PRESERVICE MIDDLE SCHOOL SCIENCE TEACHER'S ATTITUDES AND BELIEFS TOWARD BIOLOGICALLY DIVERSE ANIMALS

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INTRODUCTION

To fully understand ecosystem processes, students must learn information about biodiverse groups of animals (National Research Council, 2011). Students cannot learn information they are not exposed to. Research has shown that United States (US) kindergarten through fourth grade (K-4) preservice elementary teachers have positive attitudes toward mammals and negative attitudes toward reptiles, amphibians and almost all invertebrates (Wagler, 2010). These attitudes affect their beliefs about what specific animal information they plan to include in their future science classroom with the vast majority of preservice elementary teachers planning to include mammal information and not information about reptiles, amphibians and almost all invertebrates (Wagler, 2010). This is problematic because approximately 99% of Earth's species are invertebrates and many ecosystem processes involve reptiles, amphibians and invertebrates. Currently, nothing is known about the attitudes and beliefs preservice middle school (i.e., 5^{th}-8^{th} grade [5-8]) science teachers have toward animals and how these attitudes and beliefs impact their role as future teachers. This is an important group of future teachers to evaluate because after completing grades K-4 students' progress to grades 5-8 where they experience increasingly complex concepts associated with biodiversity and ecosystem processes.

The purpose of this study was to assess the relationship between the US preservice middle school science teacher variables of attitude toward an animal; belief concerning likelihood of incorporating information about that animal into their future science classroom (henceforth referred to as "likelihood of incorporation") and the characteristics of US preservice middle school science teachers. These observed characteristics included preservice middle school science teacher gender; preservice middle school science teacher age; the number of college biological science courses (with an animal biodiversity component) the preservice middle school science teacher has taken and the preservice middle school science teacher's preference to teach biological science or physical science when they are an inservice middle school teacher.

METHODOLOGY

Research Questions and Hypotheses: Research Question 1: Is there an association between US preservice middle school science teacher attitude toward an animal and the preservice middle school science teacher characteristics? H_{01}: There is no association between US preservice middle school science teacher attitude toward an animal and the teacher characteristics. H_{a1}:

There is an association between US preservice middle school science teacher attitude toward an animal and the teacher characteristics.

Research Question 2: Is there an association between US preservice middle school science teacher likelihood of incorporation into future science classroom and the preservice middle school science teacher characteristics? H_{02}: There is no association between US preservice middle school science teacher likelihood of incorporation of an animal and the teacher characteristics. H_{a2}: There is an association between US preservice middle school science teacher likelihood of incorporation of an animal and the teacher characteristics.

Study Participants: The participants for the study consisted of 204 US preservice middle school (5-8) science teachers at a US midsized urban southwestern border region university with a predominantly Hispanic/Latino population. All of the preservice middle school science teachers were enrolled in a middle school science methods course. Of the 204 preservice middle school science teachers, 142 were female and 62 were male; mean age: 29.28; 187 Hispanic/Latino, 10 White, 5 African-American and 2 Other. All were participating were in the last semester (i.e. 16 weeks) of their senior level (i.e. fourth year) university public school teaching internship.

Study Procedure: The participants were asked to record their gender, age, number of college biological science courses (with an animal biodiversity component) taken and their preference to teach biological science or physical science when they were an inservice middle school teacher. The participants were then shown thirty randomized pictures of biodiverse animals (See APPENDIX Table 1) using a Microsoft PowerPoint presentation. Each animal was presented on a single PowerPoint slide. All of the animal pictures presented were in color, were the same size, were in non-aggressive positions and were of single adults in natural environments. The thirty animals chosen represent an extremely biodiverse group of animals across many trophic levels. For a detailed explanation of the protocol used to select the animal pictures see Wagler, 2010. For each picture the participants were first asked to rate their attitude (Likert scale: Extremely Negative [1], Negative [2], Neutral [3], Positive [4], Extremely Positive [5]) toward the animal shown by circling their response on the data collection sheet. The participants were then asked to rate the likelihood, based on their attitude (Likert scale: Extremely Unlikely [1], Unlikely [2], Likely [3], Extremely Likely [4]), of incorporating information about the animal shown into their future science classroom.

RESULTS

Dimensionality of Attitude: The largest three eigenvalues resulting from the polychoric correlation matrix of attitude scores were 7.510, 4.619, and 2.321 and these account for 70.5% of the response variability. Utilizing the factanal function in R operating on the polychoric correlation matrix as input, the resulting loadings for a three factor model are provided in Table 1. The characteristics of the animals that load for each attitude factor are provided in Table 2. The items that do not load on one of the three defined factors are not included in the subsequent analysis for attitude and likelihood of incorporation.

Table 1

Factor Loadings for Attitude and Likelihood of Incorporation

Attitude				Likelihood of Incorporation			
Animal	Factor 1	Factor 2	Factor 3	Animal	Factor 1	Factor 2	Factor 3
Lizard	0.86			Elephant	0.99		
Crayfish	0.81			Dolphin	0.91		
Snake	0.78			Lion	0.69		
Cockroach	0.75			Monkey	0.61		
Spider	0.73			Rabbit		0.73	
Salamander	0.73			Frog		0.59	
Worm	0.65			Sparrow		0.57	
Lion	0.59			Lizard		0.56	
Grasshopper	0.57			Turtle		0.54	
Mouse	0.56			Goldfish		0.54	
Deer	0.54			Perch		0.54	
Butterfly		0.91		Cockroach			0.77
Dolphin		0.89		Crayfish			0.72
Seal		0.70		Salamander			0.69
Rabbit		0.64		Spider			0.64
Monkey		0.56		Worm			0.64
Goldfish		0.53		Snake			0.63
Coral			0.80	Grasshopper			0.62
Sponge			0.65	Caterpillar			0.55
Clam			0.57				

Note: The cut-off for the estimated loadings was 0.50.

Table 2

Attitude and Likelihood of Incorporation Factors

Factor	Example Animals	Characteristics of Animals
Attitude 1	Snake, Cockroach and Spider	Unpopular; Evoke strong negative emotions of fear, disgust or perceived danger.
Attitude 2	Butterfly, Dolphin and Monkey	Popular; Evoke strong positive emotions; Do not evoke strong negative emotions of fear, disgust or perceived danger.
Attitude 3	Coral, Sponge and Clam	Aquatic invertebrates that are not popular or unknown based on their physical appearance. Do not evoke strong negative or positive emotions and do not evoke emotions of fear, disgust or perceived danger.
Likelihood of Incorporation 1	Elephant, Dolphin and Monkey	Popular large vertebrate mammals.
Likelihood of Incorporation 2	Rabbit, Turtle and Goldfish.	Popular small vertebrates that are commonly kept as pets by children and are housed in US school classrooms. Do not evoke strong negative emotions of fear, disgust or perceived danger.
Likelihood of Incorporation 3	Cockroach, Spider and Snake.	Almost all invertebrates; Over half are arthropods (i.e., insect, arachnid and crustacean). Unpopular and evoke strong negative emotions of fear, disgust or perceived danger.

Dimensionality of Likelihood of Incorporation: Similar to the structure of the attitude items, the likelihood of incorporation items also yield a three factor fit. However, the loading pattern is different than the loading pattern for the attitude scores. The first three ordered eigenvalues based on the estimated polychoric correlation matrix are 8.385, 3.229, and 2.162 and the first three principal components account for 53.4% of the variability in likelihood scores. Table 1 contains the factor loadings for the likelihood of incorporation scores also computed in R using the factanal function and a promax rotation. The characteristics of the animals that load for each likelihood of incorporation factor are provided in Table 2.

Internal Consistency: These factor models provide evidence that the attitude and likelihood of incorporation items are valid measures. The internal consistency of the items is evaluated using Cronbach's alpha. For the set of attitude scores, internal consistencies are 82.4%, 75.0%, and 63.3%, respectively for factors 1, 2, and 3. Similarly, for the likelihood of incorporation scores, the internal consistency is 71.8%, 66.1%, and 82.3%, respectively, for factors 1, 2, and 3.

Attitude and Likelihood of Incorporation Factors: The six factor groups of animals (See Table 1 and 2) are consistent with past research findings. Specific groups of animals have been found to evoke negative attitudes, elevated levels of disgust, fear and perceived danger in humans (Prokop et al. 2010; Wagler, 2010; Wagler & Wagler, 2011). For example, females have significantly higher negative attitudes toward insects and spiders than birds and mammals (Wagler, 2010; Wagler & Wagler, 2011). Groups of animals are also defined by humans as being popular and unpopular (Kellert, 1993; Prokop & Tunnicliffe, 2010), with mammals evoking extremely positive attitudes (Wagler, 2010) and most invertebrates evoking negative attitudes (Kellert, 1993; Wagler, 2010; Wagler & Wagler, 2011).

Analysis of Attitude Items: With regard to testing research question 1 or $H_{01,}$ the model suggests that age and gender are significantly associated with the responses belonging to attitude factor 1 (95% simultaneous log OR CIs: Age=(-1.616, -0.190) and Gender=(0.213, 1.694)) while the number of college biological science courses taken, ethnicity (i.e., White or minority) and binary variable indicating preference to teach biological science or physical science are not good predictors in the model (e.g., all log OR interval estimators contain 0). Thus, H_{01} is rejected for factors Age and Gender for this set of animals.

For this subset of animals and with regard to the null hypothesis H_{01}, the number of college biological science courses taken and gender are pointwise (not simultaneously) significant predictors in the model (95% simultaneous log OR CIs: number of college biological science courses taken (NCBSCT)=(-0.031, 0.424) and Gender=(-1.524, 0.015)) while the remaining explanatory variables are not helpful explaining the response. Thus, H_{01} is rejected assuming only pointwise statistical significance for factors NCBSCT and Gender for this set of animals.

With regard to hypothesis H_{01}, only one of the preservice middle school science teacher characteristics are helpful in predicting the item response for the subset of items rating the attitude of animals. That is, there is no difference in how preservice middle school science teachers rate their attitude by these characteristics. Thus, we fail to reject H_{01} for any factors for this set of animals.

Analysis of Likelihood of Incorporation Items: In reference to research question 2 and hypothesis H_{02}, note that none of the preservice middle school science teacher characteristics are statistically significant for predicting the likelihood of incorporation for this subset of animals. Thus, we fail to reject H_{02} for any factor for the factor 1 animals.

Note that the number of college biological science courses taken is positively associated with the likelihood of incorporating this subset of animals, but not when simultaneously estimating these parameters (95% simultaneous log OR CIs: NCBSCT=(-0.032, 0.404) and Age=(-1.257, 0.231)) for testing H_{02}. All other predictor variables are not helpful in predicting the likelihood of incorporation for this subset of animals. Thus, H_{02} is rejected for factors NCBSCT and Gender with only pointwise statistical significance for this set of animals.

For testing hypothesis H_{02}, note that the number of college biological science courses the preservice middle school science teachers took and their age affects the likelihood of incorporation for this subset of animals (95% simultaneous log OR CIs: NCBSCT=(0.149, 0.632) and Age=(-1.570, 0.002)). Thus, H_{02} is rejected for factors NCBSCT and Gender for the third set of animals.

DISCUSSION

Attitude Toward Factor 1 Animals: Given that the null hypothesis for attitude was rejected for the Age and Gender factors, there is evidence that older preservice middle school science teachers are more likely to have a higher attitude than younger preservice middle school science teachers with all other variables held constant. Additionally, it is found that male preservice middle school science teachers are more likely to rate factor 1 animals higher than female preservice middle school science teachers with all other variables held constant.

Attitude Toward Factor 2 Animals: None of the variables included show evidence of affecting attitude towards factor 2 animals when the overall type I error is controlled. However, the null hypothesis was rejected with pointwise significance for the number of college biological science courses taken and gender have pointwise statistical significance. This provides evidence that those with more biological science courses have higher odds of having a favorable attitude towards factor 2 animals. Additionally, the factor 2 animals are more favorably rated among male than female participants.

Attitude Toward Factor 3 Animals: None of the variables exhibit familywise or pointwise statistical significance for this subset of the animals since the null hypothesis failed to be rejected for any factor for this set of animals. These animals in general received moderate ratings with little variability.

Likelihood of Incorporation for Factor 1 Animals: None of the variables exhibit familywise or pointwise statistical significance for this subset of the animals since the null hypothesis failed to be rejected for this set of animals. These animals in general received high ratings with little variability. Most preservice middle school science teachers rate these animals highly with little differences observed between the preservice middle school science teacher characteristics.

Likelihood of incorporation for Factor 2 Animals: None of the variables exhibit significance with the familywise type I error rate is controlled. However, the null hypothesis for this set of animals was rejected pointwise for both the number of college biological science courses taken and age appear to exhibit pointwise significance when the levels of the remaining variables are held constant. According to the model, taking one more college biological science course increases the odds of incorporating factor 2 animals and younger students are less likely to incorporate factor 2 animals.

Likelihood of Incorporation for Factor 3 Animals: For the set of factor 3 animals, the null hypothesis was rejected for the number of college biological science courses taken and age are statistically significant when holding all other variables constant and when controlling for the familywise error. In this model, the number of college biological science courses taken increases the odds of incorporating this class of animals and older preservice teachers have increased odds of incorporating this animal.

IMPLICATIONS

The findings of this study are clear. The preservice middle school science teacher characteristics that positively increased the preservice middle school science teacher's attitude or the likelihood of incorporating information about biodiverse group of animals into their future classroom are being a male, having taken one additional college biological science course (with an animal biodiversity component) or being older than 26 years of age. The implications of these findings will be addressed in this order. An additional finding is that these preservice middle school science teacher characteristics have the greatest positive effect on the factor 1 animals for attitude scores (i.e., overwhelmingly reptiles, amphibians and invertebrates) and the factor 3 animals for likelihood of incorporation scores (i.e., reptiles, amphibians and invertebrates) (See Table 1 and 2). These two groups of animals have the common characteristic that they tend to be unpopular or evoke strong negative emotions of fear, disgust or perceived danger in most humans (Kellert, 1993; Prokop & Tunnicliffe, 2010; Wagler, 2010; Wagler & Wagler, 2011).

Gender: Past research has shown females tend to have greater disgust, fear, perceived danger and negative attitudes toward specific animals than males (Prokop & Tunnicliffe, 2010; Prokop et al. 2010). Our finds are consistent with those of past studies but new to this study is the finding that these emotions are an influence (See Figure 1) that decreases the amount of biodiversity information female preservice middle school science teachers plan to include in their future classrooms. This was not the case with male preservice middle school science teachers, as they plan to include a much broader amount of biodiversity information including information about invertebrates (e.g., insects, spiders and worms), reptiles (e.g., snakes) and amphibians (e.g., salamander).

Based on this finding teacher programs should implement activities, focused on female preservice middle school teachers, that expose them to information about biodiverse groups of animals. These activities may include activities during their science methods course, field trips or cooperative activities between the university, zoos, nature centers or other entities where living animals exist. These events should also allow the preservice teachers to develop activities with

living animals that they can teach to children that come to the zoo, nature centers or other appropriate entity. Instead of the normal societal tendency to focus on charismatic megafauna such as mammals and birds (Barney, Mintzes, & Yen, 2005), efforts should focus on invertebrates, reptiles and amphibians.

Number of College Biological Science Courses Taken: Also unique to this study is the finding that preservice middle school science teachers that have taken an additional biological science course (with an animal biodiversity component) plan to include information about invertebrates, reptiles and amphibians in their future science classroom. Teacher education programs should encourage their students to take an additional biological science course (with an animal biodiversity component) as an elective to increase their understanding of the interaction of biodiversity and ecosystem processes.

Age: Previous research, with children, has found age is a factor in human attitudes toward animals (Prokop & Kubiatko, 2008). New to this study is the finding that, with adults, age is a factor effecting human attitudes and likelihood of incorporation toward animals. We have found that preservice middle school science teachers that are older than 26 years of age have more positive attitudes toward a larger group of biodiverse animals and are willing to incorporate a larger amount of information about biodiverse groups of animals into their future classrooms than preservice middle school science teachers that are 19 to 26 years of age (See Table 1 and 2). This dynamic provides a unique opportunity, during activities, to allow older preservice middle school science teachers to mentor and partner with younger preservice middle school science teachers.

CONCLUSION

This study shows preservice middle school science teachers that are females, younger than 27 years of age or have taken fewer college biological science courses (with an animal biodiversity component) do not plan to teach their students about the vast majority of life on Earth. Middle school students cannot learn information they are not exposed to. This lack of biodiversity information may affect middle school student's understating of Earth's biodiversity and global ecosystem processes. This content is essential to having a complete understanding of biology and being an ecologically literate citizen that can fully participate in the preservation of global ecosystems (Wagler, 2011; Wagler, 2011a; Wagler, 2012). Educational intervention is needed with preservice middle school science teachers. Teacher education programs should use the minimal amount of funds needed to implement simple but effective activities with living animals that have been experimentally shown to increase both attitude and likelihood of incorporation in preservice teachers (Wagler & Wagler, 2011).

APPENDIX

Table 1

Animal Pictures Used in the Study

PowerPoint Slide Number	Animal	PowerPoint Slide Number	Animal
1	Fox	16	Bird (Sparrow)
2	Clam	17	Spider
3	Seal	18	Bird (Red-tailed Hawk)
4	Starfish	19	Caterpillar (Monarch)
5	Lion	20	Salamander
6	Crayfish	21	Mouse
7	Bear	22	Rabbit
8	Cockroach (Madagascar Hissing)	23	Sponge
9	Butterfly (Monarch)	24	Turtle
10	Grasshopper	25	Lizard (Iguana)
11	Elephant	26	Dolphin
12	Snake	27	Deer
13	Fish (Goldfish)	28	Coral
14	Frog	29	Monkey
15	Fish (Freshwater Perch)	30	Worm (Earth)

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