

Introduction

BIOL 336, the Fundamentals of Evolutionary Biology, is a required course for all Biology majors at UBC. One of the core course objectives is for students to develop a solid understanding of how evolution works, from the origin and spread of genetic variation in populations, to the evolution of novel traits, new species and lineages, and the shape of the tree of life. Evaluation of student exam responses indicated that many excelled at questions focused on single evolutionary concepts, but encountered challenges when expected to demonstrate synthesis across evolutionary processes, suggesting the need to facilitate understanding around the interconnectedness of evolutionary processes. The "Making Connections" class activity aimed to use a guided design, case study approach to help students integrate multiple concepts.

Activity overview

- The study system: Pacific field cricket
- Students were provided with a total of 6 prompts, each describing real world data from a particular published study (e.g. Figure 1)
- In small groups, students evaluated the data in each prompt, and tried to connect their interpretations to different evolutionary processes with the aid of guiding questions.
- Groups were invited to anonymously share their ideas on a shared Padlet (see results, Figure 4).

Prompt 2

So we know that male song is important for mate choice. But what if I told you that on the island chain of Hawaii, another creature, is also attracted to the songs of singing males?

The parasitoid fly, *Ormia ochracea* locates its field cricket hosts by eavesdropping on the calls of males. Pregnant female flies locate calling male crickets and spray maggots on them, which will burrow into the cricket and basically eat him from the inside out (gross much).

There is a higher density of these flies on the island of Kauai, than on the other islands.

- What do you think this means for the fitness of singing males on Kauai compared to the other islands?
- Can you draw how selection might be influencing fitness in males? (And how would this differ for females?)
- Now, how do you think males, especially in Kauai, can overcome this strong selective force to avoid being parasitized by this fly?

Prompt 3

What if I told you that between 1999 and 2003, researchers working in Kauai noticed that the level of cricket noise went from almost deafening, to mostly silent. They originally thought the cricket had left (or died out), but when they went looking- they found tons of crickets, but...most males encountered could not sing!

Normal male Flatwing male

How each wing type fares when flies are either absent or present:

- Males that could not sing (called mutant flat wings) had weird wings compared to males that could, (normal wing) so they were unable to produce sound when rubbing their wings together.
- How does this influence mate choice?
- Crickets were still abundant, so that means even silent males could still find willing mates...
- So, how are females still finding mates?
- What strategies can males use to increase their chance of encountering females if they themselves cannot sing?
- What does this mean about the "power" of female mate choice?

Figure 1: Example of consecutive prompts. Students would thus evaluate their responses to Prompt 3 by incorporating what they learned in prompt 2, building on knowledge gained and the consequences with each new prompt

Methods

- We created two surveys, one pre-activity, and one post-activity using Qualtrics, provided by UBC
- The pre-survey asked students to assess their comfort with key evolutionary concepts studied in class
- The post-survey invited students to revisit their responses and evaluate perceived learning gains.
- The pre-survey, n = 68 valid replies (i.e., complete); post-survey n = 43 valid replies.
- In total, the activity offered a retention rate (defined as the ratio of valid post-survey entries by pre-survey entries) of 63.2%.
- We created a pipeline for analysis of results that include automatic processing of students answers using python scripts and Snakemake workflow manager.

INDEX	QUESTION
Q1	Please reflect on the evolutionary concepts you have learned in the: (a) adaptation; (b) mutation and drift; (c) speciation; and (d) quantitative traits lectures. Identify and share three concepts that you find challenging to connect or relate to one another. Separate them by comma. NOTE: PLEASE write down the three concepts on a piece of paper or on your device before proceeding
Q2	On a scale of 1 to 5 (1 = not confident at all; 5 = extremely confident), how confident do you feel in your ability to identify relationships between evolutionary concepts when analyzing a specific scenario or setting?
Q3	In a few words, explain your choice for the question above.

Figure 2: Questions that students answered on the pre-activity survey.

INDEX	QUESTION
Q1	Please write the name of your favorite animal followed by any sequence of 5 numbers. PLEASE ensure that it matches your pre-survey answer.
Q2	Please enter the first concept you are referring to. It should match one of the concepts you mentioned in the pre-survey.
Q3	On a scale of 1 to 5 (1 = not helpful at all; 5 = very helpful), how helpful was the case study in helping you better understand the connections between this concept and others?
Q4	Please enter the second concept you are referring to that is different from the first one. It should match one of the concepts you mentioned in the pre-survey.
Q5	On a scale of 1 to 5 (1 = not helpful at all; 5 = very helpful), how helpful was the case study in helping you better understand the connections between this concept and others?
Q6	Please enter the third concept you are referring to that is different from both the first and second concepts. It should match one of the concepts you mentioned in the pre-survey.
Q7	On a scale of 1 to 5 (1 = not helpful at all; 5 = very helpful), how helpful was the case study in helping you better understand the connections between this concept and others?
Q8	On a scale of 1 to 5 (1 = not confident at all; 5 = extremely confident), how confident do you feel after completing this exercise in your ability to identify relationships between evolutionary concepts in action within a specific scenario or setting?
Q8.1	In a few words, explain your choice for the question above.

Figure 3: Questions that students answered on the post-activity survey.

Results

- Students submitted their responses via Padlet, enabling the teaching team to provide immediate feedback and validate ideas in real time.
- Facilitates the identification of patterns in student responses.
- Supports timely interventions when necessary (e.g., a class-wide clarification or announcement).

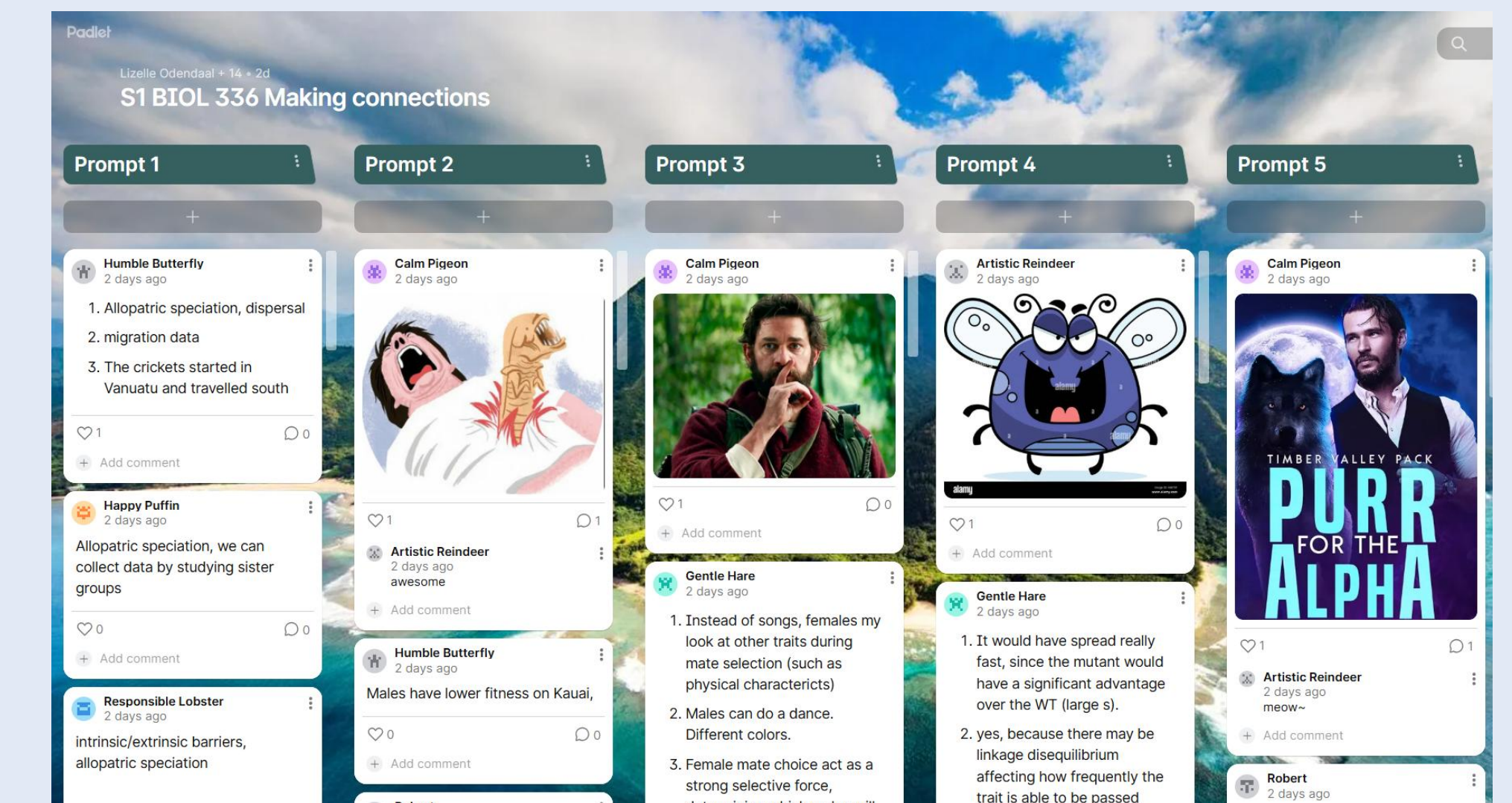


Figure 4: Screenshot of Padlet interface with students answers, taken on June 16th, 2025.

What topics contain concepts that student find the most challenging to connect or relate to one another?



Figure 5: Word cloud of pre-survey answers. Some words or sentences were merged to match closest best and broadest concept (e.g., allopatric speciation -> speciation, ecological species concept -> species concepts).

Was the activity helpful in improving overall confidence in connecting evolutionary concepts across different topics?

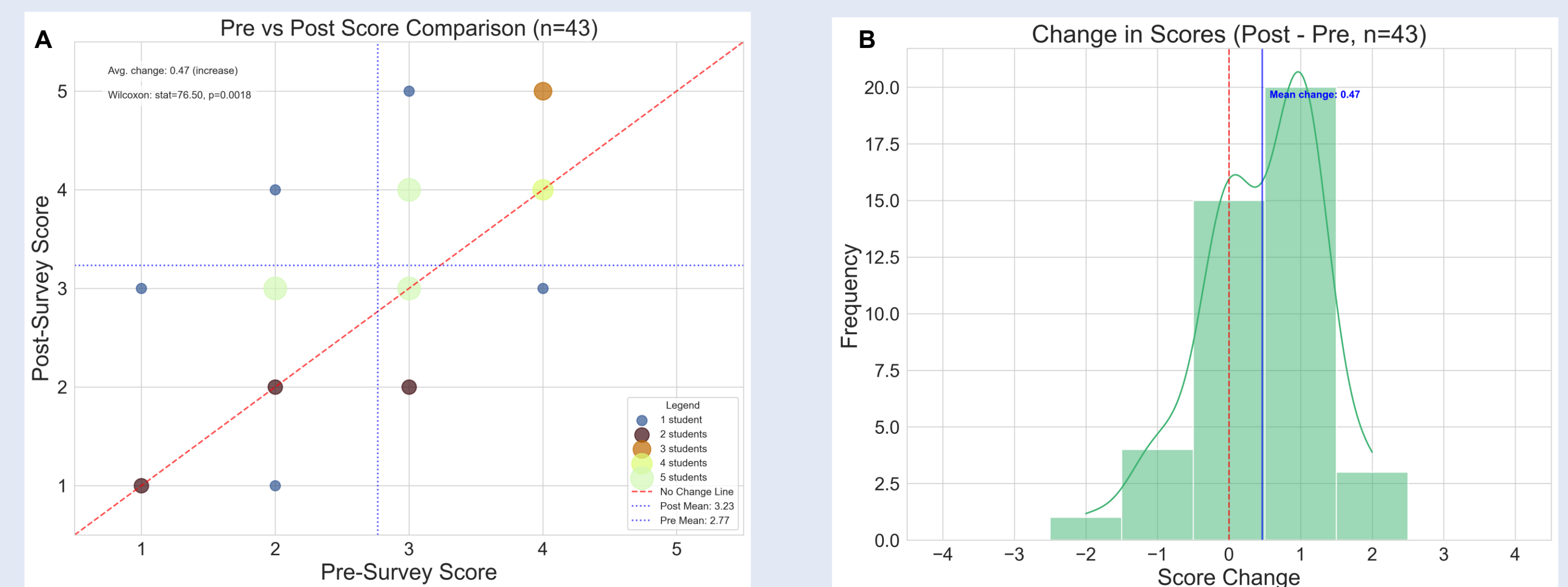


Figure 6: a) Scatter-bubble chart of pre- vs. post-activity confidence. Bubble size reflects the number of students at each (pre, post) point. The red dashed line ($y = x$) indicates no change; most points lie above it. Wilcoxon Signed-Rank Test: $p = 0.0018$. b) Mean score change: red line shows no change ($\Delta = 0$); blue bar indicates increased confidence.

Insights from students

Pre-Survey

"I understand the concepts individually but its hard to put the together and ensure I add proper terms in my answers"
 "I understand the concepts of evolution, but I am not very confident in how I will connect them without having an idea of which ones to apply in a specific scenario."
 "I feel like I understand the concepts in class, but lacking the practice in order to apply these concepts."
 "I can understand many of the evolutionary concepts on their own but it is hard to look at the big picture."

Post-Survey

"The case study provided great examples that could be applied to real life examples"
 "Still not super confident but I think this laid it out in a way that was helpful for my own thought process"
 "Doing the prompts in class has given me opportunities to link ideas together but I did have difficulties connecting some topics together. However I think practicing more questions like this will be helpful when preparing for the final."
 "I still need to study more but I definitely learned a good amount on the different concepts today. This was helpful!"
 "The prompts were structured in a way that allowed for multiple different concepts to connect to multiple others in a way that was easily digestible and thought provoking."

Acknowledgements

We are grateful to every student who participated in the activity and/or in the surveys.