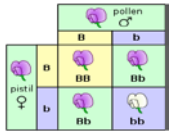
Using Visuals to Improve Quantitative Literacy Outcomes in Principles of Genetics (GN 311)

Introduction

- Through an interdisciplinary partnership we developed assessment measures and data visualization activities to improve student learning in GN 311 around a quantitative literacy topic.
- Quantitative literacy is one of NC State's General Education Competencies (called the "Pack Proficiencies").
- Quantitative literacy (QL) requires contextualized reasoning with quantities and refers to the ability to interpret data and to reason with numbers within real-world problems.

Background

- Instructors of GN 311 (Principles of Genetics) identified trouble areas in quantitative literacy including students' understanding of the basics of population genetics.



- Students had difficulty conceptualizing frequencies of phenotypes and genotypes in a population and how those frequencies behave over time.
- Program faculty in Genetics partnered with faculty in Statistics (the "Pack Proficiencies" QL Champion) and the Office of Assessment to design and assess an intervention to improve learning of probability.

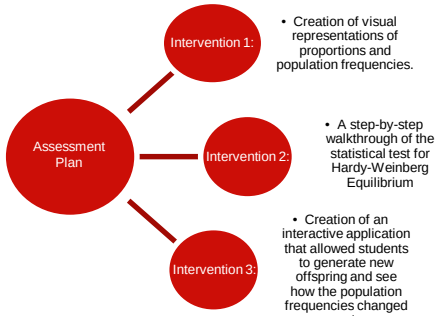
Methods

- The team developed an assessment plan which included: identifying the timing of interventions, selecting appropriate measures, and analysis design (descriptive statistics; logistic regression).
- The interventions were centered on population genetics, Hardy-Weinberg equilibrium, and natural selection.
- Student performance post-intervention was compared to performance in previous terms and disaggregated using a number of demographics and student characteristics to better identify performance patterns.

Research Questions

What is the impact of an instructional intervention on student performance in GN 311 on concepts tied to Hardy-Weinberg equilibrium and natural selection?

Design



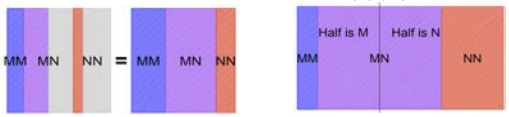


Figure 1: Example visuals from the intervention.

Offspring (F1):

Genotype	MM	MN	NN	Total
Proportion	f(MM)*Wmm = 0.16*1 = 0.16	f(MN)*Wmn = 0.48*0.5 = 0.24	f(NN)*Wnn = 0.36*0.25 = 0.09	0.49
Updated	0.16/0.49 = 0.3265	0.24/0.49 = 0.4898	0.09/0.49 = 0.1837	1.00

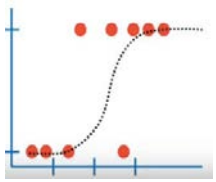
Table 1: Calculations behind the visuals in Figure 1.

Access the Hardy-Weinberg application here.

Student Assignment Questions

Q4	• What is the expected number of BB plants?
Q5	• What is the expected number of BR plants?
Q6	• What is the expected number of RR plants?
Q7	• What is the calculated chi square value?
Q17	• What is the frequency of black beetles after selection?
Q18	• What is the frequency of brown beetles after selection?
Q19	• What is the frequency of white beetles after selection?

Findings



- Overall, student performance on Hardy-Weinberg equilibrium and natural selection concepts improved post-intervention.
- In the model, the level of students' highest previous math course (200 level or above vs. lower then 200 level course) was significant.
- Prior enrollment in 200 level or above math course was associated with better performance.
- Students also completed critical reflection questions on their thought process when solving the problems. Qualitatively, many students said the visual interventions were helpful.

Cohort	Q 5	Q 6	Q 7	Q 17	Q 18	Q 19	Aggregate
Fall2019	0.876	0.868	0.868	0.911	0.867	0.880	0.900
Spring2020	0.921	0.906	0.901	0.931	0.927	0.921	0.921

Table 2. Proportion of correct answers on questions of interest for the Fall (pre-intervention) and Spring (post-intervention) groups.

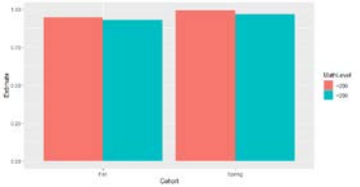


Figure 2: Performance on Q17.

Trends were similar across most questions- the same pattern in performance associated with Math Level pre/post-intervention.

Conclusions and Implications

- Findings suggest that the invention in GN 311 positively influenced student performance on questions assessing their ability to interpret concepts related to Hardy-Weinberg equilibrium and natural selection.
- The highest previous math course a student had taken also influence their performance. This underscores the idea that this performance discrepancy may be part of a broader quantitative literacy issue.
- In critical reflection questions, students reported finding the visual aids helpful; reflection questions will be analyzed qualitatively to better understand students' approaches and thought processes to further refine the interventions and to create additional that may be helpful for students who had previously not enrolled in a 200 level or higher math course.
- Additionally, this study highlights the value of interdisciplinary collaborations to assess and improve teaching and learning.

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