PALEOTEACH: STEM INTEGRATION THROUGH PALEONTOLOGY & 3D TECHNOLOGY FOR K-12 EDUCATION

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INTRODUCTION

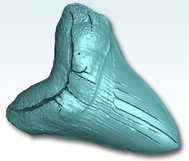
- PaleoTEACH is a collaboration involving the Florida Museum of Natural History, Duke University, and science educators.
- The goal is to create curricula using high-quality 3D models for a K-12 audience.
- Fossils are oftentimes delicate or rare, and not universally suitable for classroom use. Therefore, 3D scanning and printing technology provides a unique opportunity to make these specimens available for K-12 education.
- Paleontology is an interdisciplinary and engaging area of study that provides distinctive opportunities for STEM integration.
- STEM integration is an instructional method that aims to emphasize the connections between **Science**, **Technology**, **Engineering**, and **Math**.
- This method helps introduce concepts in these subjects in a way that is more meaningful to students and it also replicates the way science is practiced.
- Students can acquire 21st century skills and improve STEM literacy when they understand relationships between disciplines and can apply these relationships to real life experiences.
- Instruction through STEM integration and connection to real life issues is more relevant to students and therefore, increases motivation, self-efficacy, college readiness, and potentially promotes interest in science careers.
- PaleoTEACH advances our understanding of the potential efficacy of the recently developed 3D scanning technology in K-12 science learning.
- This approach to integrate 3D technology can improve the relevance of educational practices in our schools and broaden the impact of ongoing digitization efforts of paleontological research collections.
- Lessons that we have developed are rooted in the idea of STEM integration.
- Lessons have been designed to teach concepts of extinction, evolution and climate change (science) through the use of 3D printed teeth and 3D models (technology), applying concepts of geometry & data analysis (math).

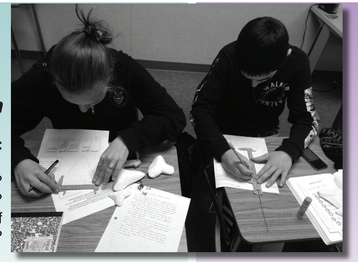
EXTINCTION & EVOLUTION

Carcharocles megalodon

Driving Questions:

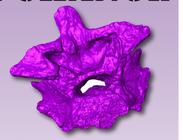
How big was Megalodon and how it might have become extinct?
How could scientists determine the length of Megalodon using fossil teeth?
How do scientists use modern sharks to help them gain understanding of fossil sharks?





CLIMATE CHANGE

Titanoboa cerrejonensis
Eunectes murinus



Driving Questions:

How long was the snake?
Was the size tells us about paleoclimate?
What can we say about the morphology and anatomy?

DIMENSIONS

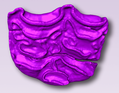
Practices: behaviors that scientists engage in
Cross Cutting Concepts: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change.
Disciplinary Core Ideas: physical sciences, life sciences, earth & space sciences and engineering, technology and applications of sciences.

MATH
Focus: less topics
Coherence: Linking topics and thinking across grades
Rigor: conceptual understanding, procedural skills and fluency, application.

ELA
Scientific Articles I Technical Subjects I Critical Thinking I Societal Issues
21st Century Skills

EVOLUTION & CLIMATE CHANGE

Anchitherium clarencei
Archaeohippus blackbergi
Calippus cerasinus
Calippus elachistus
Dinohippus mexicanus
Equus ferus fraternus
Equus simplicidens
Sifrhippus sandrae
Mesohippus sp.
Nannipus aztecus
Nannipus peninsulatus
Neohipparion eurystyle
Neohipparion trampasense
Parahippus barbouri
Parahippus leonensis

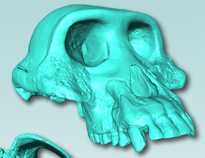


Driving Questions:

What are the changes in fossilized horse teeth in response to co-evolution of plants?
What is the intraspecies variation and changes in a single horse population?
Is there a better way to communicate evolution in museums?

HUMAN EVOLUTION

Pan troglodytes
Australopithecus africanus
Australopithecus boisei
Australopithecus afarensis
Homo habilis
Homo erectus
Homo neanderthalensis
Homo sapiens
Homo heidelbergensis



Driving Questions:

Do these fossils form a sequence?
Which is closest to the chimp?
Which to the human?
Do any other animals seem to show trends of change with climate over time that could receive the same explanation as that you proposed for human fossils?

RESEARCH & METHODS

Online Pre Survey is administered before students are exposed to the STEM integrated activity using 3D technology. Survey has 32 Likert 5-point questions seeking to identify significant information on student's motivation and attitudes towards science education (Velayutham, 2011).

Online Post Survey is administered after students are exposed to the STEM integrated activity in adittion to 5 open-ended questions on perceptions about the technology and content knowledge. I nformation regarding English learners perceptions is especially important since the nature of the activity is mostly visual and we want to know if this helps them better understand the concepts relating to each of the STEM disciplines. Results by gender will be also analyzed.

BROADER IMPACTS

This project has the potential to impact communities of all students, but most importantly, of students predominantly composed of Hispanics and English learners, and other students who struggle with sciences taught in a traditional method where fewer hands-on activities are provided and more memorization is required.

Because of the integrated nature of the instructional design envisioned, we can also increase the engagement of female students in the sciences and technology.

Providing opportunities to experience the integrated nature of STEM disciplines will better preapare K-12 students for the STEM workforce and provide them with 21st century skills and STEM literacy.

INTELLECTUAL MERIT

This project advances our knowledge on STEM integration. There is a great deal of literature on how mathematics can support science education, but there are no significant studies on how technology (Honey, 2014), specifically 3D technology, can support science and math education and how these three disciplines and co-exist together in a K-12 classroom setting.

In addition, the study advances our knowledge on student and teacher roles and to what extent these are shifting in a technology-based society. How much of the use of 3D technology can be student-lead versus teacher lead? These are questions that can only be solved with exploratory research through pilot activities.

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