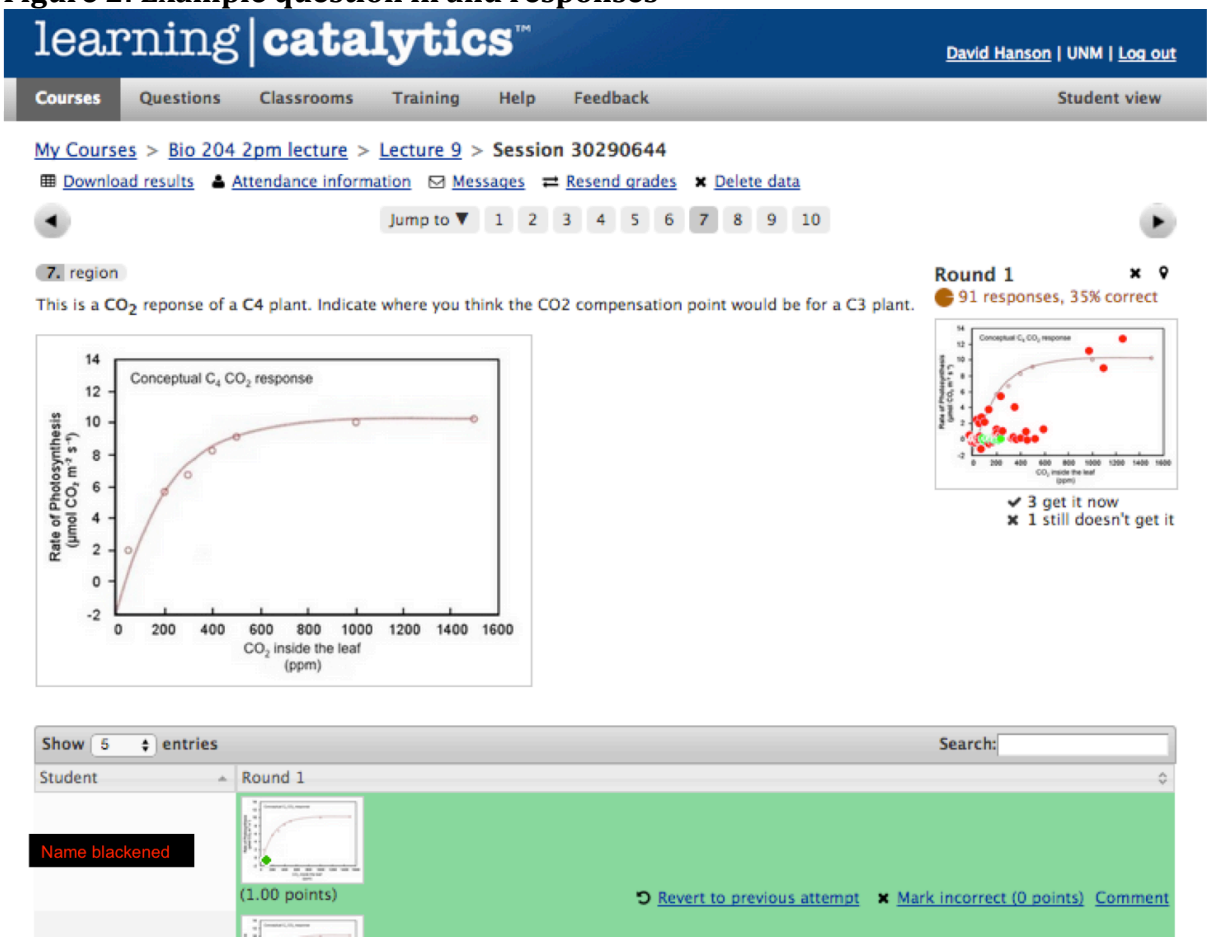
(laptops, tablets, smartphones) to run an interactive web-based program. Many features for question types are similar to other services like Top Hat or even i-clicker. However, Learning Catalytics has a few truly unique features. One is the ability to combine student responses with their location in the room *and* to use this information to *automatically* assign groups for think-pair-share style activities. This had the potential to solve some of the problems from fall 2014, but we were concerned about cost to the students so we surveyed them at the start of spring 2015 (see bottom of Table 1). Half of our students already had access to Learning Catalytics through Pearson's Mastering Biology product and the others could get access for $12. This was pretty good but almost all students had an iclicker from a prior class where no additional expense was required. Almost all students also had a mobile device and we were able to purchase 3 mini-tablets from course fees for students to check out during class if needed.

Wireless connectivity was also a concern for using mobile devices but initial in-class tests showed it was reasonably good, though responses were sometimes slow for some students. To test this further, throughout the plant half of spring 2015, both Learning Catalytics (via

mobile devices) and i-clickers (in-room remote with in-room base station) were used on the same day and on separate days. The ability of students to register mobile devices for each session did not appear to be hampered since the numbers of registered mobile devices generally matched or exceeded the number of registered clicker responding for the same session. Learning Catalytics records both the time a mobile device was registered for a session and the time of any responses. Using these data for both Rm 100 (2pm lecture with about 100 students) and Rm 55 (5pm lecture with about 50 students), we could see that on average 90% of the registered students responded to Learning Catalytics questions. It is not clear what proportion of the remaining 10% did not respond because of connectivity problems or because they opted to not participate. Within individual sessions the percent response often varied by 10%, so my guess is that connectivity was a very minor issue.

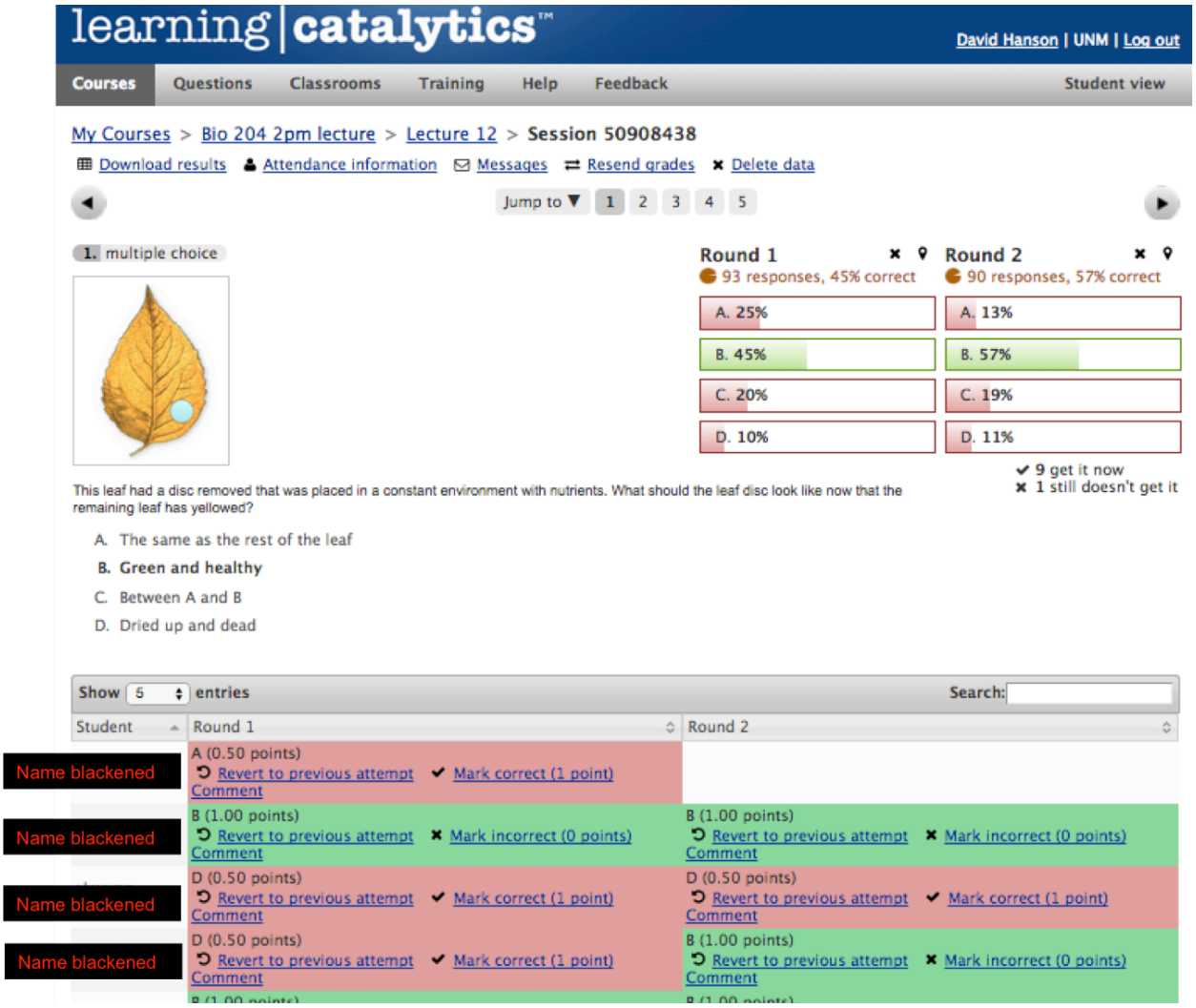
Since connectivity and accessibility did no not appear to be road-blocks, we report how we used some of Learning Catalytics' features. Figure 2 is a screen shot of the instructors view for a question where a graph was presented to the students (upper left) and they were asked to mark the correct region on it. The composite student answers are shown in the inset (upper right) where red dots are incorrect responses and green dots are correct responses. Individual student responses are also shown at the bottom of the screen.

**Figure 2: Example question in and responses**



The ability to indicate responses on a graph or to submit an illustration is on other platforms, but this software also auto-grades the responses in real-time if desired and does a nice job of showing whole class responses (also viewable by the class if desired) and their individual answers. When a class map is used, the location of correct and incorrect answers can also be seen by the instructor during class. However, the most innovative tool with the map is that the software can use the responses of each student to define groups automatically in real-time. The instructor uses the "assign groups function" and then can re-deliver the question or deliver a new one. Students are then told through their mobile device which student (first name and seat location – i.e. Joe, behind you) or students to interact with when answering the next question. In practice, this was very helpful for the instructor by preventing the same students always talking to each other and the students thought it was really cool. Figure 3 is a screen shot of what the instructor sees for a think-pair-share response where the pairing was automated by Learning Catalytics.

**Figure 3: Instructor view from auto-paired and graded think-pair-share activity**



Comparing iclickers and Learning Catalytics, the cost of Learning Catalytics is a little higher (around half of our students had to pay $12), the response speed is a little slower, and it requires switching between a web program and presentation software. However, it allows a more complex assessment of students' understanding, facilitates group work in a standard classroom, and auto-grades more complex responses (though this is not integrated in to UNM Learn, grades can be imported). Use of both technologies in the same term is not worth repeating since it just adds frustration for students and instructors. However, both work well enough that instructor preference should determine which to use.

***Improvement***

The most significant remaining improvement will be to numerically quantify outcomes assessment beyond opinion surveys. This will require agreement among instructors on sets of questions that will be included each term for the six primary learning objectives and tracking student performance. Many questions have already been aligned with the outcomes so the next step will not require much effort. We also intend to increase the number of active learning modules to make teaching in a studio classroom feasible.

***Expansion***

At least some reforms have been adopted by all instructors for all sections of the course, so expansion is not needed. However, we will assist with the expansion of active learning in other courses.

***Sustaining***

We have begun sharing resources through Google Drive and UNM Learn as a way to increase the sustainability, including a syllabus with what activities were tried for each lecture and comments about their successes and failures. We will also continue active learning discussions with interested faculty throughout the coming year, expanding on meetings organized by Kelly Howe last year. All Bio 204 faculty will be informed of the results of the assessments and ensuing discussions each semester. Within the limitations of academic freedom, all faculty will be encouraged to participate and consider how the findings might impact their instruction. At the end of the academic year, faculty will be asked to respond briefly in terms of how they developed their instruction during the academic year in response to the assessment recommendations and discussion.

***Challenges***

Our challenges will be: 1) to ensure that resource sharing functions as intended, 2) to increase our ability to assess the success of our outcomes through pre-post style questions, 3) to maintain datasets that can provide metrics for our successes, and 3) to increase the amount of effective active learning by growing the Biology learning community and increasing interactions with other departments.