



STORYLINES EFFICACY IN HIGH SCHOOL BIOLOGY

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FOCUS QUESTION

Does a biology storyline curriculum increase student engagement and comprehension of the Next Generation Science Standards (NGSS) concepts when compared to a traditional linear-unit curriculum?

BACKGROUND

Storylining is a curriculum replacement that engages students with a phenomenon and continues to be driven by student-generated questions. Concepts are spiraling in nature and are revisited in ever-increasing depth as the curriculum unfolds.

CONTEXT

This project was conducted at Billings Central Catholic High School (BCCHS) in Billings, MT. BCCHS has a population of slightly over 300 students. Students at BCCHS typically take biology as freshmen. This project looked at data from 154 biology students over the course of two years.

METHODOLOGY

The first year followed a conventional linear-unit curriculum. Storylines were introduced during the second year. At the end of each year, students completed the NWEA MAPS 9-12th Grade NGSS Life Science computerized test. Students also completed two surveys, one to assess student perceived abilities in the NGSS Science and Engineering Practices on a Likert rating scale while the other survey was verbal to gather student impressions on engagement and concept retention.

Question	Activities to help answer	NGSS Cross-cutting concepts (ECS) and Science and Engineering Practices (SEPs) that were emphasized	What we figured out (vocab, diagrams, concepts)
What causes albinism? Is it genetic?	- Intro Video - Genetics Notes - Amoska Sisters - Bikini Bottom us - Pipe Cleaner Babies	- Cause-effect patterns - Analyze data using math	DNA Punnett Square Dominant (D) Recessive (d) Homozygous (DD) Heterozygous (Dd) Gregor Mendel
What type of inheritance pattern causes albinism? Autosomal recessive?	- Amoska sisters "pedigree" - Pedigree us - Albinism pedigree - Helena's Story	- Patterns develop use models - Constructing explanations	Chromosomes Variation Gene Genotype (BB) Phenotype (brown) Sex-linked traits Pedigrees Carriers Autosomal and sex-linked
What determines traits? DNA → Protein	- Protein Synthesis Foldable - "A's" = DNA team + B's = us - Codons Practice - Alien Artwork pods	- System models - Structure + function developing + using models	Ribosome tRNA mRNA amino acids codon anti-codon Transcription translation

Figure 4. An example of a storyline tracker that students used to connect driving questions to NGSS components and prompt the next question in the storyline.

DATA ANALYSIS

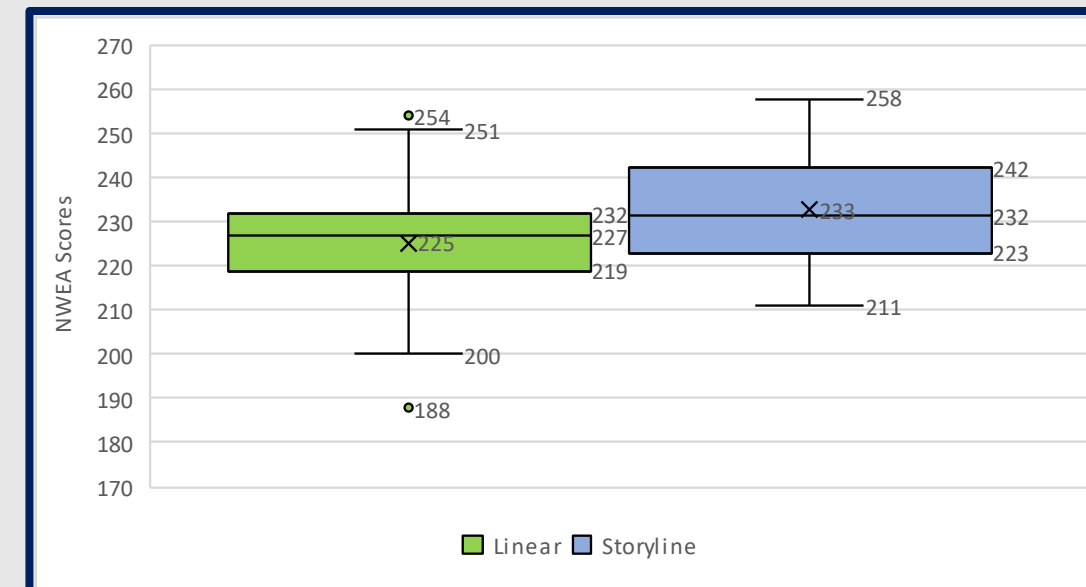


Figure 1. Student NWEA MAPS test scores, (N=154).

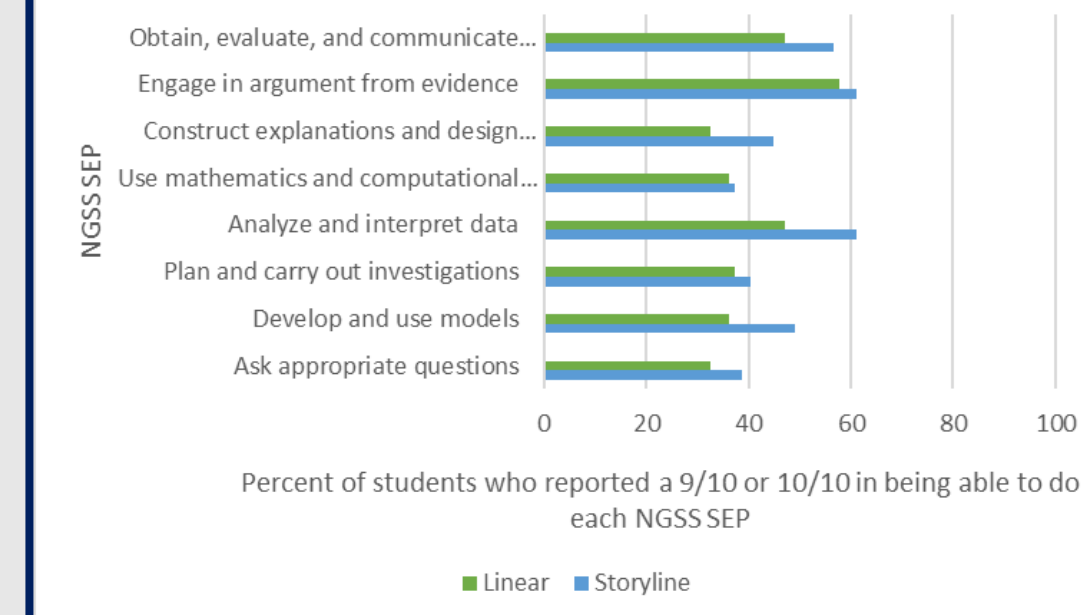


Figure 2. NGSS Science and Engineering Practices student survey results, (N=154).

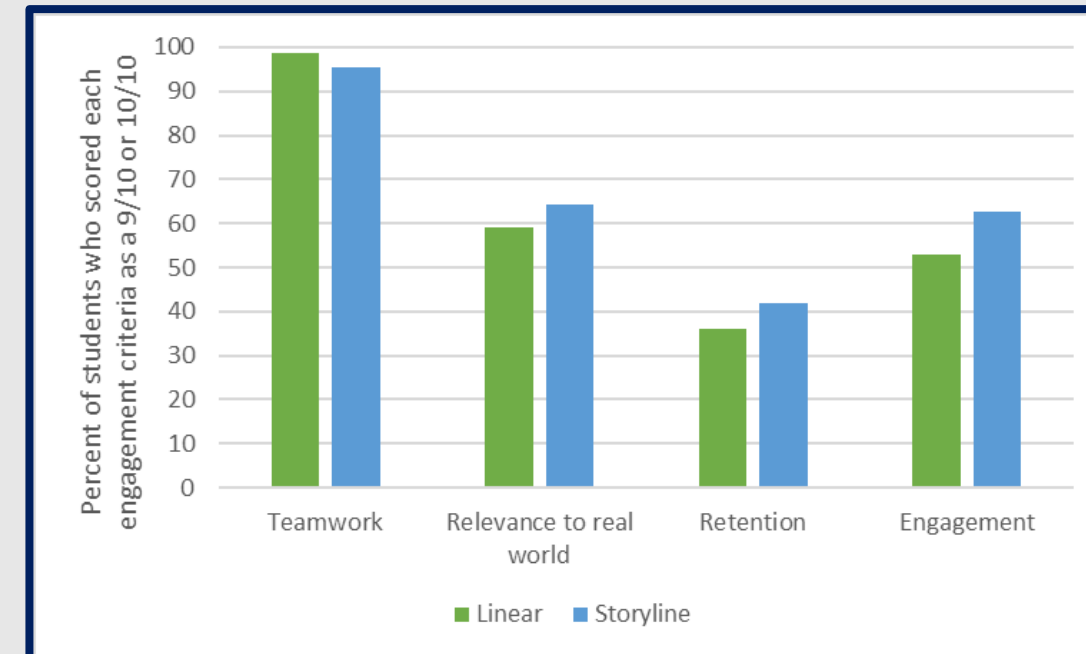


Figure 3. Engagement student survey results, (N=154).

Students in the storyline curriculum scored an average of seven points above the students who used the linear-unit curriculum on the NWEA MAPS 9-12 Life Science Test. Storyline scores also showed a higher maximum and minimum score (Figure 1).

Results from the End of Course Student Survey showed that students who used the storyline curriculum reported a higher perceived ability to do all eight of the NGSS Science and Engineering Practices, with the highest score in the ability to analyze and interpret data (Figure 2).

Students in the linear-unit and storyline curriculum reported almost equally in teamwork skills, while storylines showed higher results in relevance to the real world, retention, and overall engagement with the material (Figure 3).

RESULTS

Students reported overwhelming support for storylines. Storylines showed higher scores in comprehension, engagement, and coherence while providing students with an authentic learning experience connected to real-world data.

"(Storylining) was more intriguing and you could see the connections easier."

"Storylines used things that we could see in the world right now."

"I liked that storylining wasn't random and that it brought up subjects that we had learned all year."

Student Comments

CLAIM – EVIDENCE – REASONING

There is a strong relationship between the use of storylines and student comprehension and engagement. The data shows that storylines increased both of these while also increasing students' sense of coherence. Students could see how each phenomenon was related to other concepts in biology and then apply that to future scenarios. Each storyline hooked students with a relevant phenomenon, clearly connected previously learned concepts to new material, unfolded in a way that allowed students to create coherence in their own mental framework, and applied the NGSS Science and Engineering Practices to empower students to effectively work with real-world data.

Phenomenon-driven Storylines: A full biology course curricular replacement

AFRICA STORYLINE		How do animals obtain the energy they need? (LS1.C)				How do populations change over time? (LS3.B/LS4.B)				How can species live together? (LS2.A/LS4.C)						
Why do some animals live in groups? (LS2.D)	Introducing The Anchoring Phenomenon (Lion group hunting)	Energy cost benefit analysis (Kilocalorie needs)	Relatedness within prides (Parentage – shared alleles)	Relatedness between populations (Geography & genetics)	Food web design	Energy pyramid construction	Animal nutrition data exercises	Comparing macromolecule digestion	Food chain design based on animal nutrient requirements	Nutrients as limiting factors	Investigative phenomenon (Tusklessness)	Human impacts on populations (CSI Wildlife)	Values of Wildlife	Solutions to human impact problems: Conservation efforts	Niche Partitioning	Elephants shape ecosystems (Elephant Poop Lab)
How do organisms grow and develop? (LS1.B/LS1.C)		Plant growth over time (mitosis)		Photosynthesis data points	Cell respiration by plants and animals	Summative Assessment										
HOMEOSTASIS STORYLINE				How have humans impacted the ecosystem and its communities? (LS4.D)				How does homeostasis maintain balance in ecosystems? (LS2.B)								
How are organisms interdependent within their environment? (LS2.A)		How have humans impacted the ecosystem and its communities? (LS4.D)		How does homeostasis maintain balance in organisms? (LS1.A)		How does homeostasis maintain balance in cells? (LS1.A)										
Introducing the Anchoring Phenomenon (Disappearing sea otter)	Importance of the keystone species in an ecosystem	Role of the keystone species	Abiotic factors that affect ecosystem	Carrying capacity and ecosystem stability	Sea urchin variation and natural selection	The role of the sea urchin and human impact (acidification)	The role of carbon in the ocean ecosystem (CO2 testing & the role of kelp as producer)	The role of oxygen in the ocean ecosystem – effects on pH	Direct and indirect impacts of humans on ecosystems	The role of transport in homeostasis – Egg lab (diffusion)	Calcification and its role in homeostasis	The cycling of matter: Carbon & nitrogen cycles				
How do traits occur in organisms? (LS3.A)		What makes one trait different from another trait? (LS3.B)		How are proteins used by organisms? (LS1.A)		How do genotype and phenotype impact natural selection? (LS4.B/LS4.C)										
Introducing the Anchoring Phenomenon (Albino poaching in Tanzania)	Pedigree & Punnett square analysis: Dominant vs. recessive traits	Punnett square analysis: Alleles from parents that determine traits	Karyotype analysis: From whom chromosomes come	Transcription & translation (Albinism lab)	Types & effects of mutations: Proteins & phenotype (Albinism lab)	Protein modeling: Amino acids, polypeptide chains, folding	Investigative phenomenon (Melanin function)	Skin tone & geography data points	Predict how skin color evolved based on data sets (HHMI UV map)	Rock pocket mouse activity: Selective pressures	Rock pocket mouse: Gene mutations & phenotype	Rock pocket mouse: Effect of environment vs. effect of mutation on color	Summative Assessment			

Figure 5. A portion of the storyline curriculum.