Using Human Examples to Teach Evolution

BRIANA POBINER

SSE CONFERENCE

JUNE 24, 2017

DRK-12

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Science Denial

OP-ED CONTRIBUTOR

Welcome to the Age of Denial

By ADAM FRANK
Published: August 21, 2013 | 759 Comments

ROCHESTER — IN 1982, polls showed that 44 percent of Americans believed God had created human beings in their present form. Thirty years later, the fraction of the population who are creationists is 46 percent.

Live Science › Human Nature

Evolution, Climate and Vaccines: Why Americans Deny Science

By Stephanie Pappas, Live Science Contributor | January 21, 2017 05:30pm ET

On the Scene

ON THE SCENE HUMANS & SOCIETY

Science denial in the 21st century

BY NATHAN SEPPA 5:39PM, APRIL 24, 2012

POLITICS
→ Science, Top Stories

Page 1 of 4

The Science of Why We Don't Believe Science

How our brains fool us on climate, creationism, and the vaccine-autism link.
—By **Chris Mooney** | May/June 2011 Issue

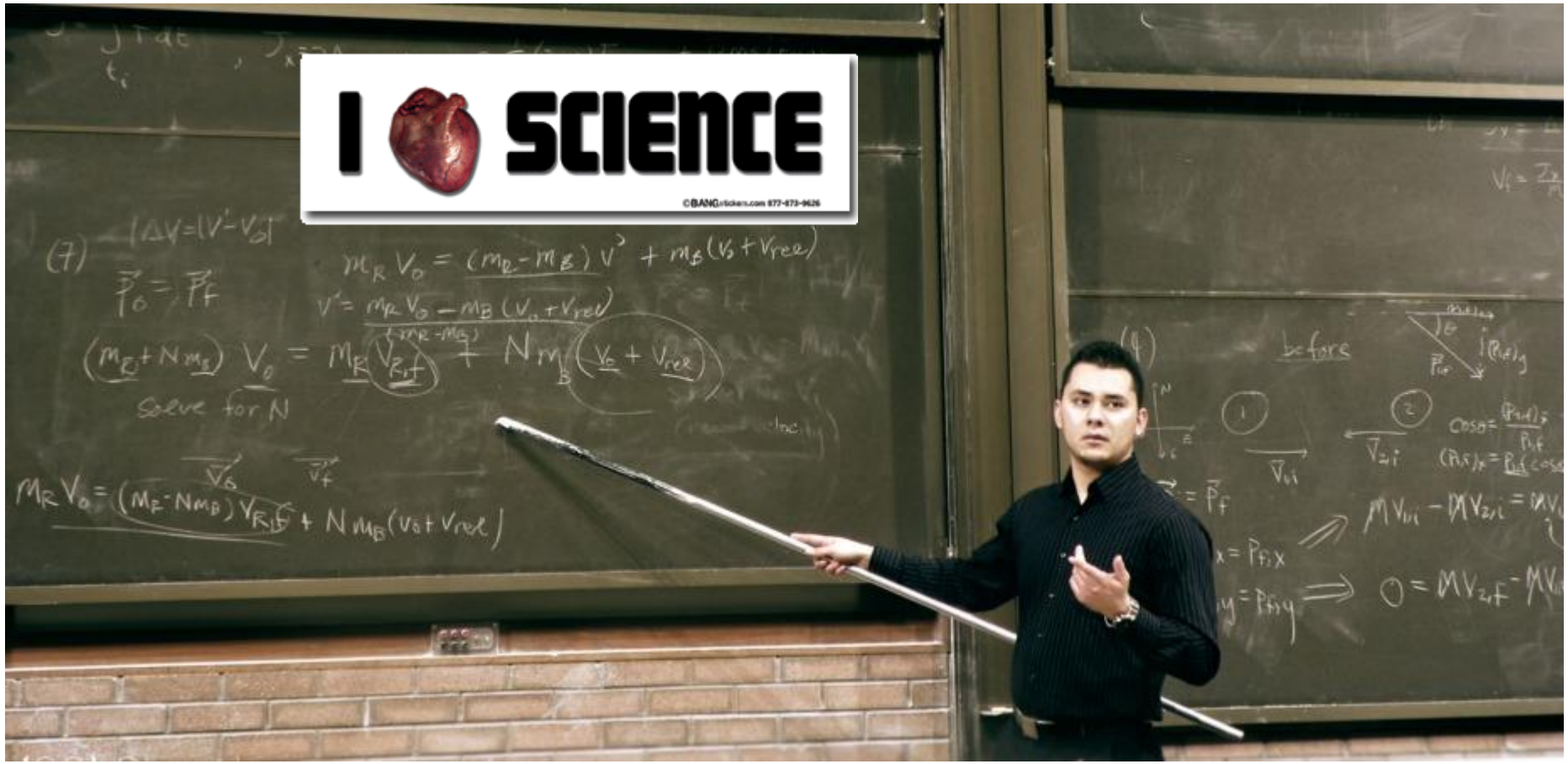
Public Trust in Scientists: HuffPost-YouGov poll (Dec 2013)

36% of Americans have a lot of trust that the information they get from scientists is accurate and reliable

78% of Americans think information reported in scientific studies is often or sometimes influenced by political ideology

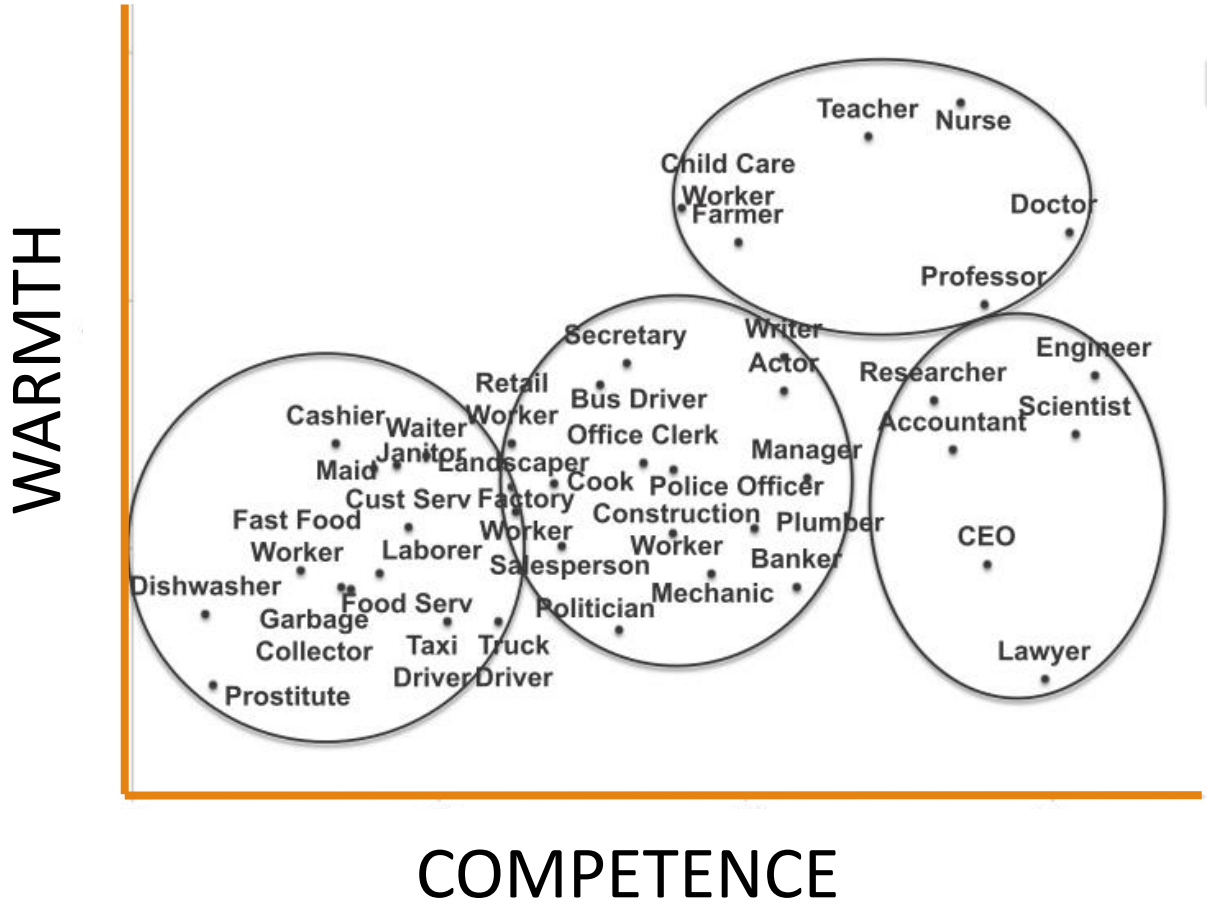
82% of Americans think scientific findings are often or sometimes influenced by the companies or organizations sponsoring them

Information Deficit Model



Expression/Word	What Scientists Mean	What the Public Hears
Theory	Scientific understanding or prediction	Hunch, speculation
Bias	Systematic error that could lead to mistaken conclusion	Not having an open mind
Error	Difference from exact true number	Mistake, wrong, incorrect
Enhance	Intensify, increase	Improve
Plausible	Theoretically possible	Likely, probably true
Safe	Insignificant risk	No risk
Significant	Not due to chance	Important, real
Not significant	Due to chance	Unimportant
Manipulation	Scientific data processing	Illicit tampering
Values	Numbers, quantity	Ethics, monetary value
Positive feedback	Self-reinforcing cycle	Praise, good response
Positive trend	Upward trend	Good trend
Negative trend	Downward trend	Bad trend
Anomaly	Change from long-term average	Abnormal occurrence

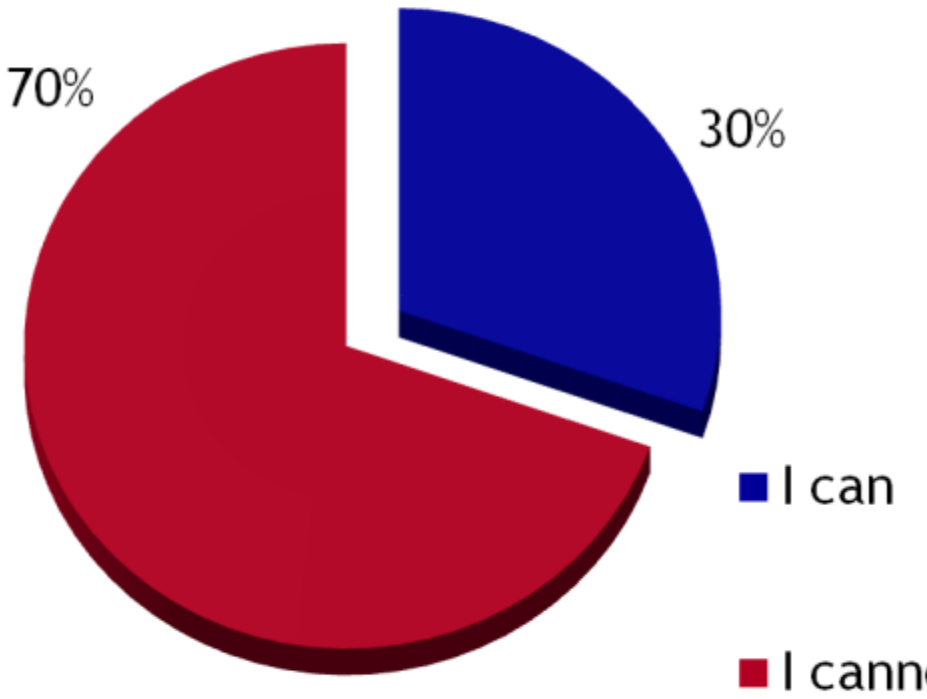
Universal Dimensions of Social Cognition: Warmth and Competence



Fiske, Cuddy, & Glick, 2007
Trends in Cognitive Sciences

Most Americans Can't Name a Living Scientist

Please name a living scientist.



Stephen Hawking	43%
Neil Degrasse Tyson	6%
Bill Nye	5%
Jane Goodall	5%
James Watson	3%
Richard Dawkins	2%
Michio Kaku	2%
Mehmet Oz	1%
Other	33%

Source: A Research!America poll of U.S. adults conducted in partnership with Zogby Analytics, with support from the American Society of Hematology, in November 2013.

The survey has a sample size of 1,000 U.S. adults with a theoretical sampling error of +/- 3.2%

Zogby Analytics

RESEARCH AMERICA
AN ALLIANCE FOR DISCOVERIES IN HEALTH

Science Storytelling

ONLY HUMAN: October 1, 2012

Why More Scientists Should Tell Stories

by Virginia Hughes

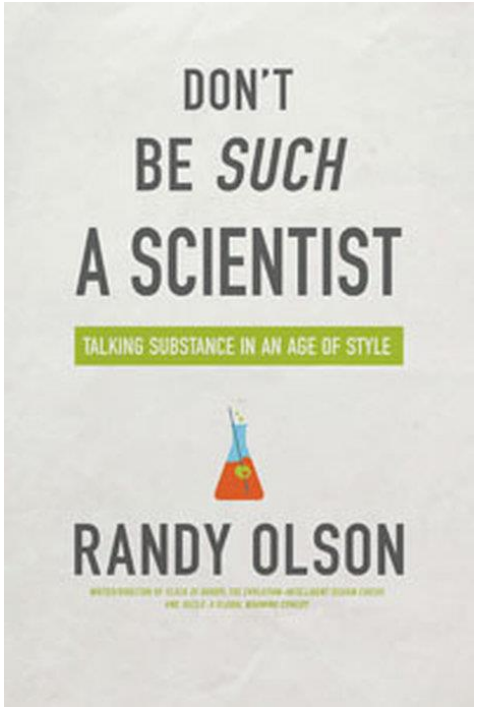
Scientists aren't very good at telling stories.

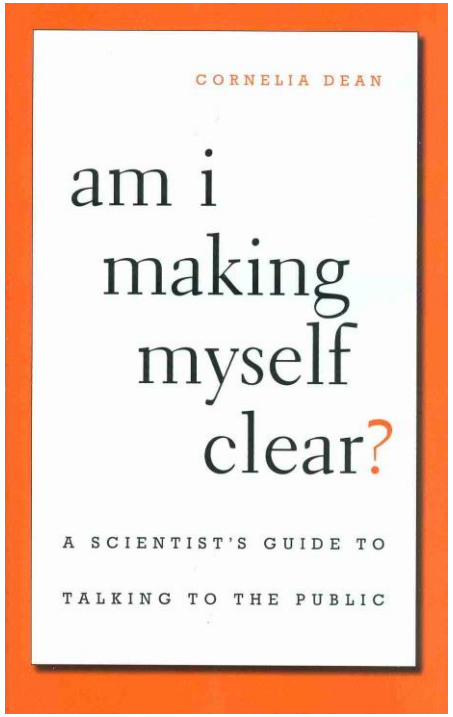
Posted on October 1st, 2013 by Laura

Video submission invitation — Science Storytelling Workshop

Science Storytelling Workshop: Video-making Tips and Tools

Sun., 8 Dec., 3:30 P.M. – 5:30 P.M.
San Francisco Marriott Marquis – Salon 4



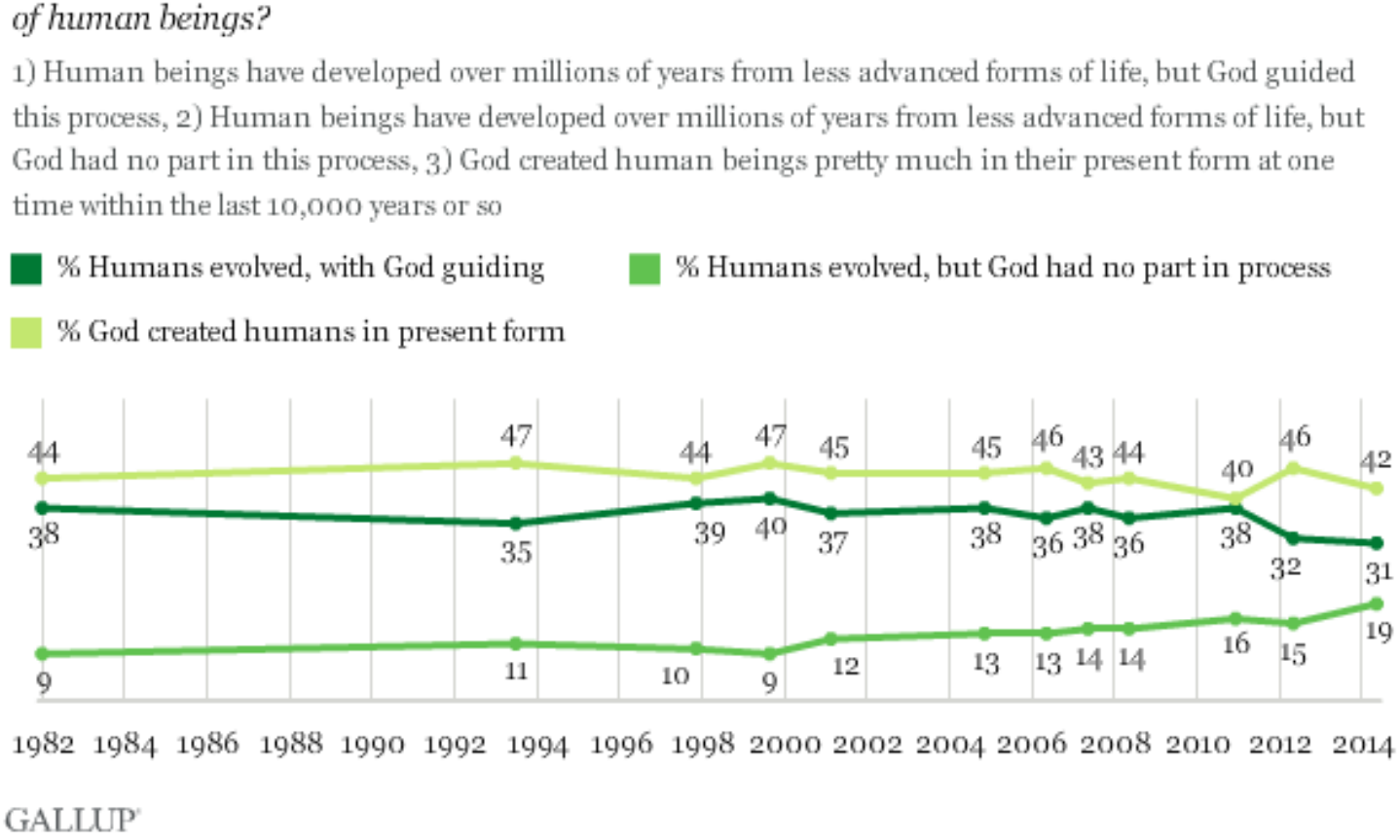


Human Evolution Research is Exciting!

But… US Acceptance of Human Evolution is Low

Which of the following statements comes closest to your views on the origin and development of human beings?

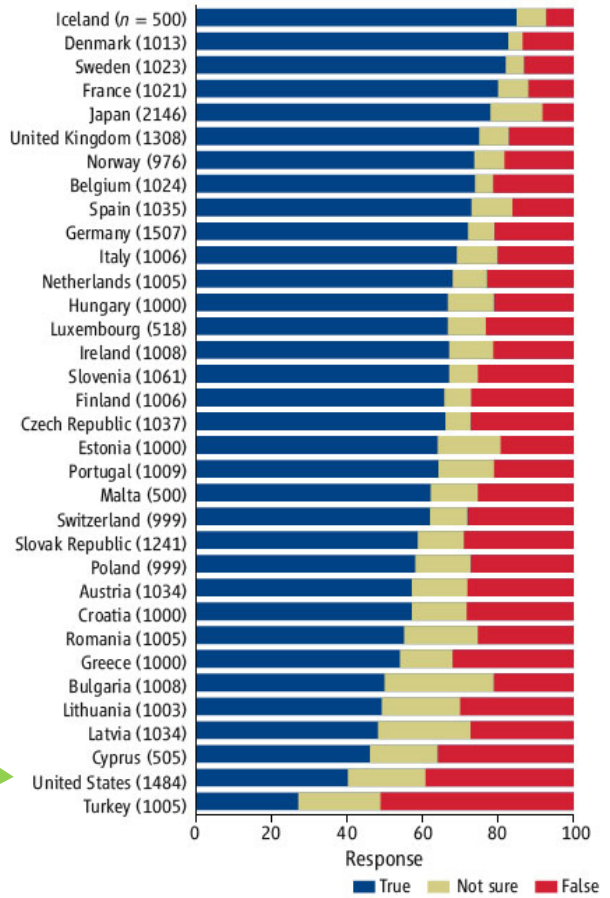
1) Human beings have developed over millions of years from less advanced forms of life, but God guided this process, 2) Human beings have developed over millions of years from less advanced forms of life, but God had no part in this process, 3) God created human beings pretty much in their present form at one time within the last 10,000 years or so



GALLUP

But… US Acceptance of Human Evolution is Low

"Human beings, as we know them, developed from earlier species of animals."

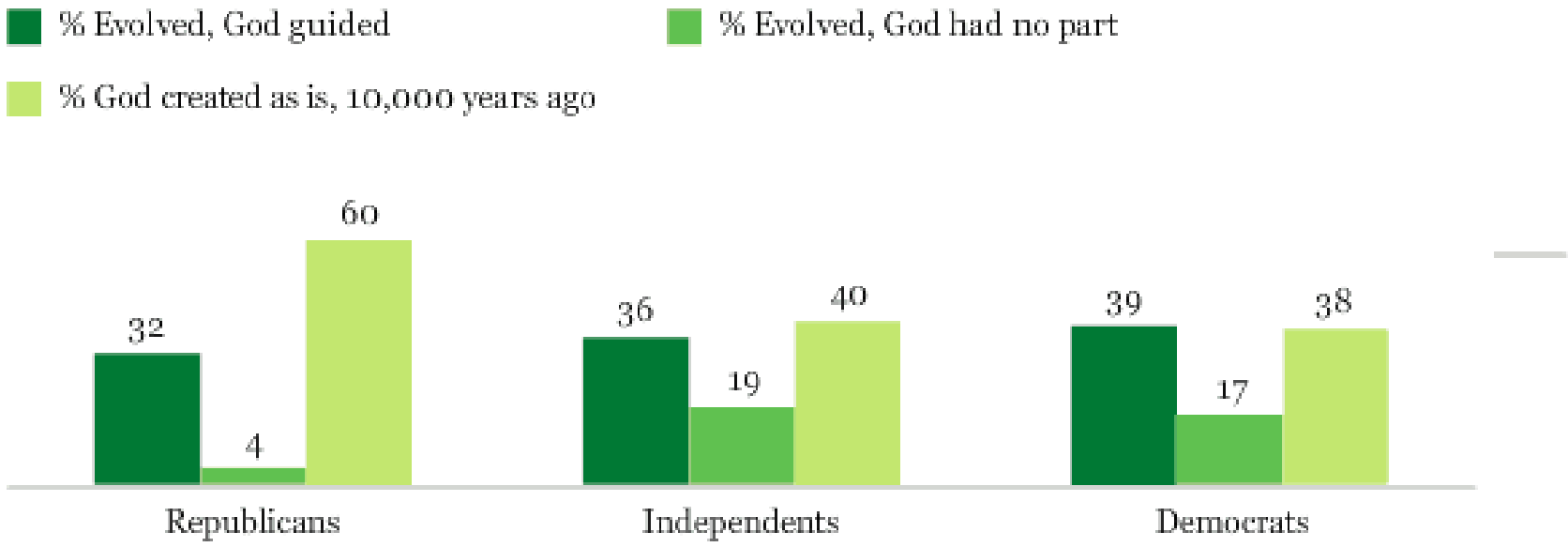


Public acceptance of evolution in 34 countries, 2005.

Factors: Education, Age, Religiosity, Politics…

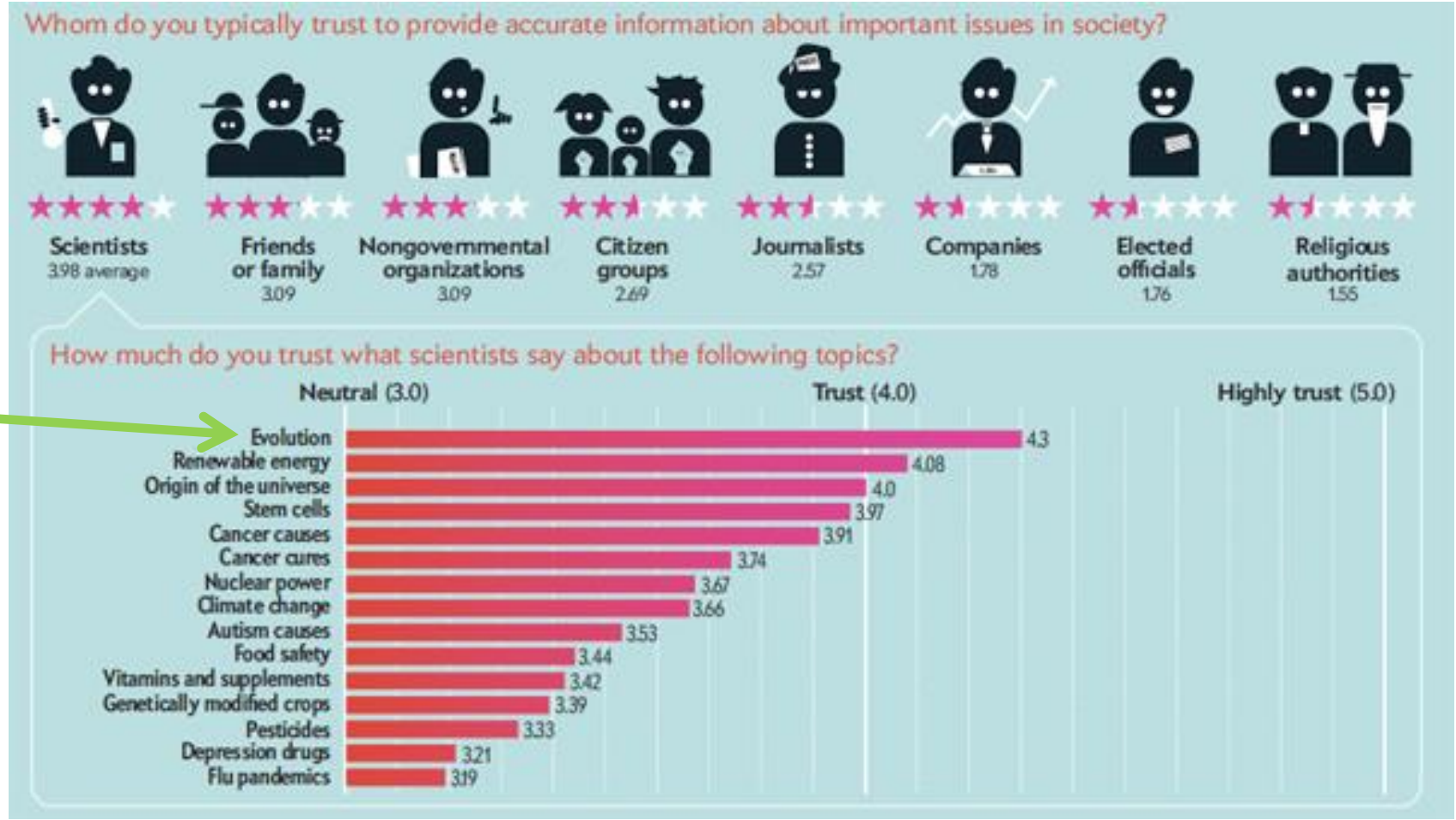
Which comes closest to your views: 1) Humans developed over millions of years, God guided, 2) Humans developed over millions of years, God had no part, 3) God created humans as is within the last 10,000 years

By party ID

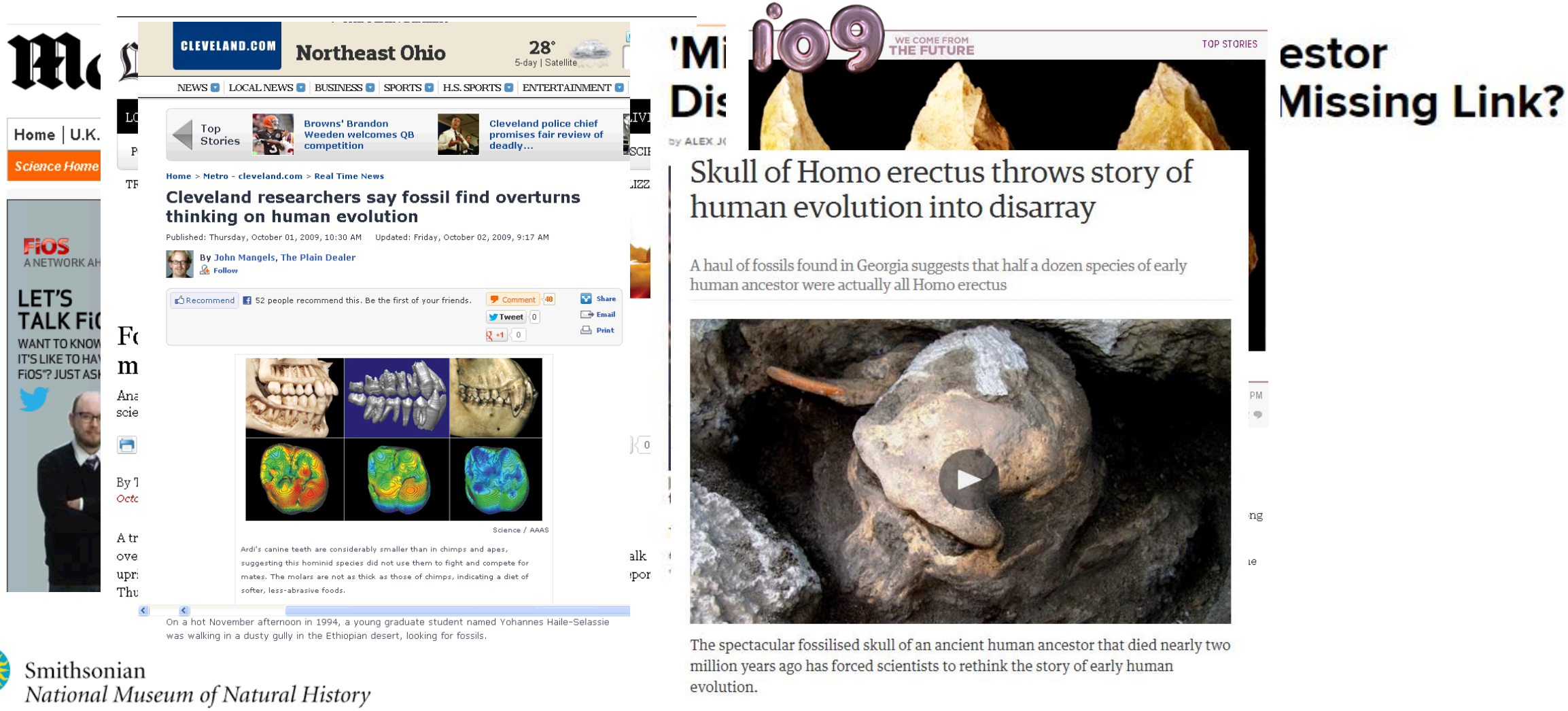


GALLUP POLL

But… Scientists are Highly Trusted about Evolution



It's the Media's Fault:
Every Discovery Overturns Everything We Know



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The Science of Why We Don't Believe Science

How our brains fool us on climate, creationism, and the vaccine-autism link.

CHRIS MOONEY MAY/JUNE 2011 ISSUE

Head-on attempts to persuade can sometimes trigger a backfire effect, where people not only fail to change their minds when confronted with the facts—they may hold their wrong views more tenaciously than ever.

"Conservatives are more likely to embrace climate science if it comes to them via a business or religious leader, who can set the issue in the context of different values than those from which environmentalists or scientists often argue. "

"If you want someone to accept new evidence, make sure to present it to them in a context that doesn't trigger a defensive, emotional reaction."

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the Cultural Cognition Project at Yale Law School

Dan Kahan

Problem

- Scientists and science education organizations overwhelmingly accept evolution
- Only 20% of high school students, 52% of college graduates, and 65% of postgraduates accept evolution (Brumfield, 2005)
- There are myriad cognitive, affective, pedagogical, epistemological, political, social, and religious factors that contribute to an anti-evolutionary worldview
- Cultural and religious objections by some to the teaching of evolution can negatively impact students' willingness to engage the topic

TEtHE (Teaching Evolution through Human Examples) Project Hypothesis

Using human examples to teach evolution will increase students' understanding and acceptance of evolution.

Meaningful and Relevant?

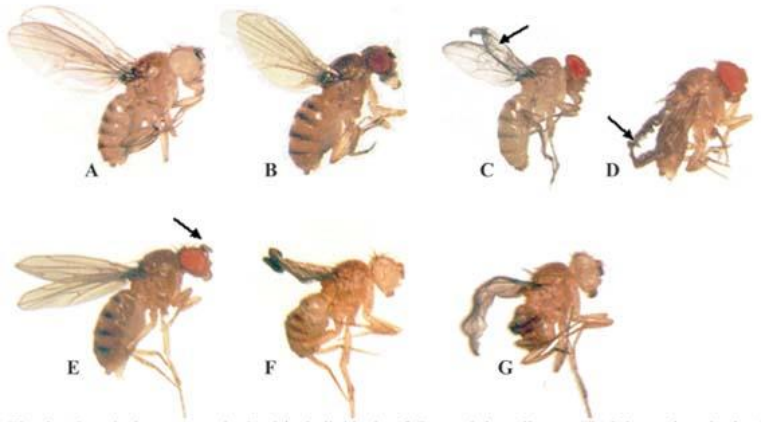


Fig. 2. Altered phenotypes obtained in individuals of *Drosophila willistoni* 17A2 isostrain submitted to temperature stress. Picture shows female individuals with altered morphologies: A. *white* (white eyes); B. *sepia* (brown eyes); C. *blistered* (arrow indicates the presence of blisters on the wings); D. *Curly* (curved wings indicated by the arrow); E. with apparently fused antennae (indicated by the arrow) - see figure 5 for details of the mutant structure; F. Female *white* and *Curly*; G. *white* and *blistered*.

Project Personnel



PI: Briana Pobiner (Smithsonian)
Co-PI: Rick Potts (Smithsonian)
Co-PI: Bill Watson (ex-Smithsonian, now Camden Catholic Schools)

Senior Personnel:
Paul Beardsley (Cal Poly Pomona) – Curriculum developer
Connie Bertka (Science & Society Resources) – CRS Resource developer

Key Partners:
Jay Labov (National Academy of Sciences)
Chris Lazzaro (College Board)

External Evaluator:
Race & Associates

Previous Research: Understanding Evolution (College Level)

- Helping students make connections between the subject matter they are learning and personal experiences or "real-world" examples can result in deeper learning (e.g., National Research Council, 2000, 2003, 2005, 2007, 2009)
- Including humans along with the rest of life increases students' interest in and acceptance of evolution (Wilson 2005)
- Biology and non-biology majors prefer science courses in which human examples are included in a comprehensive discussion of evolution (Paz-y-Mino and Espinosa 2009)
- Framing evolutionary scenarios in terms of humans produced fewer conceptual errors than framing logically identical scenarios in terms of other animals (Nettle 2010)
- People can see variation from one person to another more easily than variation among animals (Nettle 2010)
- Students who appreciate the extent of individual-level variability are more likely to have a correct mechanistic grasp of natural selection (Shtulman and Schulz, 2008)

Previous Research: Attitudes Towards Evolution

- Many students hold worldviews that preclude acceptance of biological evolution
- Students are unlikely to learn about evolution until these issues are explicitly addressed
- Acknowledging the controversy and fostering positive dialogue may be the most effective instructional methods for teaching evolution as a controversial issue

Project Goals

1. Create and field test a set of human evolution-centered constructivist, guided inquiry ***curriculum mini-units*** that align with AP Biology learning objectives, are scientifically rigorous and accurate, and relevant to students
2. Create and field test set of cultural and religious sensitivity ***teaching resources*** that provide teachers with strategies to create a supportive classroom environment for the teaching of evolution and to support an understanding of the nature of science
3. Evaluate the effect of using the curriculum units ***with and without*** the teaching strategies on student understanding and acceptance of evolution

Project Outcomes

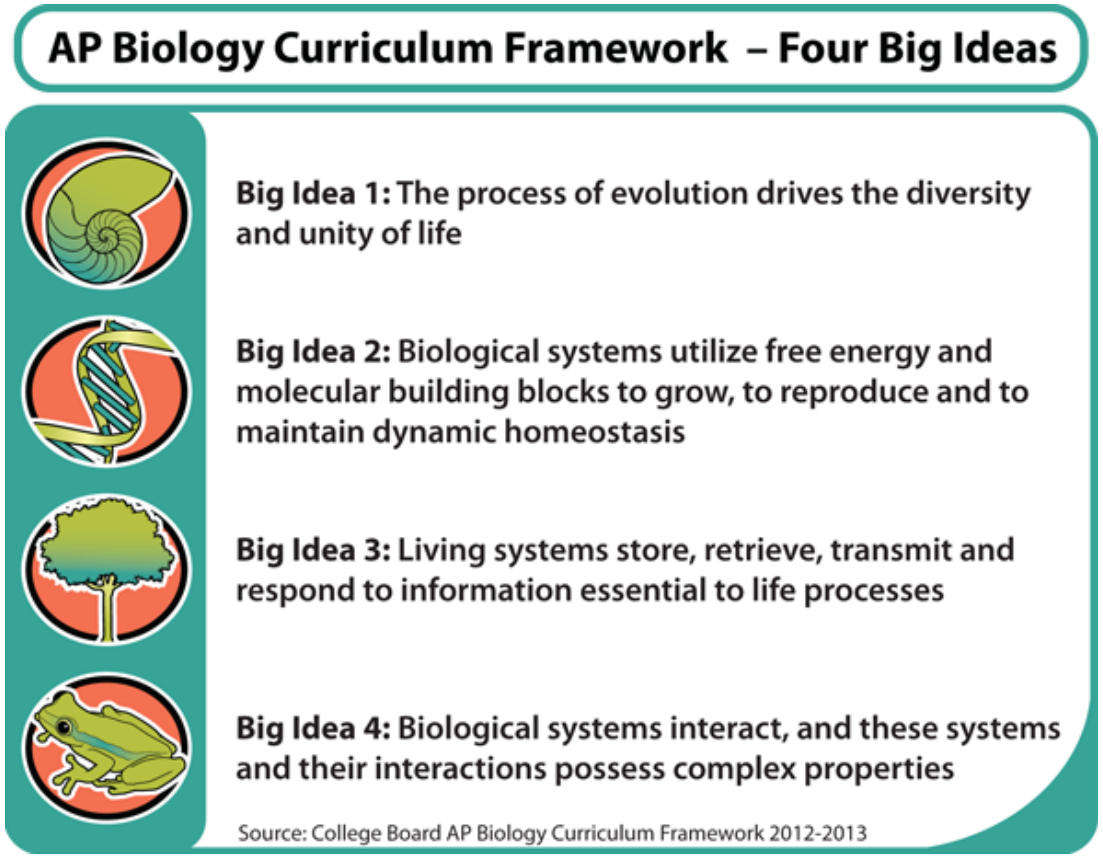
Student Outcomes:

- Increase their understanding of evolution concepts
- Decrease in evolution cognitive biases and misconceptions
- Increase their acceptance in evolution
- Increase their interest in evolution

Teacher Outcomes:

- Increase their confidence in teaching evolution
- Increase their understanding of evolution

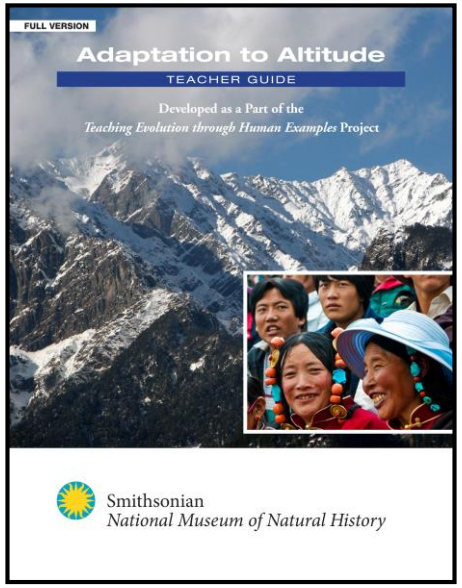
Target Student Audience: AP Biology

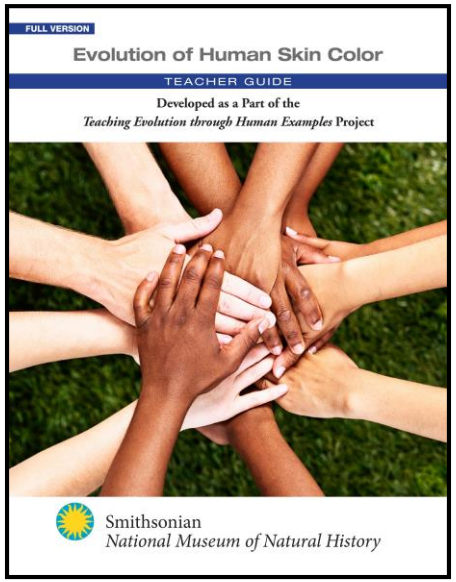


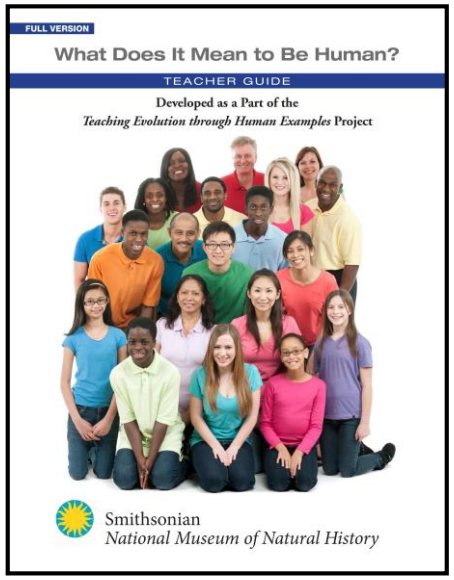
Topic selection:

- Incorporated science content that is sufficiently robust for the potential of sustained use
- Offered a high potential to engage and excite teachers and students because it is relevant to their lives

Curriculum Units: Topics & Pedagogical Approach



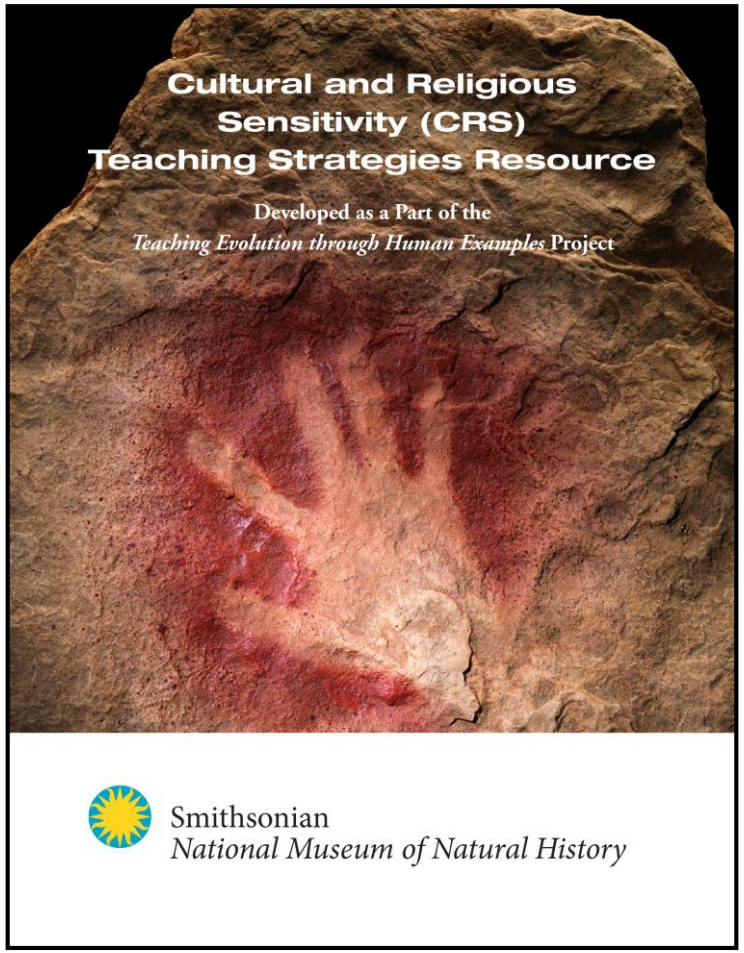




- Constructivist, guided-inquiry that incorporate important components of the nature of science
- Addresses common teacher and/or student prior ideas about evolution when appropriate
- 4-5 lessons taught over 5-9 days, depending on whether the full or condensed version is used

Cultural and Religious Sensitivity (CRS) Teaching Strategies Resource: Purpose

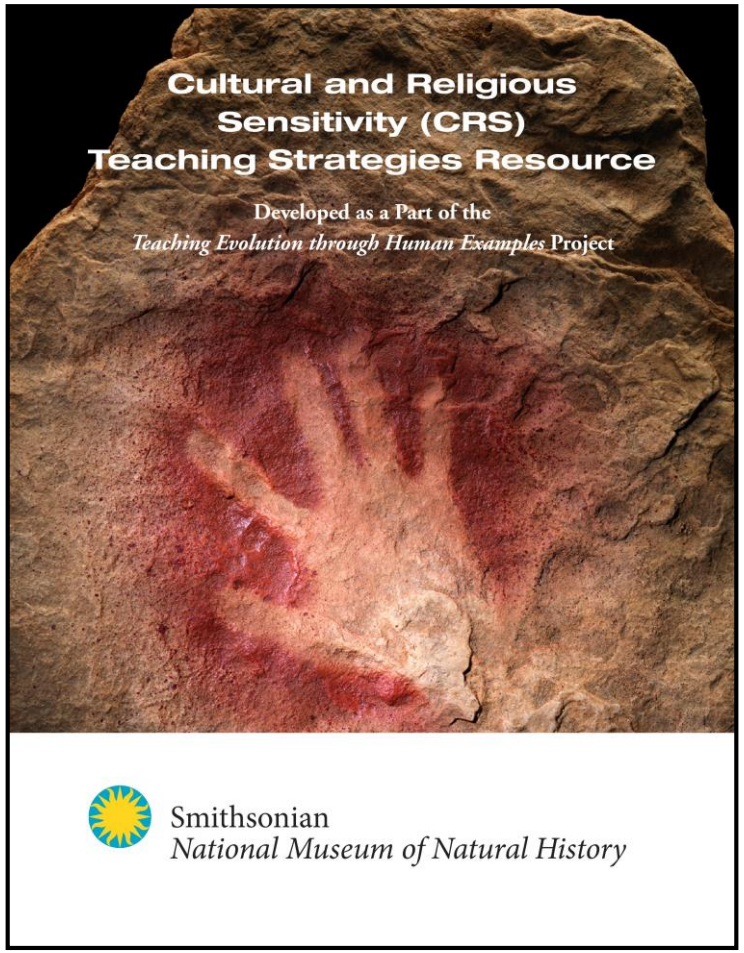
- Encourage and help equip high school teachers to promote positive dialogue around the topic of evolution in their classrooms.
- Create an environment that allows for a greater understanding of science by helping teachers to both acknowledge and manage cultural and religious controversies, as needed, should they arise in the classroom.
- Not to specifically resolve any conflict the student may see between their personal worldview and the scientific account of human evolution, but to help create a non-threatening classroom environment.



Cultural and Religious Sensitivity (CRS) Teaching Strategies Resource: Purpose

Factors in teachers' discomfort:

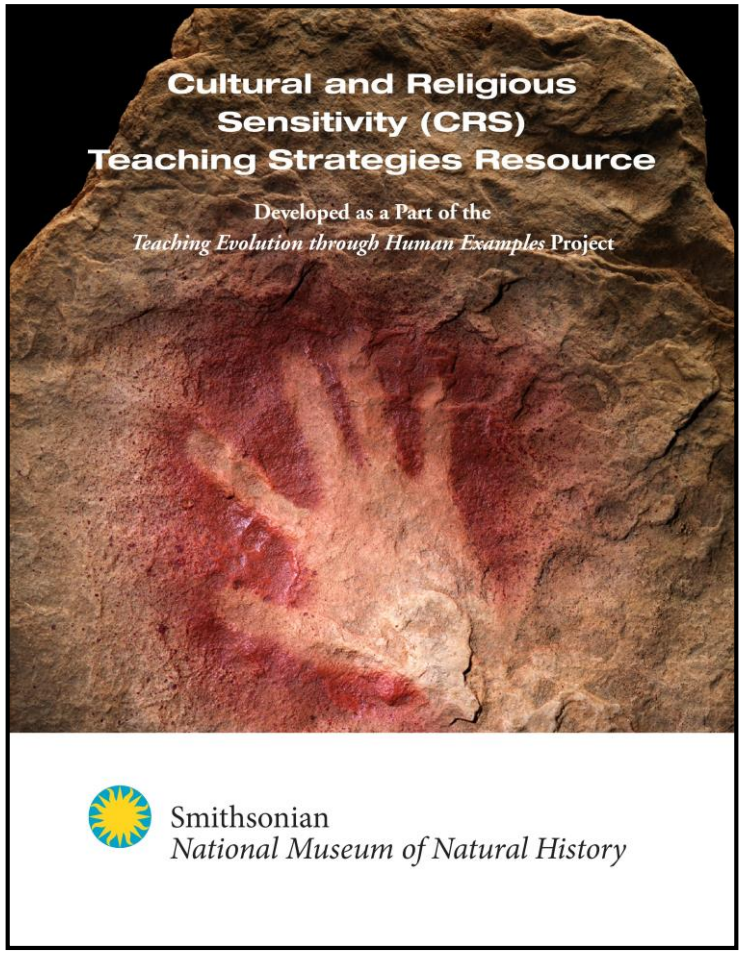
- pressure (from administrators, school board members, colleagues, parents, clergy, other community members, and students themselves)
- negative attitudes and mixed messages from state and local leaders; state, district, and school guidelines, standards, and exams for teaching evolution
- actual or perceived support within the school itself for teaching evolution
- their awareness of the attitudes toward the importance and teaching of evolution in their communities
- their positions in their respective professional communities
- their ideas about teaching and learning
- unfamiliarity with laws about teaching evolution and creationism in science classrooms
- lack of time
- lack of knowledge, training, and preparation to teach evolution
- lack of awareness of available instructional resources
- their own evolution learning experiences



Pedagogical Approach

Hermann, 2008

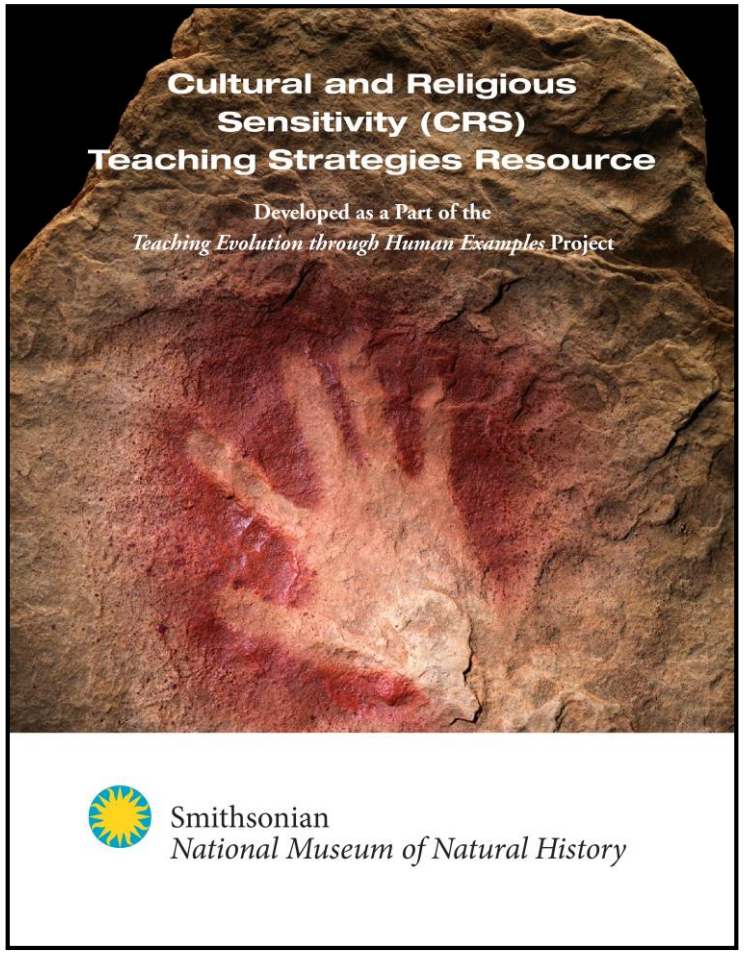
- Advocacy: teacher argues for the position he or she holds
- Affirmative neutrality: teacher presents multiple sides of a controversy without revealing which side he or she supports
- ***Procedural neutrality:*** information about a controversy and different points of view are elicited from students and resource material



CRS Resource: Contents

Part I - Foundational Information: background information to inspire confidence in the teacher's ability to respond to questions about cultural and religious controversies

1. Nature of Science
2. Range of Creationist Beliefs
3. Possible Relationships between Science & Religion
4. Legal Cases Dealing with Teaching Evolution

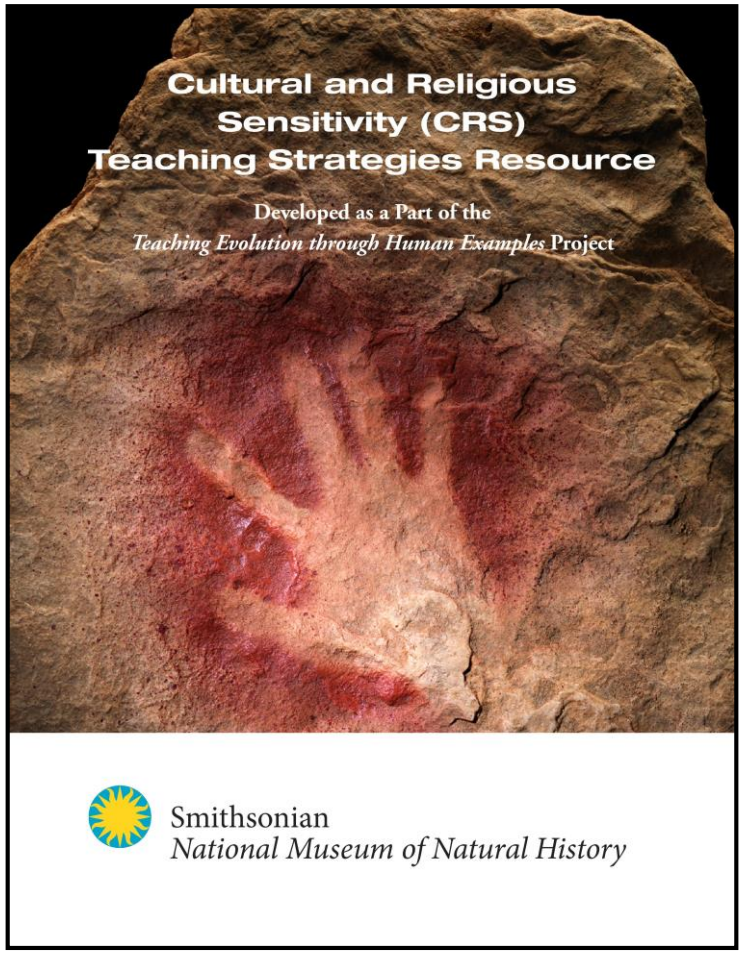


Classroom Activities

- Activity 1: "Directed Discussion: Why Study Evolution?"
  - before evolution curriculum unit
  - in areas with high resistance to learning evolution

Brief description:

- Before the class met, students completed an assignment that provided insight into their current knowledge and concerns about evolution.
- In small group and class discussions students explored the nature of science, possible relationships between science and religious or cultural beliefs, and evolutionary theory as a tool that biologists use to solve problems and construct testable hypotheses.

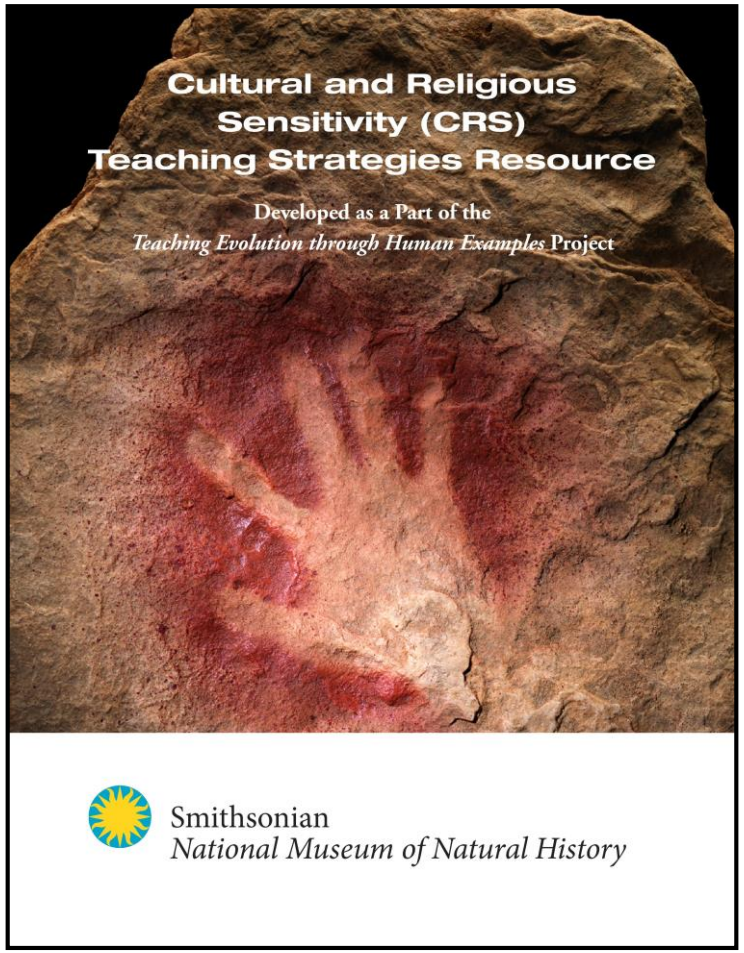


Classroom Activities

- Activity 2: "A Historical Role Play: How Do People Think About Evolutionary Theory?"
  - after evolution curriculum unit
  - in areas with low resistance to learning evolution

Brief description:

- Students were assigned one of eight historical characters and worked in groups to envision how their character would reply to questions about Darwin's theory of evolution.
- Paired character groups worked together to draft both a historical and modern-day response to concerns about evolution highlighted by one of their characters.



National Field Test: 2013-2014 school year

- 10 schools in 8 states: California (2), Connecticut (1), Colorado (2), Maryland (1), New Jersey (1), New York (1), Utah (1), Virginia (1)
- Mix of public/private & urban/suburban/rural
- 320 students field tested curriculum mini-units
- 148 students (6/10 teachers) also field tested one of two CRS classroom activities

Data collection measures: quantitative and qualitative

OUTCOME	QUANTITATIVE MEASURE	QUALITATIVE MEASURE
Student Understanding	(1) ACORNS (Assessment of the Contextual Reasoning of Natural Selection) (2) TTCI (Tree Thinking Concept Inventory)	Student feedback forms
Student Acceptance	GAENE (Generalized Acceptance of Evolution Evaluation)	Student focus groups
Student Interest	Student feedback forms	Student focus groups
Teacher Comfort/Confidence	Teacher Feedback Forms	Teacher Interviews
Teacher Understanding	n/a	Teacher Interviews

ACORNS – Understanding

Nehm et al. 2012

Question 1 (human):

How would biologists explain how individual people alive today who can digest lactose originated within a population of people who were all lactose intolerant?

Question 2 (mouse):

How would biologists explain how some individuals of a mouse species that have claws originated within a population of a mouse species that lacked claws?

ACORNS – Understanding

Nehm et al., 2012

- Key concepts, cognitive biases, misconceptions
- Alpha reliability coefficient: 0.74
- Scores range from 0-6
- Interrater reliability: 0.73
- Repeated measures nested ANOVA
- Immediately before & after curriculum unit

Table 5 Normative and non-normative causal elements scored for in students' evolutionary explanations

Key concepts (normative causal)		Naïve ideas (non-normative causal)	
KC1	Causes of variation	NI1	Need as a goal (teleology)
KC2	Heritability of variation	NI2	Use and disuse
KC3	Competition	NI3	Intentionality
KC4	Biotic potential	NI4	Adapt (acquired traits)
KC5	Limited resources	NI5	Energy reallocation
KC6	Differential survival	NI6	Pressure
KC7	Change over time		

ACORNS – Key Concepts

Nehm et al., 2012

- Variation: presence of variation caused by mutations, genes, or changes in DNA
- Heritability: genes are passed on to the next generation, production of offspring with the same traits, inheritance, heritable
- Competition: competition, struggle
- Hyperfecundity: overproduction of offspring, more individuals born than can survive
- Resource limitations: resources, predation (predator or prey)
- Differential survival: Greater or higher survival, others died off, more fit, advantage of a trait, reproduce more, trait/gene selected for or favored, sexual selection
- Frequency/Distribution: Generational changes in the distribution or frequency of variation, over time, gene or trait became dominant or more common

ACORNS – Cognitive Biases

Nehm et al., 2012

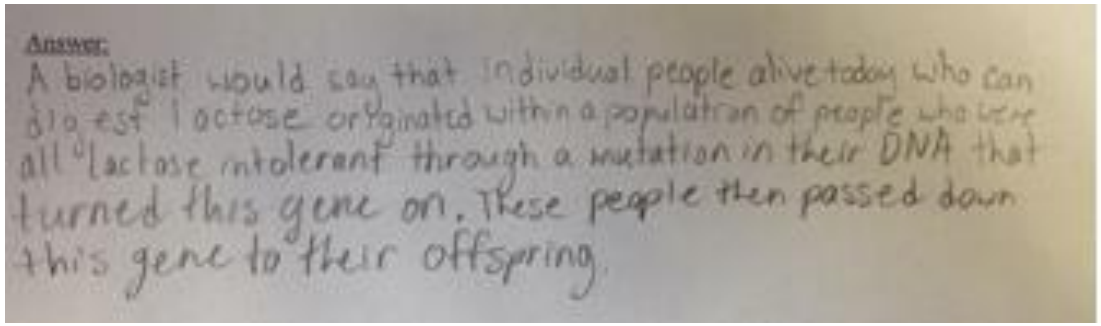
- Essentialism: belief that individuals and groups have an essential nature that allows them to be placed into categories or kinds with sharp, immutable boundaries
- Intentionality: assumes that events may be caused by an intentional mental agent and are purposeful, goal-directed, or progressive, including the idea that evolution is progressing toward an ideal
- Teleology: assumes that the characteristics and actions of entities or groups have a goal or are inevitable and that aspects of an object's or organism's form is explained by its ultimate purpose

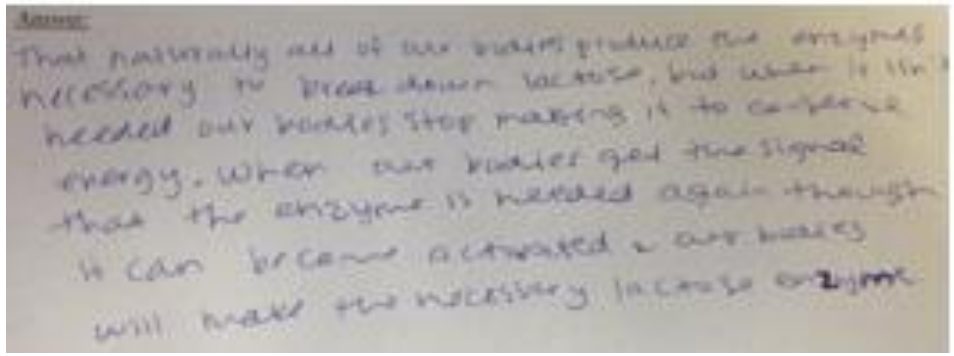
ACORNS – Misconceptions

Nehm et al., 2012

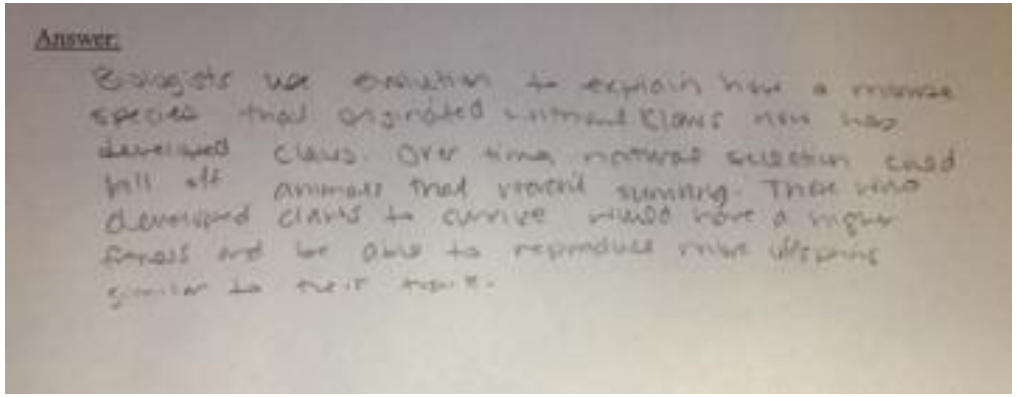
- Pressure: pressure (by an external force) or lack thereof causes a mutation or trait to occur
- Adapt: *individuals* change to adapt to their environment
- Need: need of an organism causing a mutation or trait to occur so it could survive or reproduce, does not include process
- Must: desire or preference of an organism caused a change
- Use: traits changed because they were being intensively used or no longer being used (Lamarckian)
- Energy: energy/resources were reallocated to another trait for better use

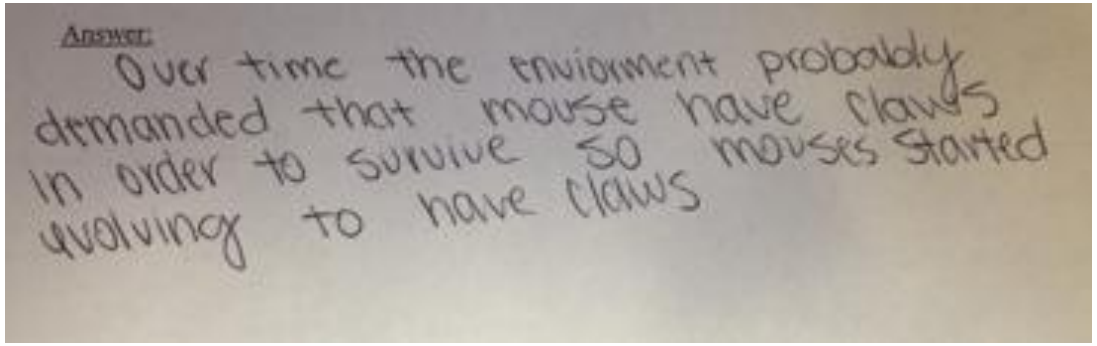
ACORNS – examples (human)


Answer:
A biologist would say that individual people alive today who can digest lactose originated within a population of people who were all lactose intolerant through a mutation in their DNA that turned this gene on. These people then passed down this gene to their offspring.


Answer:

ACORNS – examples (mouse)





GAENE – Acceptance

Smith et al., 2016

- 16 items
- Likert scale
- Human & non-human evolution
- Scores range from 0-80
- 1 factor (PCA), Cronbach's alpha: 0.94
- Eigenvalue of 8.45, accounted for 52.8% of the variance
- Beginning & end of school year

5=Strongly Agree	
4=Agree	
3=No Opinion	
2=Disagree	
1=Strongly Disagree	

1. The evidence used to support evolutionary theory is weak and inconclusive.	1	2	3	4	5
2. The theory of evolution is the product of good science.	1	2	3	4	5
3. Evolutionary biology is not really science.	1	2	3	4	5
4. Evolutionary theory is well supported by scientific data, research, and study.	1	2	3	4	5
5. The current theory of evolution is the best current available scientific explanation on the origin of new species from preexisting species.	1	2	3	4	5
6. Evolutionary theory explains why humans and chimpanzees share many characteristics.	1	2	3	4	5
7. The theory of evolution can be used to develop sound explanations about living things in the world today.	1	2	3	4	5
8. Humans do not evolve.	1	2	3	4	5
9. Evolution is happening now.	1	2	3	4	5
10. Species exist today in the same form in which they always have.	1	2	3	4	5
11. Any species could be evolving right now.	1	2	3	4	5
12. Humans have evolved from previously existing species.	1	2	3	4	5
13. New species arise from previously existing species.	1	2	3	4	5
14. There is a lot of evidence that supports the theory of evolution.	1	2	3	4	5
15. Evolutionary biology is a science just as much as any other, such as genetics.	1	2	3	4	5
16. Evolutionary biology is not very scientific.	1	2	3	4	5

Summary of Implementation

Curriculum Unit	Teacher	Fidelity: Implement	Fidelity: Assess	CRS 1	CRS 2	n
Altitude	4	High	High	No	No	51
Altitude	6	Low	Low	No	No	39
Altitude	10	High	High	Yes	No	18
Altitude	11	High	Moderate	Yes	No	52
Altitude	14	Unknown	Low	No	Yes	28

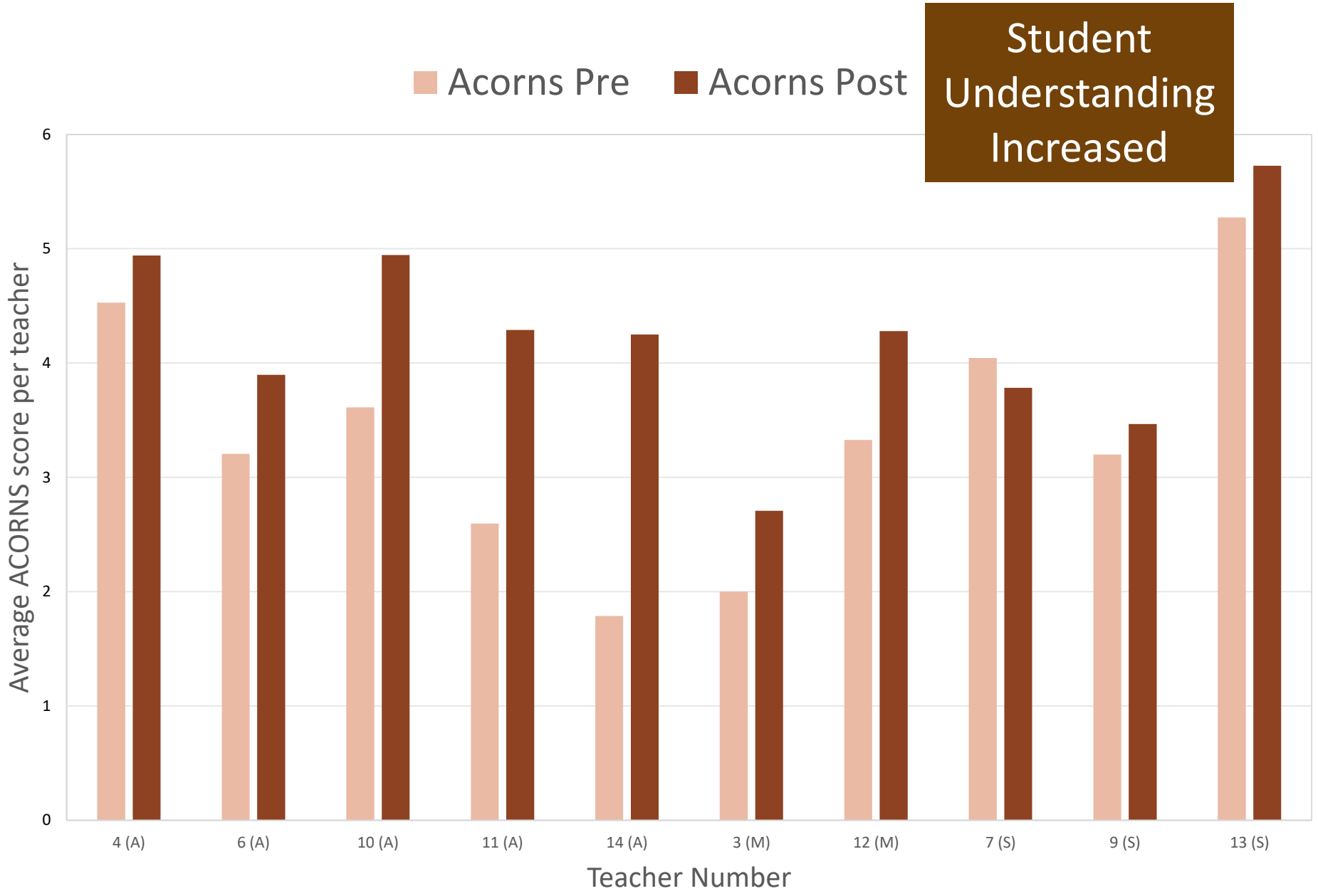
Curriculum Unit	Teacher	Fidelity: Implement	Fidelity: Assess	CRS 1	CRS 2	n
Malaria	3	High	Low	Yes	No	24
Malaria	12	High	High	No	No	43

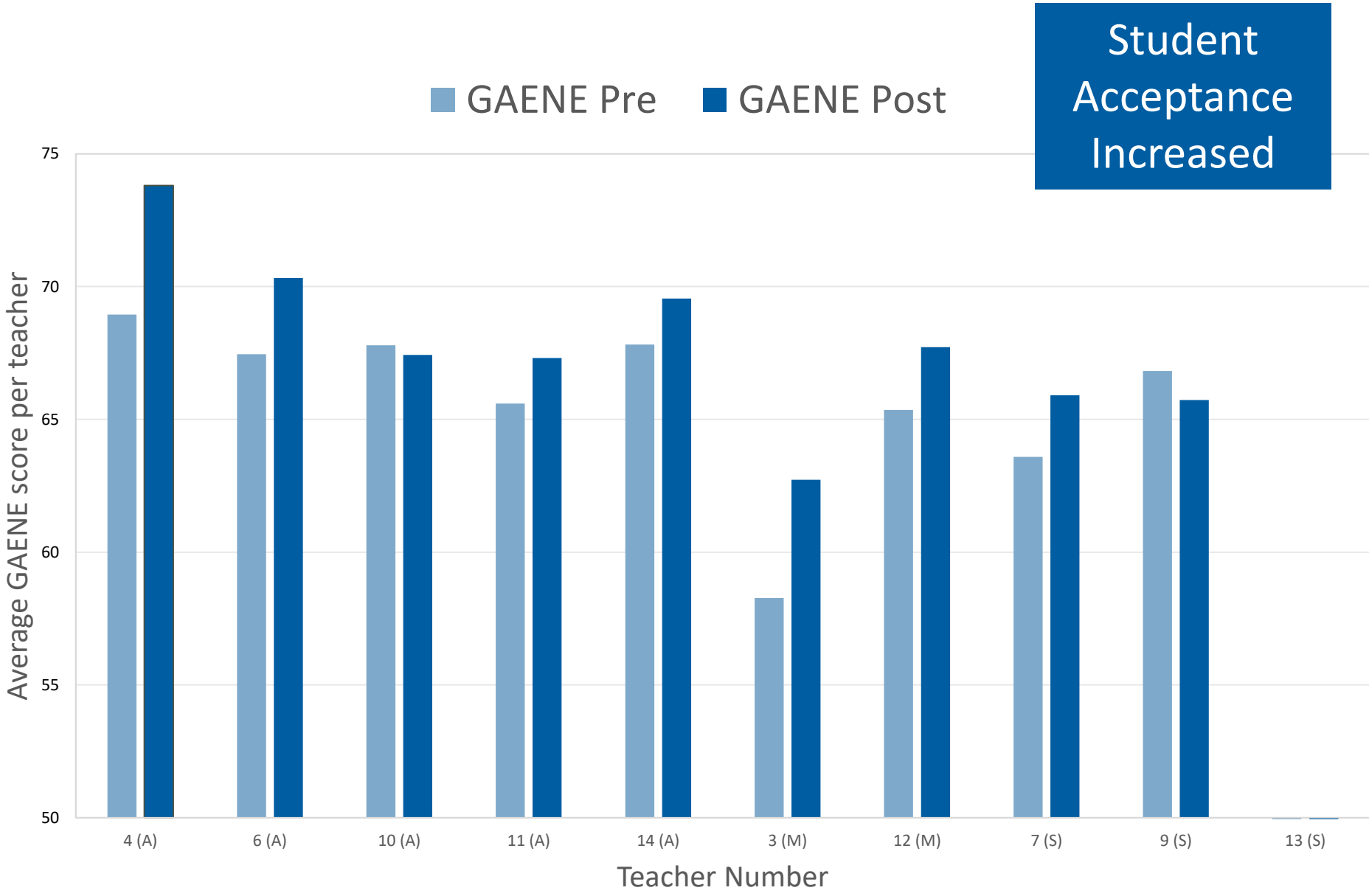
Curriculum Unit	Teacher	Fidelity: Implement	Fidelity: Assess	CRS 1	CRS 2	n
Skin Color	7	High	High	No	No	23
Skin Color	9	High	High	Yes	No	15
Skin Color	13	High	High	No	Yes	11

Summary of Results

Curriculum Unit	Teacher #	ACORNS Pre	ACORNS Post	ACORNS Gain	ACORNS Effect Size	GAENE Pre	GAENE Post	GAENE Gain	GAENE Effect Size
Altitude	4	4.529	4.941	0.411	0.26	68.95	73.81	4.87	0.78
Altitude	6	3.205	3.897	0.692	0.42	67.45	70.32	2.87	0.26
Altitude	10	3.611	4.944	1.333	0.81	67.79	67.43	1.64	0.15
Altitude	11	2.596	4.289	1.693	0.96	65.60	67.31	1.71	0.17
Altitude	14	1.786	4.250	2.464	1.32	67.82	69.55	1.73	0.14
Malaria	3	2.000	2.708	0.708	0.54	58.27	62.73	4.45	0.30
Malaria	12	3.326	4.279	0.953	0.50	65.36	67.72	2.36	0.32
Skin Color	7	4.044	3.783	-0.261	-0.16	63.59	65.91	2.32	0.25
Skin Color	9	3.200	3.467	0.267	0.15	66.82	65.73	-1.09	-0.10
Skin Color	13	5.273	5.727	0.455	0.50	-	-	-	-

Cohen's *d* effect size = pre-post/preSD – is not dependent on sample size – .30 or higher


Acorns Pre
Acorns Post
Student Understanding Increased
Average ACORNS score per teacher
0
1
2
3
4
5
6
4 (A)
6 (A)
10 (A)
11 (A)
14 (A)
3 (M)
12 (M)
7 (S)
9 (S)
13 (S)
Teacher Number


Student Acceptance Increased
GAENE Pre
GAENE Post
Average GAENE score per teacher
75
70
65
60
55
50
4 (A)
6 (A)
10 (A)
11 (A)
14 (A)
3 (M)
12 (M)
7 (S)
9 (S)
13 (S)
Teacher Number

Summary of Key Concepts Results

	Mouse Pre	Mouse Post	Mouse *Z*	Human Pre	Human Post	Human *Z*
Variation	.71	.87	**-5.378****	.71	.84	**-4.558****
Heritability	.49	.66	**-4.596****	.45	.64	**-5.388****
Competition	.03	.03	.000	.02	.01	-.632
Hyperfecundity	0.00	0.00	.000	0.00	0.00	.000
Resource Limitations	.16	.20	-1.434	.09	.11	-1.050
Differential Survival	.58	.71	**-3.563****	.34	.55	**-5.892****
Frequency/ Distribution	.22	.35	**-3.866****	.18	.33	**-5.004****

Summary of Cognitive Biases Results

	Mouse Pre	Mouse Post	Mouse *Z*	Human Pre	Human Post	Human *Z*
Essentialism	.12	.04	**-3.429****	.08	.04	-1.667
Intentionality	.04	.03	-.626	.03	.02	-.535
Teleology	.17	.07	**-4.160****	.06	.03	**-2.041***

Summary of Misconceptions Results

	Mouse Pre	Mouse Post	Mouse Z	Human Pre	Human Post	Human Z
Pressure	.04	.04	.000	.05	.01	**-3.153***
Adapt	.12	.07	**-2.359***	.13	.05	**-3.501****
Need	.16	.10	**-2.496***	.04	.03	-.943
Must	.09	.06	-1.667	.03	.02	-1.069
Use	.01	.01	-1.000	.06	.03	**-2.041***
Energy	0.00	0.00	.000	0.00	0.00	.000

Summary of CRS Results: Key Concepts

	Mouse CRS	Mouse No CRS	Mouse *Z*	Human CRS	Human No CRS	Human *Z*
Variation	.30	.04	**-4.641****	.18	.10	-1.490
Heritability	.28	.08	**-2.885***	.26	.13	-1.800
Competition	-.02	.02	-1.614	-.01	-.01	-.073
Hyperfecundity	0.00	0.00	0.000	0.00	0.00	0.000
Resource Limitations	.06	.02	-.713	.07	-.01	-1.703
Differential Survival	.26	.02	**-3.490****	.25	.16	-1.434
Frequency/ Distribution	.23	.06	**-2.577****	.15	.15	-.079

Summary of CRS Results: Cognitive Biases and Misconceptions

	Mouse CRS	Mouse No CRS	Mouse *Z*	Human CRS	Human No CRS	Human *Z*
Essentialism	-.10	-.05	-1.263	-.02	-.04	-.470
Intentionality	.01	-.02	-.964	-.01	-.01	-.058
Teleology	-.21	-.01	**-4.651****	-.04	-.02	-.650
Pressure	.02	-.02	-1.288	-.05	-.03	-.635
Adapt	-.09	-.02	-1.841	-.10	-.06	-.907
Need	-.15	.02	**-3.776****	-.02	-.01	-.589
Must	-.05	-.02	-.936	-.02	-.01	-.661
Use	-.01	-.01	-.131	-.04	-.02	-.663
Energy	0.00	0.00	0.000	0.00	0.00	0.000

Overall Summary: I/2

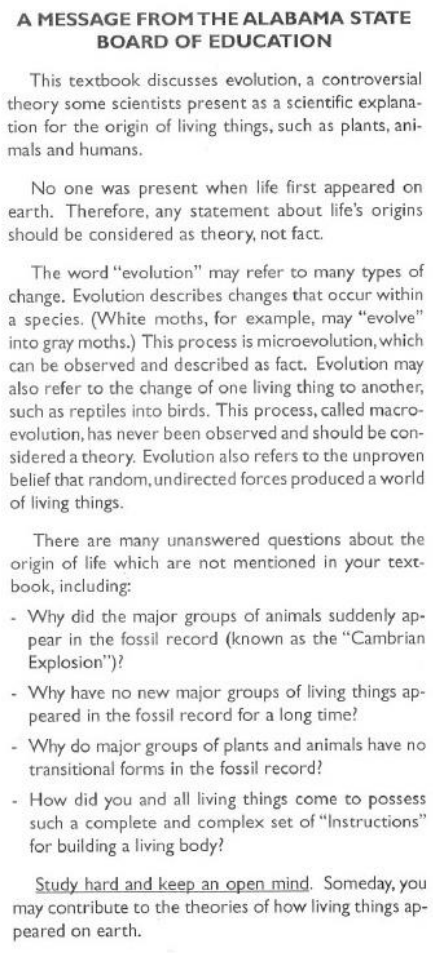
- First study to quantitatively assess high school students' understanding of natural selection before and after using curriculum materials that use human examples to teach evolution
- First study in the US to quantitatively assess high school students' understanding of natural selection before and after using teaching strategies that acknowledge the cultural controversy around teaching and learning evolution that exists in many contexts
- The overall increases in understanding of natural selection suggest that combining human examples as the context for evolution instruction with classroom activities that acknowledge the cultural controversy and promote positive dialogue around the topic of evolution hold promise as an effective strategy for high school evolution education

Overall Summary: 2/2

- Significant gains in evolution understanding in high school students from pretest to posttest in 4 aspects of understanding evolution: Variation, Heritability, Differential Survival, and Frequency/Distribution, in both Human and Mouse contexts
- Some significant reductions in cognitive biases and misconceptions across both Mouse and Human contexts
- Higher proportion of students with a Teleology cognitive bias and more misconceptions generally in the Mouse context than the Human context
- CRS activities seemed to pave the way for greater increases in understanding and decreases in cognitive biases and misconceptions in the Mouse context, but not the Human context

Next Steps: TEtHE 2.0, a.k.a LUDA!

1. Revamp curriculum materials and CRS resource for introductory high school biology
2. Create an entire curriculum unit to insure little or no other evolution content is taught
3. Create a parallel non-human curriculum unit to test the effects of ***human*** examples
4. Field test in Alabama, which adopted new state standards in 2015 that explicitly include evolution for the first time



A MESSAGE FROM THE ALABAMA STATE BOARD OF EDUCATION

This textbook discusses evolution, a controversial theory some scientists present as a scientific explanation for the origin of living things, such as plants, animals and humans.

No one was present when life first appeared on earth. Therefore, any statement about life's origins should be considered as theory, not fact.

The word "evolution" may refer to many types of change. Evolution describes changes that occur within a species. (White moths, for example, may "evolve" into gray moths.) This process is microevolution, which can be observed and described as fact. Evolution may also refer to the change of one living thing to another, such as reptiles into birds. This process, called macroevolution, has never been observed and should be considered a theory. Evolution also refers to the unproven belief that random, undirected forces produced a world of living things.

There are many unanswered questions about the origin of life which are not mentioned in your textbook, including:

- Why did the major groups of animals suddenly appear in the fossil record (known as the "Cambrian Explosion")?
- Why have no new major groups of living things appeared in the fossil record for a long time?
- Why do major groups of plants and animals have no transitional forms in the fossil record?
- How did you and all living things come to possess such a complete and complex set of "Instructions" for building a living body?

Study hard and keep an open mind. Someday, you may contribute to the theories of how living things appeared on earth.

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