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Effects of Animals in Post-Secondary Science Classrooms on Academic Achievement, Academic Retention, and Intrinsic Motivation

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Abstract This study investigates biophilia, the love of life, and how to incorporate this concept, originally recognized by E.O. Wilson, into schools [9] Studies have shown animals can increase student interest, motivation, attitude, academic achievement, and academic retention. However, resistance to animals in classrooms has emerged because of safety concerns. After consulting past research, the prediction is made that after attending lessons taught using the 5E Learning Cycle, students in a class with animals will have higher academic achievement, academic retention, and intrinsic motivation. Students were taught using a 5E lesson design for two nonconsecutive lab experiences. During the two-pronged study, students were differentiated into each one of the following groups at one point throughout the study: 1) content covering evolution using living herpetofauna, versus images, and 2) the Theory of Natural Selection using the classroom's terrariums and enclosures as models, versus images. After the study, a paired t-test was run and found no significant difference in the academic achievement and academic retention for student taught with animals versus those that were not. There was however, a difference in intrinsic motivation, which turned the focus into what the change in motivation means for future research. This study was one step in a much larger academic reform involving how students learn, and continued research is needed in order to ensure significance with biophilia in the classroom.

Keywords: *biophilia, science classroom, E.O. Wilson, student motivation*

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1. Introduction

Biophilia is a term coined by Edward O. Wilson meaning "the love of life" [11]. The concept also refers to the idea that all organisms have biophilia in their DNA to be attracted to other living things, such as plants and animals [6]. In understanding that students have an attraction towards living things, it would make sense to have living organisms in the classroom. The Biophilia Hypothesis supports the claim that nature can increase mental health and personal fulfillment for humans [11]. In a classroom, living organisms could help students refresh their mind and have a better environment for learning.

Animals not only help students remain active learners, but assist students with connecting to nature. In today's society, students are interacting with nature less and less [8]. Children are spending more time inside than they once did because of technology or parental safety fears of having their children explore nature [8]. Animals in the classroom can increase student exposure to nature and get them more interested in the outdoors. Nature has shown to have positive impacts on the human body by lowering of blood pressure and lowering the mortality rate of heart disease patients [8]. To get students more involved in nature, teachers could bring nature to them by having living organisms in their classrooms. This simple endeavor will spark students' interest in nature and can encourage them to interact more with the living world outside.

Biophilia can increase mental and psychological health while stress and mental fatigue can decrease mental and psychological health. The mind gets fatigued when it has to do long hours of work, studying, or worrying. Kaplan and Kaplan (as cited in [11]) found the fight to pay attention causes mental fatigue. Involuntary and voluntary attentions are two distinct types of attention. Involuntary attention is when the mind will passively pay attention to something that is interesting, exciting, fascinating, or engaging to the person, and does not require effort to stay focused [11]. Voluntary attention requires the person to force themselves to pay attention [11]. Living organisms have the ability to make things exciting, fascinating, and engaging which can help lead to involuntary attention [11]. Human learners will be able to pay attention better, without forcing themselves, and cause less mental fatigue if attention is modified from voluntary to involuntary attention through personal engagement and excitement.

However, even with the benefits of animals and living organisms in the classroom some schools are making administrative decisions to deny animals from being located in school classrooms. School boards are preventing animals in the classroom by creating policies to ensure safety for their students. For instance, some institutional leaders have prohibited animals at Cambridge Public schools, VT-including spiders, reptiles, and mammals [3]. Another school board in Port Angeles, WA is banning dogs, rabbits, snakes, and baby chicks [9]. Both school districts state they are using these policies to protect students from possible zoonotic diseases the animals could potentially bring into the school. In adhering to such mindset, the governing powers are protecting their students and families by denying contact with possibly infected animals [3,9].

Even with certain groups against animals in classrooms, research is being done to see if biophilia affects students. Klingenberg [7] performed a study where he looked at living animals in the classroom (n=35) compared to videos of animals in the classroom (n=29). In the study 6th and 7th grade students were split into 2 different groups, the one group which used videos and exuviae, or an animal's cast or sloughed skin, and another group that used living animals. The living animals used in the study were invertebrates, such as sow bugs and leeches. Results were found using a pre-test, post-test, and retention test (2 months after lesson). In both groups, results showed a significant increase in knowledge compared to the control group, but students in the living animal group had an increase in interest and positive attitude. The living animal group students observed and interacted with the animals, which helped spark student interest and positive attitude in the classroom. Students also enjoyed working with living organisms during an interactive lesson, which lead to an increase in interest level [7].

Animals in the classroom improve students' ability to learn and retain information over time [4]. Hummel and Randler [4] found classes taught using living animals increased student achievement compared to the control group without living animals. In this study 400 students observed mice, woodlice, and snails, followed by students recording their observations. Three different groups were formed for this study. The three groups were a living animal group, without living animal group, and a control group. The students took a pre-test, post-test, and two retention tests (6-8 weeks, and 7-9 months after last day). Having animals in the classroom allowed students to be more hands-on during learning and helped improve student learning.

Based on the above studies, educational research about animals in the classroom is a relatively new area of study, and needs to be further examined. Past research has found many interesting ideas about animals in the classroom, but has not put these ideas together in one study. By using a control group and treatment group, the proposed research will examine animals in the classroom using the following variables: presence of animals (independent variable), test scores (dependent variable) and lesson design (constant). The hypothesis is that animals in the classroom will improve academic achievement, academic retention, and intrinsic motivation. The prediction is that after attending a lesson taught using the 5E learning cycle, post-secondary students in the class with herpetofauna will have a higher academic achievement, academic retention, and intrinsic motivation.

2. Materials and Methods

Participants in the study were originally going to be a part of a college transition program at a small liberal arts college in the Midwest. Due to permission issues and miscommunication, this portion did not occur, which decreased the participant count in the study. Instead, participants were volunteer recruits from introductory fall biology courses at the college. Researchers visited classrooms, gave a brief description of the study, and formed an email list of participants. The vast majority of the participants were Elementary Education majors or Business majors. The participants came from a variety of academic backgrounds, consisted of both genders, and ranged between 18-20 years of age. The participants were asked to select a set of lab days out of two options that they would attend. Each set included two 1-hour biology sessions. The groups were further split evenly into the two groups, so some volunteers had to switch from their initial preferred group. When the students arrived to the lesson presentations they were assigned an identification number kept on file separate from the researchers, which they used on all tests taken: including the retention and motivation test.

The lab days were taught using a productive lesson plan design chosen based on the results of Ajaja [1]. The research found, on average, students had the highest post-test scores after being taught using the 5E learning cycle as compared to more traditional lesson plan designs. The parts of the 5E cycle are engagement, exploration, explanation, elaboration, and evaluation; using this design the researchers co-taught four one-hour laboratory-based lessons, where each participant attended two. The participants split into two groups that switched lessons on the second session. The first day's lesson focused on the process of natural selection and Charles Darwin (Appendix A). In the second lab experience, groups switched rooms to encounter the opposite learning environment and completed a lesson on evolution. The switching between experimental and control group members was to ensure all students have the ability to see the animals and not feel like they were treated unfairly or excluded. This dual-pronged procedure also allowed researchers to measure intrinsic motivation among students. When the students were able to experience both the course with lives animals and a course taught without live animals they could compare the experiences for the motivation section of the study. By creating this two-prong style experiment students could be counted in one study for the control and the other study in the experiment.

During data collection, four different tests were given to participants. The four tests provided data on academic achievement, academic retention, and intrinsic motivation of the students. The four tests were a pretest, posttest, retention test, and a motivation test. The tests were identical for the two different groups. Other than quantitative data, qualitative data was obtained, and recorded, through post-lab reflection. Researchers transcribed personal reflections on how they believed the lessons transpired and what could be improved.

The pretest and posttest provided data about academic achievement, and were written by the two researchers. The pretest, posttest, and retention test were the same test. Each test was 15 questions and was directly correlated with what was taught during the lesson (Appendix B). The pretest was taken before any content was covered and the posttest was given after the lab was completed, but before the student's switched groups. The academic test questions were found using the sample questions in textbooks covering the content taught and were reviewed by research advisors and current science instructors. Scoring of the academic tests was performed by both researchers separately to ensure no mistakes were made.

The motivation test was a twelve question motivation test [2]. Questions from the previously tested motivation test were reworded and conformed to specifically fit this study (Appendix C). Students were given the motivation test after completion of the second posttest which was on the second learning experience so participants had experienced both options. The last test administered allowed subjects to show individual academic retention (process is shown in Figure 1). The academic retention test showed how well the students remembered the material. The lapse in teaching and contact provided time to firmly investigate whether academic retention existed, and to what extent retention rate affected the college students within the confines of this study. The retention test provided statistical data on classroom animal influence on academic retention.

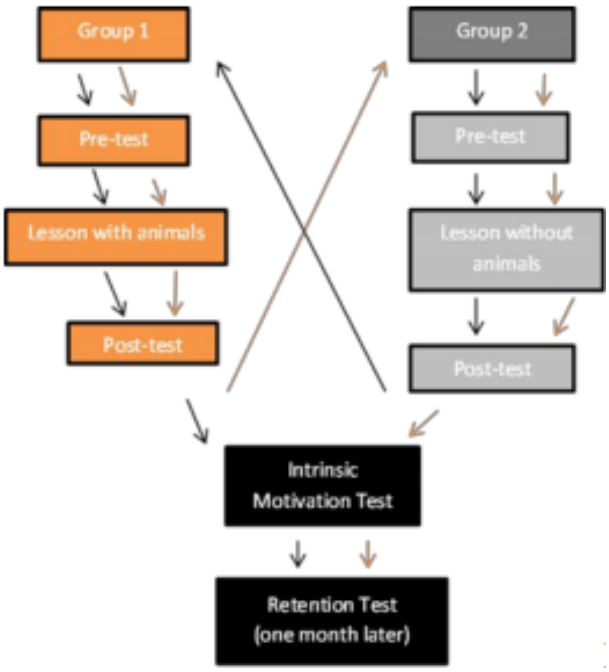

Figure 1. Methods process

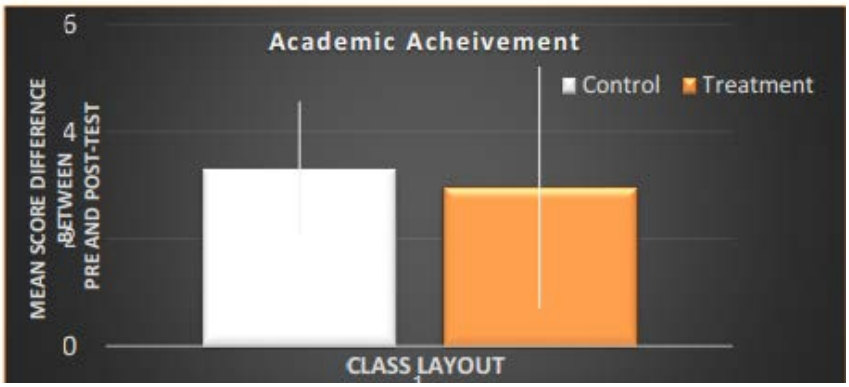

Figure 2. This graph displays the difference in academic achievement (pre-test score-post-test score) for the treatment (n=27) and control group (n=13)

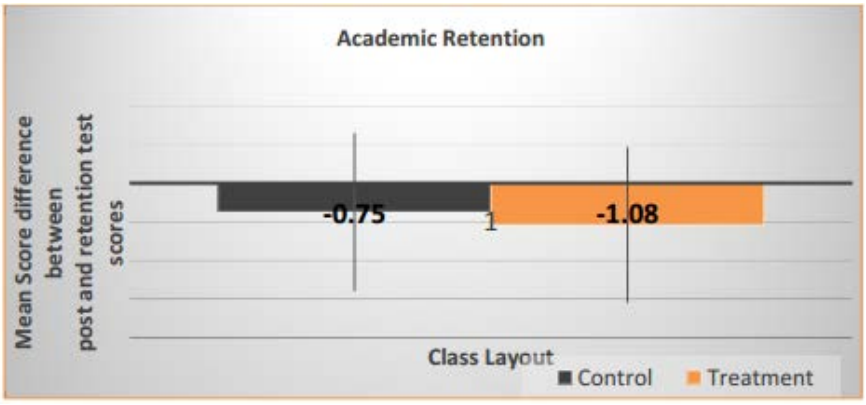

Figure 3. This graph displays the difference in academic retention (pre-test score-retention test score) for the treatment (n=12) and control group (n=8)

3. Results

Based on the test scores from the aforementioned tests, statistical analysis was conducted using a paired t-test. There was no significant difference in academic achievement (Figure 2) between the class taught with herpetofauna, and the class taught in a traditional classroom. The paired t-test also found no significant difference in academic retention graph (Figure 3), between the two groups. We found the p value to equal 0.1273 for academic achievement and the p value for the academic

retention test was 0.7236 which again is not a significant statistical difference. However, significant differences existed between the students' intrinsic motivation levels, with the majority finding themselves more engaged and excited when taught with herpetofauna (Figure 4). The two tables below (Table 1 and Table 2) contain the raw data from the test results. The spots on the table that are not complete are areas volunteer students did not participate.

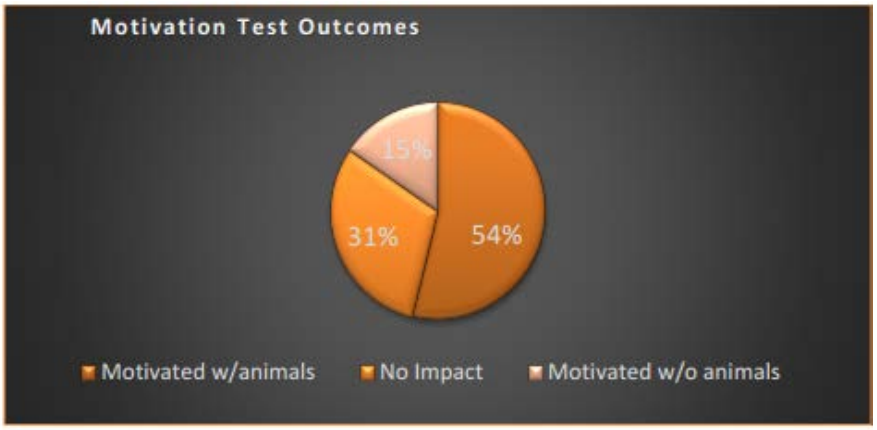

Figure 4. This graph displays the difference in intrinsic motivation found from the motivation test for treatment and control group. Some students felt now difference between the classes (n=13)

Table 1.

Participant	Category	Pre-score	Post-score	Difference	Retake	Difference post and ret
1	T	3	4	1		
2	T	5	10	5		
3	T	6	5	-1	4	-1
4	T	8	9	1		
5	T	6	10	4	10	0
6	T	12	12	0		
7	T	10	11	1	13	2
8	T	8	10	2		
9	T	11	14	3		
10	T	9	9	0		
11	T	2	5	3		
12	T	10	14	4	10	-4
13	T	6	13	7	9	-4
14	T	6	10	4		
15	T	6	10	4		
16	T	6	11	5		
17	T	4	8	4		
18	T	4				
19	T	7	10	3	8	-2
20	T	8	10	2		
21	T	6	9	3	9	0
22	T	10	11	1		
23	C	7	9	2		
24	C	7	9	2	11	2
25	C	5	8	3		
26	C	6	10	4		
27	C	6	8	2	5	-3
28	no					
29	no					

Table 1. Above is the raw data found from the first two days in lab. C stands for the control lab and T stands for the treatment lab. Both were taught using the lab on Evolution during this day. Students without scores either did not take the retention test or did not participate in day 1 lab.

Table 2.

Participant	Category	Pre-score	Post-score	Difference	Retake	Difference post and ret
1	C	6	11	5		
3	C	7	10	3		
4	C	12	14	2	10	-4
5	C	8	12	5	13	1
12	C	13	15	2	14	-1
13	C	11	15	4	14	-1
19	C	10	15	5	14	-1
21	C	9	13	4	14	1
24	T	9	13	4	11	-2
25	T	9	14	5	14	0
26	T	5	14	9	11	-3
28	T	10	12	2	11	-1
29	T	12	13	1	15	2

Table 2. Above is the raw data found from the second two days in lab. C stands for the control lab and T stands for the treatment lab. Both were taught using the lab on Evolution during this day. Students without scores either did not take the retention test or did not participate in day 2 lab.

4. Discussion

The research conducted was a small step in a much larger process. The hypothesis was that after attending a course taught using the 5E learning cycle, students in the class with herpetofauna will have a higher academic achievement, academic retention, and intrinsic motivation. Our hypothesis was not supported based on the statistical findings from the study for academic achievement and academic retention; however the hypothesis for intrinsic motivation was supported based on the results from the motivation test. The results modified the focus of the reporting to focus more on student motivation than academic achievement and retention.

The motivation test allowed students to reflect on their own motivation and engagement, after analyzing results researchers found more students scored higher on intrinsic motivation after being taught with animals. Based on previous research [4,7] this finding makes sense, because soft-skills are impacted by classroom setup. In education, many schools are moving to evaluate not only content knowledge, but also measures called soft-skills. Soft-skills are features like personality traits, communication, work ethic, dedication, and empathy. Soft-skill and motivational developments are connected to social emotional development; there are three levels used to describe this growth. The first level is to build positive relationships. Children are able to build positive relationships through human animal interaction by community building, learning about caring, promoting their self-confidence, and creating home-school connections [5]. The first level focuses on building confidence of the students and teaching them about life lessons.

The second level of social-emotional development is prevention and supportive environments. The preventative practices include well-defined rules, set routines, and positive attention that will help students feel comfortable in the classroom [5]. The living organisms in this level help demonstrate how animals need well-defined rules when caring for them. Living organisms need set schedules when to be fed and receive attention so they do not become neglected. The third level of social-emotional development is social and emotional learning strategies. In this level, human interaction can help students learn how to deal with different feelings and emotions that they develop from interaction with the animals [5]. This higher level also assists in building human-human friendships; students can work in groups using the animals to help spark conversation and build respectful, interactive relationships with one another.

With an increase in intrinsic motivation with animals, we expected academic achievement would similarly increase. However, researchers did not find this to be true. The reason for the lack of simultaneous progression could be due to the low sample size or high dropout rates. Researchers suggest four steps that could be taken in order to improve and build from this study. The first step would be to increase sample size, the larger participant population would provide more accurate statistics that could lead to the predicted significant results for academic achievement and academic retention. The previous studies used to formulate the hypothesis had larger sample sizes; Hummel and Randler's [4] study had 400 participants and Klingenberg [7] had 62 participants which allowed for them to get significant results. This endeavor could be accomplished through a variety of ways. One would be to use an actual class; another is to possibly offer something to the volunteers for participating in the study to increase willingness to stay on. Another means to increase participation could be to carry out the study in partnership with other schools, to get a more diverse group of students and a larger sampling. The lack of commitment from the volunteers in the current study gave rise to issues in the statistics of the study.

Another suggestion to improve the study is to extend the methods into a unit's time; this would allow for an increase in content coverage and provide more time for data collection. By increasing the amount of content covered a more reliable academic test could be given with more questions. In Klingenberg's study, the lessons were a unit time allowing more content coverage resulting in significant results in academic achievement; the retention test was 2 months after the unit which gave enough time for students to be away from material, resulting in

significant difference in retention tests between groups [7]. The third suggestion is to reach students in a variety of academic fields; providing for a more realistic classroom makeup of student clientele. By simulating the most realistic classroom, the study would be able to exemplify an actual class making the results more reliable. The length of the current study consisted of four lab periods and a retention test day, which may not have covered enough content in depth or girth. The last suggestion would be to attempt the process in other content areas besides science; this modification would support the idea that biophilia affects student's abilities to connect cross-curricular content and have higher academic achievement.

Acknowledgments

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References

[1] Ajaja P. 2013. Which strategy best suits biology teaching? Lecturing, concept mapping, cooperative learning or learning cycle? Electronic Journal of Science Education. 17(1):1-37.

[2] Bechtel, M. D. [internet]. 2012. Perceptions of student-teacher relationships, self-efficacy, and subject matter retention in a secondary chemistry course; [updated 2012 March 23, cited 2014 March 30]. http://www.linkedin.com/pub/dr-michael-d-bechtel/34/618/950#.

[3] Cambridge School Board [internet]. 2011. Cambridge (MA): Policy on animals in the school [updated 2013, cited 2014 March]. http://www3.cpsd.us/media/theme/ProCambridge/network/10516/media/CPS%20Redesign/documents/Policies/SCPolicyManual03181 1AnimalsinSchoolPolicy.pdf?rev=0.

[4] Hummel E, Randler C. 2011. Living animals in the classroom: a meta-analysis on learning outcome and a treatment–control study focusing on knowledge and motivation. J Sci Educ Technol. 21:95-105.

[5] Jegatheesan B, Meadan H. 2010. Classroom pets and young children. Supporting early development. Young Children. 5: 70-76.

[6] Johnston L. 2010. From biophilia to cosmophilia: the role of biological and physical sciences in promoting sustainability. 7-23.

[7] Klingenberg K. 2013. 'Primarerfahrung' with living animals in contrast to educational videos: a comparative intervention study. Journal of Biological Education. 1-8.

[8] Louv R. 2005. Last Child in the Woods. New York, New York: Workman Publishing Company. 7-72.

[9] Peninsula Daily News [internet]. 2014.

[10] Port Angeles (WA): Classroom pet ban planned by Port Angeles School Board; [updated 2014, cited 2012 February 13]. http://www.oregonlive.com/pacific-northwestnews/index.ssf/2012/05/classroom_pet_ban_planned_by_p.html.

[11] Taylor LK. 2007. An Exploration of Biophilia and its Implications in Design of the Built Environment Exemplification in a Site Specific Design for a Corporate Retreat. The Florida State University DigiNole Commons. 4-16.

[12] Wilson, E.O. 1984. Biophilia. Harvard University Press.

Appendix A

Teacher: Casey Krull and Josie Suchomel

Date: September 30th

Subject / grade level: Mostly College Freshmen or in introductory sciences courses TREATMENT DAY 1

Materials:
Reptiles, Graphic Organizer, Introductory PowerPoint, Pictures of Ancestral Animals

Iowa Essential Standards and Clarifying Objectives
Standard 7.Understands biological evolution and the diversity of life
Topic Natural selection and biological evolution
Level IV (Grade 9-12)
Benchmark 2. Understands the concept of natural selection (e.g., when an environment changes, some inherited characteristics become more or less advantageous or neutral, and chance alone can result in characteristics having no survival or reproductive value; this process results in organisms that are well suited for survival in particular environments)

Lesson objective(s): After the lesson about evolution, volunteer freshmen students will be able to correctly list five evolutionary differences between amphibians and reptiles.

5E

ENGAGEMENT
- Introduce the researchers
- Introduce the animals (geckos, snakes, frogs, toads, turtles)
- Give brief safety lesson on animal handling

EXPLORATION

- First tell the students they do not have to handle animals but have to be involved in the group
- Split students into two different groups
- Students will be given a Venn diagram to take notes, will be able to compare and contrast
- One group will look at reptiles first and the other will be looking at the amphibians
- The groups will switch after about 10-15 minutes
- After looking at both groups, students will be given some time in their groups to compare and contrast the reptiles and amphibians

EXPLANATION

- Class will come back together to discuss what they found
- Researchers will discuss anything they missed

- Define evolution and the different variables that play a role

ELABORATION

Use evolution of technology, cars, and fashion as a "close to home" example

- Have the students list how one of the above categories has changed over time and why
- Not talking about there being a creator
- Ex. Different features, appearances, quality, and variety

EVALUATION

- Post-Test/Pre-Test
- Informal assessment/Check for understandings

5E Lesson Plan

Teacher: Casey Krull and Josie Suchomel

Date: October 2nd

Subject / grade level: Mostly College Freshmen or in introductory sciences courses CONTROL DAY 1

Materials:
Reptiles, Graphic Organizer, Introductory PowerPoint, Pictures of Ancestral Animals

Iowa Essential Standards and Clarifying Objectives

Standard 7.Understands biological evolution and the diversity of life
Topic Natural selection and biological evolution
Level IV (Grade 9-12)
Benchmark 2. Understands the concept of natural selection (e.g., when an environment changes, some inherited characteristics become more or less advantageous or neutral, and chance alone can result in characteristics having no survival or reproductive value; this process results in organisms that are well suited for survival in particular environments)

Lesson objective(s): After the lesson about evolution, volunteer freshmen students will be able to correctly list five evolutionary differences between amphibians and reptiles.

5E

5E

ENGAGEMENT

- Introduce the researchers
- Introduce the different animal pictures used throughout the lesson (geckos, snakes, frogs, toads, turtles)

EXPLORATION

- Split students into two different groups
- Students will be given a Venn diagram to take notes, will be able to compare and contrast
- One group will look at reptile pictures first and the other will be looking at the amphibian pictures
- The groups will switch after about 10-15 minutes
- After looking at both groups, students will be given some time in their groups to compare and contrast the reptiles and amphibians

EXPLANATION

- Class will come back together to discuss what they found
- Researchers will discuss anything they missed
- Define evolution and the different variables that play a role

ELABORATION

Use evolution of technology, cars, and fashion as a "close to home" example

- Have the students list how one of the above categories has changed over time and why
- Not talking about there being a creator
- Ex. Different features, appearances, quality, and variety

EVALUATION

- Post-Test/Pre-Test
- Informal assessment/Check for understandings

5E Lesson Plan

Teacher: Casey Krull and Josie Suchomel

Date: October 9

Subject / grade level: Mostly College Freshmen or in introductory sciences courses TREATMENT DAY 2

Materials:
Reptiles, Graphic Organizer, Introductory PowerPoint, Pictures of Ancestral Animals

Iowa Essential Standards and Clarifying Objectives

Standard 7.Understands biological evolution and the diversity of life

Topic Natural selection and biological evolution

Level IV (Grade 9-12)

Benchmark 2. Understands the concept of natural selection (e.g., when an environment changes, some inherited characteristics become more or less advantageous or neutral, and chance alone can result in characteristics having no survival or reproductive value; this process results in organisms that are well suited for survival in particular environments)

Lesson objective(s): After the lesson about the theory of natural selection, volunteer freshmen students will be able to correctly list 3 traits of each selected animal that would help it to survive.

ENGAGEMENT

- Introduce the animals and describe their natural living environment
- Talk about how their tanks are closely related to their natural environment

EXPLORATION
- Have students pair up and have the students go to one of the numbered tanks around the room
- Students will have three minutes at each tank
- Students will take note of the different living conditions

EXPLANATION
- Explain the different theorist (Darwin, Lamarck, Copernican, Linnaeus, Hutton, Lyell, Malthus, Wallace)
- Natural selection (disruptive selection, directional selection, stabilizing selection)

ELABORATION
- Give students different scenarios exemplifying the different types of natural selection
- Students will need to determine which type and why

EVALUATION
- Post-Test/Pre-Test
- Informal assessment/Check for understandings

5E Lesson Plan

Teacher: Casey Krull and Josie Suchomel

Date: October 6

Subject / grade level: Mostly College Freshmen or in introductory sciences courses CONTROL DAY 2

Materials:
Reptiles, Graphic Organizer, Introductory PowerPoint, Pictures of Ancestral Animals

Iowa Essential Standards and Clarifying Objectives
Standard 7.Understands biological evolution and the diversity of life
Topic Natural selection and biological evolution
Level IV (Grade 9-12)
Benchmark 2. Understands the concept of natural selection (e.g., when an environment changes, some inherited characteristics become more or less advantageous or neutral, and chance alone can result in characteristics having no survival or reproductive value; this process results in organisms that are well suited for survival in particular environments)

Lesson objective(s): After the lesson about the theory of natural selection, volunteer freshmen students will be able to correctly list 3 traits of each selected animal that would help it to survive.

5E

ENGAGEMENT
- Introduce the animals and describe their natural living environment
- Pictures are going to be of Dr. Bechtel's tanks
- Describe that the tanks represent their natural living environment

EXPLORATION
- Have students pair up and have the students go to one of the numbered pictures around the room
- Students will have three minutes at each picture
- Students will take note of the different living conditions

EXPLANATION
- Explain the different theorist (Darwin, Lamarck, Copernican, Linnaeus, Hutton, Lyell, Malthus, Wallace)
- Natural selection (disruptive selection, directional selection, stabilizing selection)

ELABORATION • Give students different scenarios exemplifying the different types of natural selection • Students will need to determine which type and why
EVALUATION • Post-Test/Pre-Test • Informal assessment/Check for understandings

Appendix B

Evolution pre, post, and retention test.

1. Fill in the blanks with best possible answers: the_____ and _____ of a species effects its ability to survive
   a. Color, reproduction ability
   b. Color, living environment
   c. Color, health
   d. All of the above
2. When a pollutant enters the water which animal is least likely to survive?
   a. Frog
   b. Toad
   c. Tortoise
   d. Snake
3. Evolutionary change is a(n)_____.
   a. Assumption
   b. Fact
   c. Collection of hypotheses
   d. Debatable opinion
4. In order to survive intense sunlight and heat desert snakes have evolved to have_____?
   a. An internal cooling systems
   b. The ability to hibernate
   c. A short life and just reproduce quickly
   d. None of the above
5. When one species gives rise to many species this is called, _____.
   a. Divergent evolution
   b. Convergent evolution
   c. Adaptive evolution
   d. None of the above
6. Why are amphibians used as environmental health indicators?
   a. They don't move very far
   b. They have permeable skin
   c. They reproduce slowly
   d. They have evolved very little
7. Change in the gene pool of a population from generation to generation, is the definition for_____.
   a. Reproduction
   b. Evolution
   c. Mutation
   d. Natural Selection
8. If a flood wipes out almost an entire population which trait (from below) is going to be beneficial to the population?
   a. Having legs

b. Being able to climb
c. Fast reproduction
d. Blue/green colored skin

9. New species cannot usually form without
   a. Barrier isolation
   b. Convergent evolution
   c. Analogous structure
   d. Reproductive isolation
10. Wings in butterflies, birds, and bats are an example of_____.
   a. Evolution
   b. Analogous structure
   c. Heterologous structure
   d. Similar structure
11. The relative frequency of an allele effects_____.
   a. Sex of organism
   b. Speed of evolutionary change
   c. Rate of reproduction
   d. Gene pool
12. Farmers change the gene pool of a population by
   a. Artificial selection
   b. Adaptive radiation
   c. Natural selection
   d. Convergent evolution
13. New species usually form only when populations_____.
   a. Have genetic drift
   b. Have similar gene pools
   c. Are isolated
   d. Are in adjoining niches
14. A new species will have a good chance of surviving if it_____.
   a. Occupies an empty niche
   b. Leaves a niche
   c. Shares a niche
   d. Destroys a niche
15. A group of similar-looking organisms that breed with one another and produce fertile offspring is a _____.
   a. Species
   b. Niche
   c. Population
   d. Phenotype

Natural Selection pre, post and retention test.

1. The process in which something in a living thing's surroundings determines if it will or will not survive to have offspring is called
   a. survival of the fittest
   b. variation
   c. competition
   d. mutation
2. The type of selection that favors both the extremes for an organism is called
   a. directional selection
   b. stabilizing selection
   c. disruptive selection
3. The definition of stabilizing selection is natural selection
   a. that favors the extremes in the population
   b. that favors the average individuals in the population
   c. that favors one extreme over the mean and other extreme
   d. that favors all types of selection

4. In a population of mice, there is white, brown, and dark brown mice. The environment that the mice live favors the white and dark brown mice. This is an example of
    a. disruptive selection
    b. directional selection
    c. stabilizing selection
    d. all of the above
5. What animals did Charles Darwin predominantly study on the Galapagos Islands
    a. mice
    b. rabbits
    c. finches
    d. snakes
6. The definition of directional selection is natural selection
    a. that favors all types of selection
    b. that favors one extreme over the mean and other extreme
    c. that favors the extremes in the population
    d. that favors the average individual in the population
7. In a population of rabbits there are small, medium and large sized. The environment where these rabbits live favor the medium sized rabbits. This is an example of
    a. stabilizing selection
    b. disruptive selection
    c. directional selection
    d. all of the above
8. Individuals of a population that have less desirable traits for the environment in which they live will reproduce
    a. at a steady rate
    b. at a high rate
    c. at a low rate
    d. never
9. Natural selection takes place
    a. never
    b. always
    c. sometimes
    d. only when an organism wants to
10. A population of birds has short, medium, and large beaks. The environment favors birds with short beaks. This is an example of
    a. disruptive selection
    b. directional selection
    c. stabilizing selection
    d. all of the above
11. Survival of the fittest can be best described as the
    a. ability of a population to survive and reproduce
    b. ability of an individual to survive and reproduce
    c. ability of an individual to stay alive
    d. ability of a population to stay alive
12. The main person that came up with the term natural selection was
    a. Jean-Babtiste Lamarck
    b. Gregor Mendel
    c. Charles Darwin
    d. Thomas Aquinas

13. Where did Charles Darwin go to do his research
    a. Hawaiian islands
    b. Madagascar
    c. Amazon Rain Forest
    d. Galapagos
14. What characteristic of the finches did Charles Darwin look at?
    a. Wing span
    b. Overall body size
    c. Beak size
    d. None of the above
15. Birth weight of humans babies is a result of
    a. Stabilizing selection
    b. Directional selection
    c. Disruptive selection
    d. All of the above

Appendix C

Motivation Test

Motivation 8 (Turkish version MSLQ) #2-9 The following questions ask about your motivation for, and attitudes about, evolution and natural selection. Remember there is no right or wrong answers; just answer as accurately as possible. Use this scale to answer questions. If you think the statement is very true of you, mark "very true of me"; if a statement is not at all true of you, mark "not at all true of me". If the statement is more or less true of you, find the place between the two ends that best describes you.

01. I believe I received an excellent grade on the posttest taken over natural selection and evolution.

1	2	3	4	5	6	7
not at all true of me						very true of me

02. I am certain I understand the most difficult material presented in the two class periods over natural selection and evolution.

1	2	3	4	5	6	7
not at all true of me						very true of me

03. I am confident I understand the basic concepts taught in the two class periods over natural selection and evolution.

1	2	3	4	5	6	7
not at all true of me						very true of me

04. I am confident I understand the most complex material presented by the instructor in the two class periods over natural selection and evolution.

1	2	3	4	5	6	7
not at all true of me						very true of me

The following questions ask about your motivation for, and attitudes about, natural selection and evolution. Remember there is no right or wrong answers; just answer as accurately as possible. Use this scale to answer questions. If you think the statement is very true of you, mark "very true of me"; if a statement is not at all true of you, mark "not at all true of me". If the statement is more or less true of you, find the place between the two ends that best describes you.

05. I am confident I did an excellent job on the assignments and tests for the two class periods over natural selection and evolution.

1	2	3	4	5	6	7
not at all true of me						very true of me

06. I expected to do well in the two class periods over natural selection and evolution.

1	2	3	4	5	6	7
not at all true of me						very true of me

07. I am certain I mastered the skills taught in the two class periods over natural selection and evolution.

1	2	3	4	5	6	7
not at all true of me						very true of me

08. Considering the difficulty of this course, the teacher, and my skills, I think I did well in the two class periods over natural selection and evolution.

1	2	3	4	5	6	7
not at all true of me						very true of me

The following questions relate to your opinion on how having animals versus not having animals affected your time during the lesson

09. I felt I learned more when animals were used in the lesson.

1	2	3	4	5	6	7
not at all true of me						very true of me

10. I felt I learned more when pictures were used in the lesson.

1	2	3	4	5	6	7
not at all true of me						very true of me

11. I was more interested when animals were used in the lesson.

1	2	3	4	5	6	7
not at all true of me						very true

12. I was more engaged in the lesson when animals were used.

1	2	3	4	5	6	7
not at all true of me						very true

13. I was more engaged in the lesson when animals were not used.

1	2	3	4	5	6	7
not at all true of me						very true