Student-centered active learning curriculum in evolutionary biology

Abstract: Evolutionary biology is often taught in a large-enrollment, lecture-style format. We have developed 45 student-centered active learning lessons for teaching evolutionary biology. We highlight three tools for measuring the development of learning communities, measuring instructor performance and advancing students' science process skills. We hope to promote conversation about course transformation in evolution. Our materials and assessment tools are availble for download using QR codes.

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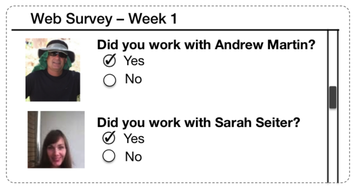
Quantifying Learning Community Growth

Network Analysis As a Tool For Measuring and Quantifying Learning Communities: Active learning relies on peer instruction and the development of learning communities. Peer instruction in group work is effective because because student-student interactions provide opportunities for individuals to meaningfully construct their understanding of the material [1]. Learning communities have repeatedly been shown to promote learning gains and reduce attrition [2]. We used network analysis to quantify the number of peer connections made by each student ("degree") and how central students became to the network ("connectedness") and evaluated the relationship between these measures and student performance [3].

Methods: We surveyed students in an upper division Evolution course about their social connections using web surveys with student photographs from our class roster (with permission). We administered the survey three times: prior to the start of the semester, at 6 weeks into the semester and 12 weeks into the semester (Figure 1). We calculated degree and connectedness using the iGraph and Network packages in R [4].

Figure 1: Example web survey given to students



Results: We found that students increased their number of network connections during the first six weeks of class, but that they did not significantly increase the number of connections during the second six weeks of class (Figure 3). We also found that class score was correlated with the number of connections gained during (Figure 4a: P=0.01, F =6.52, DF=1) and connectedness (Figure 4b: P=0.02, F=5.62, DF=1)

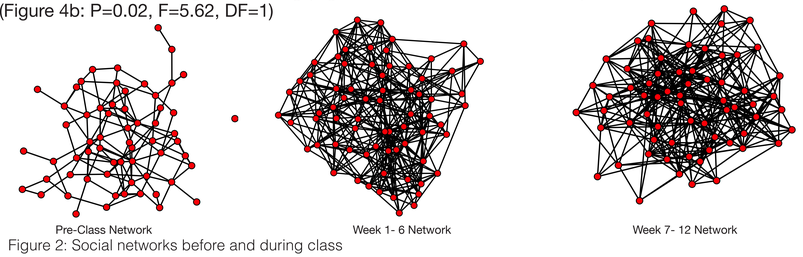


Figure 2: Social networks before and during class

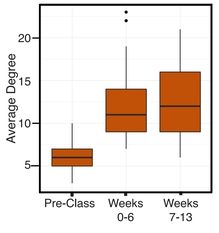
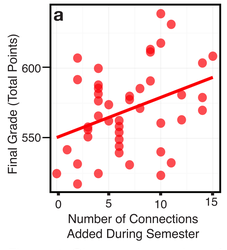


Figure 3: Average Connections per student for each survey



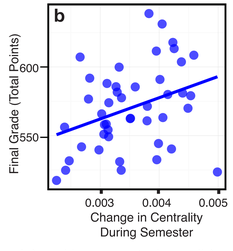


Figure 4: Changes in number of connections (a) and in connectedness (b) are correlated with final grades

Discussion: Our results show that a robust learning community can be established in 6 weeks. Further, instead of generating distraction, greater connectivity promotes learning. While the relationship between connectivity and learning may be related to unmeasured confounding factors, such as attendance, this work shows that promoting peer connectedness does not have detectable learning costs.

Download our course materials for your classroom using this QR code

Measuring Teaching Behaviors

Data Driven Teaching Evaluations: Faculty are increasingly encouraged to adopt interactive teaching practices to increase student learning and reducing attrition. Yet, instructors in STEM disciplines often lack experience and confidence in using active learning in their courses. Offering objective, data driven feedback can help novice faculty to track the effectiveness of new activities. Our tool measures multimple dimensions of faculty teaching.

Methods: Over the course of two years, we iteratively developed a faculty teaching observation tool (SITAR -- Student Interaction and Teaching Activity Report), which is "descended with modification" from the RTOP [6], TDOP [7], COPUS [8], and the Student Engagement Protocol (Erin Lane, personal communication). This tool is now being used by about 25% of our department's faculty. In evolutionary biology, we trained a research assistant to collect quantitative data using this tool during each class, and reviewed the automatically visualized data

Figure 5: SITAR Data Visualization Dashboard. The upper "Daily Trends" portion visualizes data from a single class session, while the lower "Semester Trends" portion visualizes longitudinally compiled data (in this case, from the spring 2014 evolutionary biology course). The "Daily Trends" data shown are from evolutionary biology class 10.1, which involved a case study of skin color evolution.

Download SITAR for use in your classroom using this QR code

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Posters as Authentic Assessments

Scientific Posters As A Tool For Assessing Student Research Skills: Scientific posters are a tool for communicating results in a succinct and visually clear manner, and as such they offer an opportunity for authentic assesment of students' experimental design skills, analysis, writing and data visualization skills. We explored the use of poster sessions as authentic assessments in 3 process-focused, upper-division courses. We report the results of a survey on student experiences after participating in an indpendent poster project.

Methods: Since fall 2012 faculty have jointly hosted research symposium among upper division courses. In 2012, 200 students collaborated on independent research projects, culminating in a poster session with over 50 entries. After the poster session concluded, students in the evolutionary biology course completed a survey with five open ended questions about various aspects of their experienes creating and presenting posters. Results were coded by S. Seiter, codes were organized into categories (Figure 6).

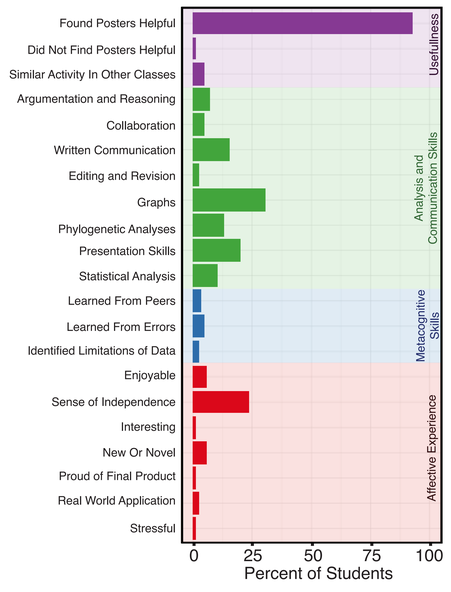

Figure 6: Survey Question 1 - *To what extent did the independent project and poster session advance your ability to graphically, verbally, or quantitatively represent evolutionary problems?*

Results: Students overwhelmingly found the poster session helpful, with 93% reporting learning gains. Nearly a quarter of students reported that that they liked choosing an independent research topic. Students reported making gains in a number of research and communication skills, notably graphical representation of data (31%) and written communication (15%).

Discussion: Our survey results indicate that poster sessions promote learning gains, and help students develop scientific analysis and communication skills. Although we present only data from Question 1 (Figure 6), analysis of the other questions indicates that students gained practice in other skills. For example, Question 5 ("To what extent did the independent project and poster session advance your ability to communicate for brevity, clarity, and scientific persuasion?"), 46% reported that they had learned to revise and select information to communicate clearly with their audience.

Download our poster rubric using this QR code

Acknowledgements

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