



Development and Implementation of Inquiry-based Case Studies in a High-Throughput Discovery Class

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Abstract

Student engagement in real-world applications of course material is a critical component of the learning process. We recently developed a novel course on high-throughput (HT) approaches in molecular biology (including DNA sequencing, small molecule synthesis, automated microscopy, and drug screening), and strove to include relevant analysis of data from primary literature in each class session in the form of inquiry-based case studies. There are currently very few publicly available educational case studies that address authentic HT approaches using real data. To address this need, we developed four case studies for use in the course, and also required the graduate students enrolled in the course to each develop one HT case study. In addition, we have received NSF funding to create the High-throughput Discovery Science & Inquiry-based Case Studies for Today's Students (HITS) Research Coordination Network to allow groups of researchers and college instructors across the country to jointly produce and share authentic HT case studies. We discuss the design and implementation of case studies in our course. We believe well-designed case studies focusing on HT approaches and using novel data sets empower students to learn current approaches and exercise quantitative reasoning in data analyses, thereby fueling student success.

Case Studies Used in the Course

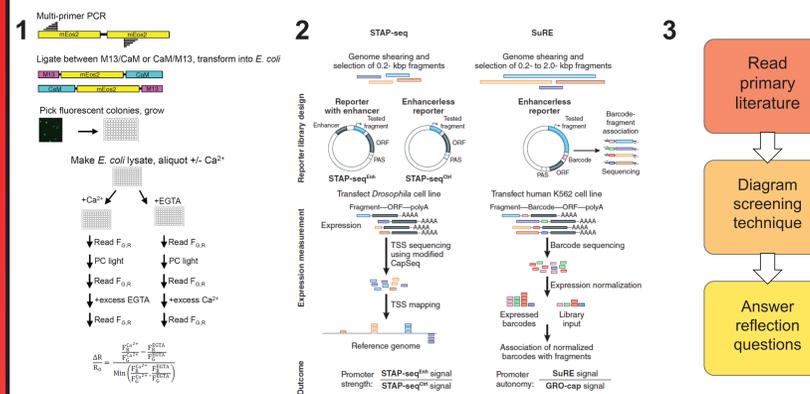


Figure 3: Examples of HT workflow diagrams from recent research publications that the students explore in class. (1) A directed evolution approach was used to create a gain-of-function mutant fusion protein to use as an *in vivo* fluorescent calcium detector. (Fosque et al, Science, 2015) (2) Comparison of two approaches to screen for promoter strength of various genomic DNA regions (reviewed by Cveticic & Lenhard, Nature Biotechnology, 2017) (3) Outline of student workflow through case studies.

Throughout the course, the instructors provided four case studies of HT in action using recent high-profile publications. This exposed the students to real-world examples, allowed the students to practice scientific literacy, and prepared them for creating case studies of their own.

Evidence of Learning

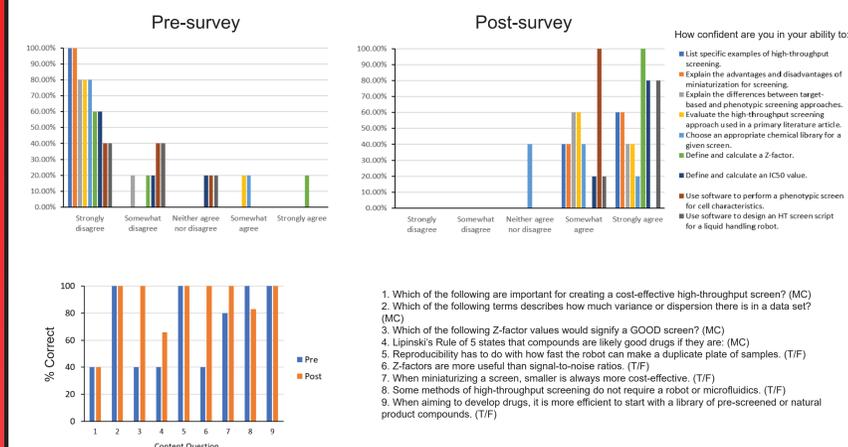


Figure 5: Analysis of data from pre/post-surveys of students taking the High-Throughput Discovery course in Spring 2017. Survey questions are listed on the right.

Students displayed an increase in both confidence and content knowledge at the end of the course, as judged by anonymous pre/post-surveys. (NCSU IRB #11758, n=5)

High-Throughput Course Design

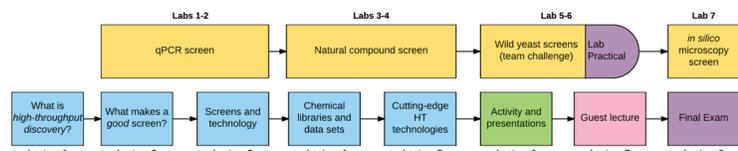


Figure 1. Outline of the course layout. The course is taught as an eight-week module with 2h lecture and 5h lab each week. The top row lays out the experiments, while the bottom row shows the lecture topics.

Item	495 points	595 points
Lab reports (3) & Lab worksheet (1)	20	20
Case studies (4)	10	10
QuantQuizzes (4)	10	10
Screen summary/diagram	10	10
In-class presentations in groups	15	10
Electronic lab notebook (ELN)	10	10
Final exam	15	10
Lab practical	10	10
Final project for graduate students: case study	-	10
Total	100	100

Figure 2. Outline of the assessments in the course. Students must learn and apply quantitative skills (QuantQuizzes, lab worksheets, lab reports, lab practical) as well as analyze existing screens (screen summary, presentation, final exam). Grad students must also develop a unique case study for future use in the course.

Learning Outcomes:

- Describe in detail the goals, methodology, and results of a published high-throughput or high-dimensional screen (HTS).
- Use software tools to analyze HT data (Gen5, CellProfiler and Cell-Profiler Analyst, Prism/Excel/JMP).
- Given a list of reagents and a defined goal, design a HT screen script for the epMotion 5075TC liquid handler.
- Maintain a database and electronic lab notebook (ELN) for a HTS.

Case Studies Developed in the Course

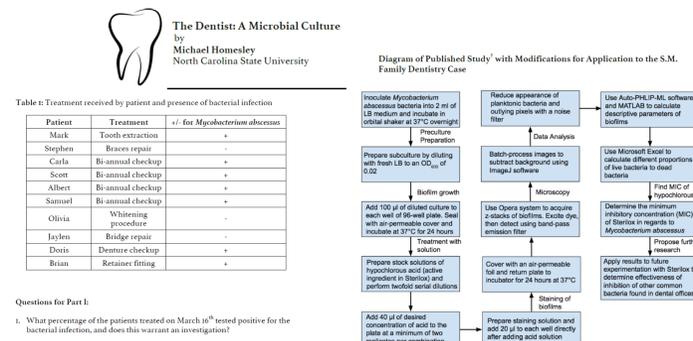


Figure 4: Excerpts of a grad project that was published through the NCCSTS. This pre-dental student focused on HT methods to screen for biofilm formation in dental equipment (UWDL's).

- As a capstone project, graduate students in the course develop high-throughput related case studies.
- Students are encouraged to submit their cases studies to the National Center for Case Study Teaching in Science (NCCSTS) for peer review and publication.
- This trial serves as a model for the recently initiated HITS Research Coordination Network.

Conclusions

- Case studies are one tool to assist student learning of complex, technical material.
- We are looking to fill a gap in available case studies involving high-throughput methodology to allow students to work directly with HT data to discover new things.
- Students can contribute by generating case studies as part of the course implementation.

Related References

- 1) National Center for Case Study Teaching in Science, University at Buffalo. <http://sciencecases.lib.buffalo.edu/cs/>
- 2) Homesley, M. "The Dentist: A Microbial Culture." NCCSTS. 2018.
- 3) NSF Award #1730317 to C. Goller. RCN-UBE: HITS: High-throughput Discovery Science & Inquiry-based Case Studies for Today's Students. https://www.nsf.gov/awardsearch/showAward?AWD_ID=1730317
- 4) K. M. Bonney. "Case study teaching method improves student performance and perceptions of learning gains." J Microbiol Biol Educ 16, 21-28 (2015).
- 5) A. Yadav et al. "Teaching Science with Case Studies: A National Survey of Faculty Perceptions of the Benefits and Challenges of Using Cases." Journal of College Science Teaching 37, 34-38 (2007).
- 6) R. Macarron et al. "Impact of high-throughput screening in biomedical research." Nat Rev Drug Discov 10, 188-195 (2011).