Using Learning Analytics to Assess Students' Ideas and Generate Reports for Real Time Use and Curriculum Customization

Poster presented at 2021 DRK-12 PI Meeting

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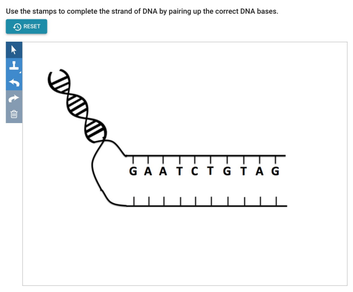
STRIDES Progress

The **STRIDES** project uses state-of-the-art technology and **natural language processing** (NLP) models to provide teachers with detailed evidence of students' progress in achieving the multi-dimensional proficiency called for by the **Next Generation Science Standards** (NGSS). The **Teacher Action Planner** (TAP) in the STRIDES web-based curriculum environment presents **patterns in students' evolving understanding in real time** and provides research-based activities for the teacher to respond to students' ideas. **STRIDES professional development** activities guide teachers to **customize the curricula** to address diverse students' evolving ideas. Project video

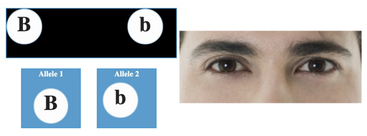
- 7 inquiry units: Genetics of Extinction, Musical Instruments, Plate Tectonics, Thermodynamics, Photosynthesis, Global Climate Change, Solar Ovens
- 9 embedded assessments with associated Teacher Action Plan (TAP)
- 5 embedded assessments with TAP in development
- 23 teachers participating in professional development courses

STRIDES Unit: Genetics of Extinction

Students explore inheritance and variation of traits, use a simulation to discover ideas about natural selection and evolution, and investigate the world's biodiversity and how species go extinct.

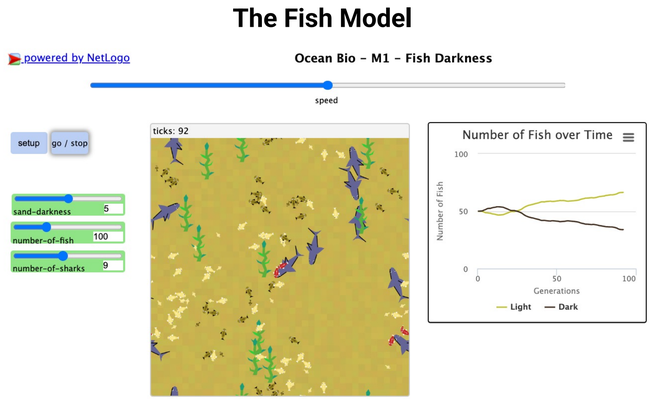


They discover ideas about inheritance. Using the drawing tool, they use stamps to complete a DNA sequence.



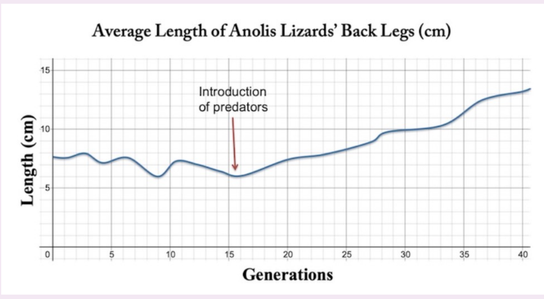
Students explore dominant and recessive genes by trying allele combinations and seeing the resulting trait.

The Fish Model



- Students vary color of the sand, # of fish, # of predators.
- They observe effect on dark and light fish populations.
- A graph shows how fish populations grow or decline over generations.

Embedded Assessment: Lizards



How did the introduction of a predator affect the length of this lizard species' back legs over time? Why?

Your explanation should include:
- Evidence from the graph
- Your understanding of natural selection

Addresses MS-LS4-6 NGSS performance expectation:
- DCI: Explain the adaptation of a species in response to an environmental change.
- SEP: Explain how, drawing on evidence from the graph, this takes place over multiple generations.

Assessing NGSS Dimensions & Knowledge Integration

Lizards Scoring Rubrics (NGSS Performance Expectation: MS-LS4-6)

DCI: Natural Selection

0	No mention of anything relevant to natural selection
1	A species changes in response to changes in environmental conditions
2	A species changes in response to changes in environmental conditions + traits that support successful survival and reproduction in the environment become more common; those that do not become less common

SEP: Evidence from graph

0	No mention of trend in the graph
1	Mention a trend, but no specifics about the changes taking place over generations of the average length of lizard legs
2	Mention the trend and graph + specifies how its's changing over generations, and/or averages

Knowledge Integration

Holistic: expression of relationships or linking ideas with evidence

1	Off-task, blank, "I don't know"
2	No link: Inaccurate, vague or incomplete ideas
3	Partial link: Accurate but isolated idea(s)
4	Full link: Links two accurate ideas
5	Complex link: Links more than two accurate ideas

Sample Explanations

"Introducing the predators made the lizard's back legs longer over time. The graph shows in the 15th generation the predators were introduced and the back legs started getting longer over many generations. The lizard's legs might have gotten longer to escape the predator."

SEP = 2: uses evidence from graph to explain that evolution takes place over generations
DCI = 0: does not mention natural selection
KI = 3: accurate idea about evolution but not linked to natural selection

SEP = 2: doesn't use evidence from graph to explain that evolution takes place over generations
DCI = 2: explains that lizards with longer legs more likely to survive and reproduce + explains that traits are passed down from generation to generation
KI = 5: links accurate ideas about natural selection (more likely to reproduce + traits are inherited)

"Longer back legs most likely allowed them a better chance of surviving and running from the snakes, and so the lizards with longer legs had a better chance of being able to live long enough to reproduce, whereas lizards with shorter legs were killed more often by these snakes. The long-legged trait got passed down throughout generations of long-legged lizards who survived, and this kept happening and happening, and the average length kept rising."

NLP Model

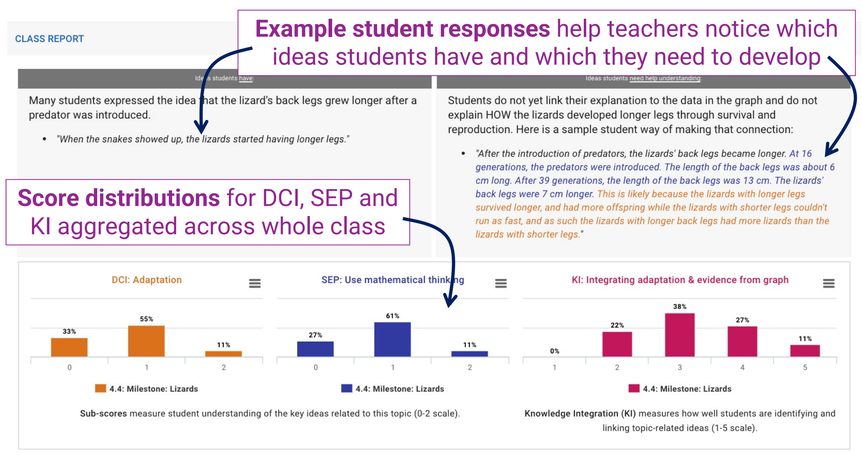
- 1586 human coded responses
- Human-machine agreement: quadratic weighted Kappa .82 for KI; .75 for SEP ; .79 for DCI
- DCI and SEP scores for initial explanation (N = 465) are highly correlated: $r = .71$, $p < .001$
- DCI and SEP scores for revised explanation (N = 451) are highly correlated: $r = .74$, $p < .001$

Report Supports Teacher to Guide Students During Instruction

Design-Based Research: Teacher Action Plan Year 1

- Implemented during remote instruction due to COVID-19
- Recommended actions featured comments teachers could send to their students to support them remotely
- Comments tailored to NGSS score levels and guided students to support activity in the unit

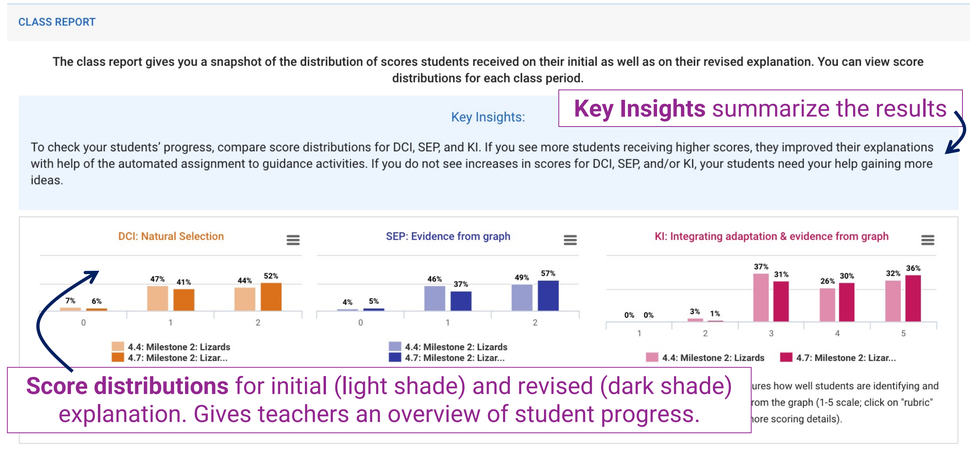
Teacher responses to the TAP:
- Teacher 1: Used TAP, sent pre-made comments
- Teacher 2: Used TAP, sent their own comments
- Teacher 3: Used TAP, modified comments
- Teacher 4: Did not use TAP, supported students with comments or gave other



"The information that the TAP gave me was good to show the general pulse of what my students were thinking… another common thing… highlighted via the TAP is that they weren't using specific data points, so I was able to ask them 'What happened at this generation?'"

"The first feature I noticed was that breakdown for what ideas students have and what they need help understanding… It even highlighted the DCI and SEP, which was very helpful for my understanding that they were actually making progress towards those essential standards."

Teacher Design-Based Research: Teacher Action Plan Year 2



- Remote instruction with synchronous Zoom sessions
- Used NLP scoring to automatically branch students to support activities for targeted guidance
- Teachers reviewed report after students revised and identified ideas or students to provide more support

Teacher responses to the TAP:
- Teacher 1: Used TAP, showed TAP during synchronous Zoom session; walked students through what DCI and SEP scores mean; held discussion about ideas when questions came up
- Teacher 2: Did not use TAP, tried to support students through other channels, emphasized challenge of reaching and engaging students during remote instruction

"I did exactly nothing with that [automated branching]… I didn't even let them know that they had different branches depending on their auto score. I just let that revision stuff kind of work naturally and maybe that could be an explanation for, especially in the Lizards item, I saw a lot more score 4 or 5."

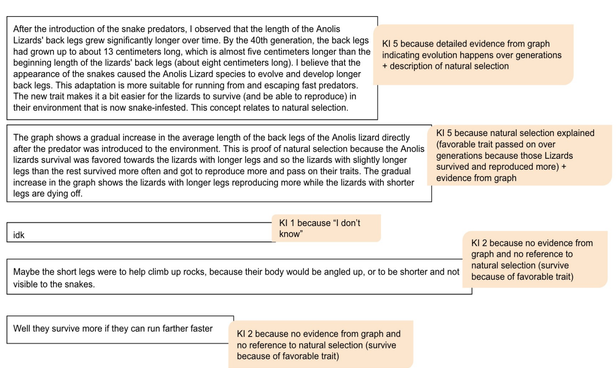
"Having it auto sort made looking at this high level like 'What does my class understand?' feedback a lot easier and then the individual scores I could just identify like, 'OK who are my heroes?' And yeah, they would have already had that intervention and then I can provide extra help when needed."

Report Supports Curriculum Customizations During Professional Development

- During PD, teachers use the TAP and additional logged student work to plan customizations to refine the unit.
- They explore the **KI rubric** to deepen their understanding of the impact of their guidance and the unit.
- They use **Curriculum Visualizer** to plan customizations.

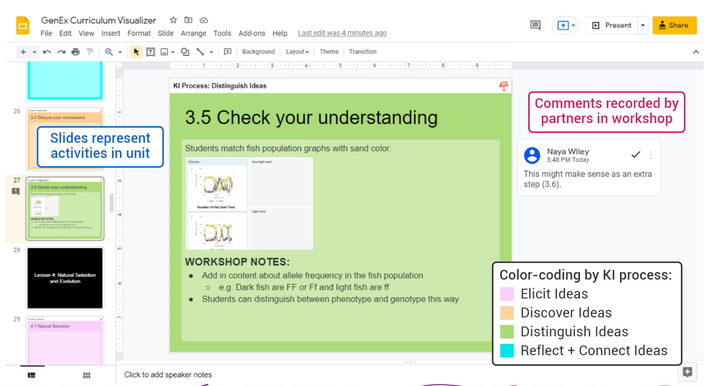
Review of Student Work

- Teachers categorize small sample of student responses using the KI rubric.
- Compare their scores to those of a trained scorer.
- Sparks discussion of NGSS assessments among teachers and researchers.



Curriculum Visualizer

- Each slide represents an activity. Teachers can view full curriculum or zoom in to customize.
- Tool makes it easy to reorder, add, or remove activities or lessons.
- Color-coded slides indicate the KI process activities support. Helps to reflect on the sequence of activities, identify which over- or underrepresented processes.



Customization Goals and Moves During PD

- Teacher PD with 23 participating teachers.
- Most common customization goals were "refining content" and "increasing accessibility".
- Most common customization moves were "adding new activities using the STRIDES unit authoring system" and "modifying existing activities".
- Also common was "adding outside resources". Teachers interleaved STRIDES units with their own teaching practice.
- Number of customization moves per teacher (customizing one unit) ranged from 0-21.

Bichler, Gerard, Bradford, & Linn (2021) in Computers in Human Behavior.

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- Bichler, S., Gerard, L., Bradford, A., & Linn, M. C. (2021). Designing a remote professional development course to support teacher customization in science. *Computers in Human Behavior, 123*, 106814. https://doi.org/10.1016/j.chb.2021.106814
- Gerard, L., Wiley, K., Bradford, A., Chen, J. K., Lim-Breitbart, J., & Linn, M. (2020). Impact of a Teacher Action Planner that Captures Student Ideas on Teacher Customization Decisions. In Gresalfi, M. and Horn, I. S. (Eds.), The Interdisciplinarity of the Learning Sciences, 14th International Conference of the Learning Sciences (ICLS) 2020, Volume 4 (pp. 2077-2084). Nashville, Tennessee: International Society of the Learning Sciences.