

Context

Evolution is central to biology but challenging to learn. Research shows that students have an easier time learning evolution concepts when they understand related ideas from genetics. We developed a new NGSS-friendly heredity and evolution unit, plus related assessment measures. We used them to understand the mechanisms of 3D student learning and misconception change in heredity and evolution.

Unit

- Focus on the mechanisms that drive genetic variation and natural selection
 - Scaffolded practice working with models, crafting explanations, and identifying cause and effect relationships
 - Embedded formative assessments
 - ~4-6 weeks of classroom time
 - Available at:
<https://teach.genetics.utah.edu/content/change/>

Modules & Essential Questions

- Traits: How are traits made?
 - Inheritance: How are traits passed down?
 - Reproductive Success: How do traits affect who reproduces?
 - Natural Selection & Adaptation: How do species' traits change over time?
 - Evidence for Evolution: How do changes in traits provide evidence for evolution?

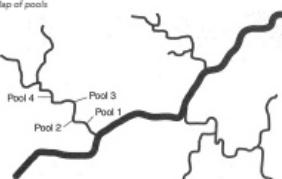
Acknowledgements

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A protocol for uncovering student's sense-making of a middle school unit that integrates heredity and evolution



Characteristics	Pool			
	1	2	3	4
Type	Deep (at a bend in the stream)	Deep (above a natural rock)	Shallow (at a bend in the stream)	Deep (above a 6ft. waterfall)
Pool location (see Figure 2.31)	50 m upstream from the river	100 m upstream from the river	150 m upstream from the river	200 m upstream from the river
Turbidity of water (NTU)	Ranges between 25.70 and 36.25	Ranges between 8.15 and 27.93	Ranges between 3.00 and 8.75	Ranges between 0.00 and 0.75
Predatory fish in pool	28	15	8	0
Guppies found in the pool (m/f)	100	165	157	231
Bright males	5	—	76	108
Dash males	41	19	10	5
Bright females	0	0	0	0
Dark females	16	22	121	147

Note: Turbidity is the cloudiness or haziness of a fluid. Nephelometric turbidity unit (NTU) range in value from 0 immediately clean to 50 very dirty water thus high turbidity.

What do you think is causing the color variation of puppies in the different pools?

If you kept collecting data for the next several years from these 4 pools, what are your predictions about the changes in each population over time?

Stimulated Recall Task



Additional Data Sources

- Classroom observations
 - Student work & assessments
 - Teacher interviews

Preliminary Findings

- Results from the student interviews suggest that students may have difficulties synthesizing the information from the traits and inheritance modules with information from the modules on reproductive success and natural selection, even though the unit integrated these concepts. One possible explanation for this observed difficulty may be how lessons are framed and transitioned.
 - Data analysis is ongoing, and new findings and insights will likely emerge.

Future Research

- Exploration of what an integrated unit needs to include to support student sense-making and connections between heredity and evolution
 - Exploration of middle school students' socio-emotional and cognitive abilities during this developmental transition and how this impacts their learning of heredity and evolution