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Assessing the Attitudes and Beliefs of Preservice Middle School Science Teachers toward Biologically Diverse Animals

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The purpose of this study was to assess the relationship between United States (US) preservice middle school science teacher characteristics, their attitude toward a specific animal and their belief concerning the likelihood of incorporating information about that specific animal into their future science classroom. The study participants consisted of 204 US preservice middle school science teachers. The participants self-reported their gender, age, number of college biological science courses 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 pictures of biodiverse animals. For each picture the participants rated their attitude toward the animal shown. The participants then rated the likelihood, based on their attitude, of incorporating information about the animal shown into their future science classroom. 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 groups of animals into their future classroom were being a male, having taken one additional college biological science course or being older than 26 years of age. Implications are discussed that are applicable to teacher education programs and science educators.

Keywords: animal, attitude, belief, preservice, middle school, science

INTRODUCTION

To fully understand ecosystem processes, students must learn information about biodiverse groups of animals (National Research Council [NRC], 1996; NRC, 2011). Students cannot learn information they are not exposed to. Research has shown

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that United States (US) kindergarten through fourth grade (i.e., 5 to 10 years of age [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 (Johnson, 2003) and many ecosystem processes involve reptiles, amphibians and invertebrates. Currently, nothing is known about the attitudes and beliefs preservice middle school (i.e., 5th-8th grade [5-8]; 10 to 15 years of age) 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.

Theoretical Underpinnings of the Study

Human attitude is defined as a "psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly&Chaiken, 1993, p.1). Human belief is defined as an estimate of the likelihood that the knowledge one has about an entity is correct or, alternatively, that an event or a state of affairs has or will occur (Eagly&Chaiken, 1998). The 1 (past attitude and beliefs of humans) (See Figure 1) that are linked to a particular entity (i.e., an animal) affect 2 (the individual's present attitude) toward that entity.

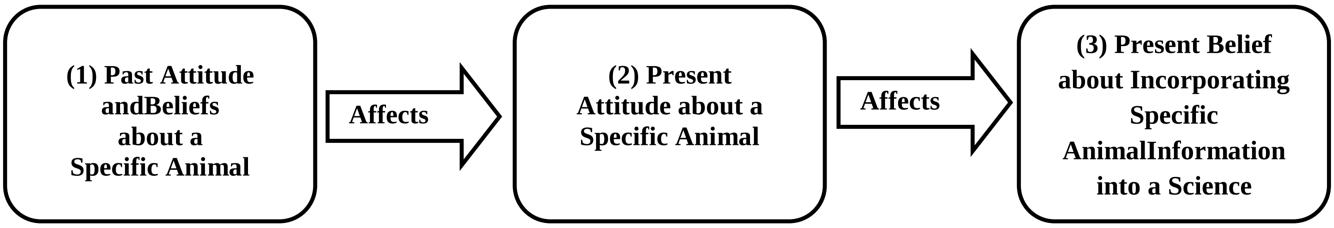

Figure 1. Association between Human's Past Attitude and Beliefs, Present Attitude and Present Belief

That attitude, in turn, affects 3 (present beliefs associated with that entity) (Kruglanski&Stroebe, 2005; Marsh & Wallace, 2005). The mechanisms by which beliefs influence attitudes and attitudes influence beliefs is based on the way attitudes and beliefs are perceptually organized (Albarracín, Johnson &Zanna 2005;

Heider, 1958), cognitively organized (Albarracín et al., 2005; Osgood &Tannenbaum, 1955; Rosenberg, 1960) and the outcomes of judgmental processes (Albarracín et al., 2005; Sherif et al., 1965). Furthermore, it is also theorized that specific human emotions (i.e., fear and disgust) toward some animals is an evolutionary adaptation that is protective and produces human avoidance of potentially dangerous and disease causing animals (Curtis, Aunger, Rabie, 2004; Seligman, 1971).

Literature Review

Norwegian children and adolescent's degree of preference for animals varied depending on the type of animal (Bjerke, Odegardstuen & Kaltenborn, 1998). The spider, crow and bee were found to be the least favorite species while the "dog, cat, horse, and rabbit were the favorite species" (Bjerke et al. 1998, p. 224). Very few of the studies participants were willing to save ecologically-significant insects (i.e., ants, bees and lady beetles) from going extinct (Bjerke et al. 1998).

Norwegian children and adolescents "degree of preference for various animal species, participation in animal-related activities, and the presence of pets at home"(Bjerke, Kaltenborn & Odegardstuen, 2001, p.86) has also been assessed. 71% of the participants had an animal at home, 72% were involved in fishing, 72% fed birds and 66% read about animals. Animal-related activity participation decreased as the children and adolescents got older. Participants without pets disliked farm and wild animals more than those that owned pets. Positive correlations were found between participation in animal-related activities and the liking of animal species. Children and adolescents "who reported allergic reactions to animals, or had been injured by an animal, liked animals as much as, or more than, did the other respondents" (Bjerkeet al. 2001, p.86). Lastly, "gender differences were largest for horseback riding (girls most) and for fishing and hunting (boys most)" (Bjerke et al. 2001, p.86). All three studies used data collected from "562 children and adolescents, aged between 9 and 15 years, from one urban and two rural areas in Southern Norway" (Bjerkeet al. 1998, p. 79).

The attention that children, the media and the scientific community give to insects and other arthropods has also been investigated (Snaddon & Turner, 2007). The study assessed the popularity of different arthropod groups drawn by United Kingdom (UK) children, "in modern culture and in the scientific literature" (Snaddon& Turner, 2007, p. 33). It was found that UK children's preference for insect groups was strongly correlated with their representation in the scientific literature and in modern culture. It was also found that none of the three measures of popularity of the arthropod groups "correlated with their abundance or conservation status in the UK" (Snaddon& Turner, 2007, p.33). Snaddon and Turner (2007) suggest that the profile of lesser-known arthropod groups "needs to be raised to reduce the chance that threatened taxa are overlooked for conservation action" (Snaddon& Turner, 2007, p.33).

The impact of keeping pets on children's concepts of arthropods (i.e., crayfish and stag beetle) and vertebrates (i.e., fish, bird and mammal) has also been assessed in Slovakian children (Prokop, Prokop&Tunnicliffe, 2008). A significant number of children showed a misunderstanding of the internal organs of arthropods. Children, up to the age of ten, produced drawings of arthropods with internal skeletons (Prokop et al. 2008). Two thousand four hundred and thirty eight animals were reported as pets by the studies 1,252 participating children. Only ten of the reported pets were arthropods (i.e., spiders and insects). In a related study, arachnid (i.e., spider) and vertebrate (i.e., bat) attitudes in Slovakian children ranging from 10-16 years of age (Prokop&Tunnicliffe, 2008) were assessed. Children had more negative attitudes toward spiders than bats with female participants having greater negativity than male participants. Alternative conceptions and knowledge of bats and spiders "were distributed randomly irrespective of children's age or gender" (Prokop&Tunnicliffe, 2008, p. 87). A moderate correlation between attitude and knowledge of bats was found. No similar tendency was found with spiders (Prokop&Tunnicliffe, 2008).

Prokop and Kubiatko (2008) investigated Slovakian children's attitudes toward a wolf (i.e., predator) and a rabbit (i.e., prey). The children in the study ranged from 10-15 years of age. Prokop and Kubiatko (2008a) found that children 10-11 years of age "showed significantly more positive attitude toward a rabbit (prey) relative to wolf (predator)" (p. 1) but as children's age increased positive attitudes toward the wolf and rabbit generally decreased. Prokop and Kubiatko hypothesized "that these patterns could reflect either greater children's 'ecological thinking' or, more simply, decreasing interest toward animals in older children" (Prokop&Kubiatko, 2008a, p. 1).

Prokop and Tunnicliffe (2010) conducted research on Slovakian primary school children's attitudes and knowledge of three unpopular animals (i.e., potato beetle, wolf and mouse) and three popular animals (i.e., rabbit, ladybird beetle and squirrel). The participants possessed better knowledge of unpopular animals compared to popular animals even though they had less favorable attitudes towards unpopular animals. Participants that had pets in their house had better knowledge and more positive attitudes of both popular and unpopular animals. "Girls were less favorably inclined than boys to animals that may pose a threat, danger, or disease to them" (Prokop&Tunnicliffe, 2010, p. 21).

Attitudes towards spiders and the level of knowledge of spiders in high school students from Slovakia and South Africa have also been compared (Prokop, Tolarovičová, Camerik&Peterková, 2010). "Biology teaching in South Africa is based on ecosystems, but the Slovakian system is based on systematic zoology and botany" (Prokop et al. 2010, p. 1670). A statistically significant but low correlation between knowledge and attitude was found among the Slovakian students. Based on Kellert's (1996) categories of attitude (scientistic, negativistic, naturalistic, and ecologistic), "the South African students scored higher in the categories of scientistic, naturalistic, and ecologistic attitudes. Comparison of attitude towards spiders of indigenous Africans from coeducational Catholic schools revealed that South African students have greater fear of spiders than Slovakian students" (Prokop et al. 2010, p. 1665).

A strong statistically significant association exists between K-4 preservice elementary teacher's attitudes towards a specific animal and their likelihood to include or exclude information about that animal in their future science classroom (Wagler, 2010). Specifically, if a K-4 preservice elementary teacher has a positive attitude toward an animal they are much more likely to believe they will incorporate information about that animal into their future science classroom. Conversely, if a K-4 preservice elementary teacher has a negative attitude toward an animal they are much more likely to believe they will not incorporate information about that animal into their future science classroom. Based on these beliefs, the science classroom that the preservice elementary teachers plan to construct will be dominated by mammals (Wagler, 2010). The classroom will be void of any information about reptiles, amphibians and invertebrates (e.g., sponges, corals, worms, mollusks, crustaceans, arachnids and most insects). This study provided the first evidence that a preservice elementary teacher's attitude toward an animal affects their belief about incorporating information about that animal into their future science classroom.

K-4 preservice elementary teachers that received frequent direct contact with Madagascar hissing cockroaches *(Gromphadorhinaportentosa)* in an educational setting during their preservice training programs had their attitudes and likelihood of arthropod incorporation in future science curriculum changed in a positive way toward the Madagascar hissing cockroaches but not toward other arthropods that they did not have contact with (Wagler&Wagler, 2011). A pre/post randomized design with a control group was used for the study. The non-contact arthropods included a butterfly, lady beetle, dragonfly, grasshopper, spider, crayfish, millipede, centipede and scorpion. This finding provided evidence that in order to positively change preservice elementary teacher attitudes and incorporate beliefs toward a specific animal, frequent direct contact in an educational setting with that specific animal is needed (Wagler&Wagler, 2011).

The general trend observed was that the preservice elementary teachers displayed two different types of attitudes and incorporation rates depending on what arthropod picture they were shown (Wagler&Wagler, 2011). Specifically, the preservice elementary teachers had positive to extremely positive attitudes toward the butterfly, lady beetle and dragonfly and negative attitudes toward the Madagascar hissing cockroach (i.e., pretest only), spider, crayfish, centipede, grasshopper, millipede and scorpion (Wagler&Wagler, 2011). The preservice elementary teachers also had likely to extremely likely belief of future curriculum incorporation rates for the butterfly, lady beetle, dragonfly and unlikely incorporation rates for Madagascar hissing cockroach (i.e., pretest only), spider, crayfish, centipede, grasshopper, millipede and scorpion (Wagler&Wagler, 2011).

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 Caucasian, 5 African-American and 2 Other. All were participating in the last semester (i.e. 16 weeks) of their senior level (i.e. fourth year) university public school teaching internship. The participants of the study did not choose what section of their senior level university science education course they were enrolled in. They were placed into the section based on the proximity of their home location to the public school they interned in. For the purposes of data collection all senior level middle school university science education methods course sections were randomized. Based on the outcome of these random numbers, a random selection of sections was chosen for inclusion in the study. Clustered sampling was utilized where the primary sampling units were sections and the secondary sampling units were participants (Lohr, 1999).

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 4) 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 or the "Selection of Animal Pictures" section in the Appendix. 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.

Statistical Methodology

Exploratory analysis of the item responses for attitude and likelihood of incorporation utilized common factor models based on a polychoric correlation matrix (Olsson, 1979). The polychoric correlation matrix is a measure of correlation appropriate for ordinal scale variables (i.e., Likert ratings). Factor analytic models are useful for reducing a large set of correlated variables into a smaller set of composite variables. In order to assess how the characteristics of the preservice middle school science teachers affect the attitude scores, proportional odds modeling was employed. Simultaneous confidence intervals for the slope parameters of these proportional odds models test the hypotheses (e.g., H_{01} and H_{02}). The confidence bounds were adjusted to control the family-wise type I error rate for the set of inferences using the method of Westfall (1997). Log odds ratios that do not include 0 indicate that the factor significantly affects the probability of increasing the attitude or likelihood of incorporation. All analysis was performed in R (R Development Core Team, 2010) using the packages polychor (Fox, 2010), multcomp (Hothorn et al., 2008), and ordinal (Christensen, 2011).

Limitations of the Study

The animal pictures were projected on a screen. Because of this, the animal pictures were not the same size as the actual animal. The animal pictures were also two dimensional while the actual animal is three dimensional.

RESULTS

Dimensionality of Attitude

Table 4 in the Appendix presents the PowerPoint slide number, the animal shown on each slide, the mean for all participants' responses to rating their attitude toward the specific animal shown and rating their likelihood of incorporating information about the specific animal shown into their future science classroom curriculum. The largest three eigenvalues resulting from the polychoric correlation matrix of attitude scores were 7.510, 4.619, and 2.321. These were significantly larger than all of the remaining eigenvalues and the first three principal components accounted for 70.5% of the response variability. These statistics imply a three factor model is appropriate for the attitude scores. 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 promax and varimax rotations both yielded the same factor structures with only minor changes in the magnitude of the loadings. 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[a]	Factor 2[b]	Factor 3[c]	Animal	Factor 1[d]	Factor 2[e]	Factor 3[f]
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.
[a]Attitude 1 Factor- Characteristics of animals: Unpopular; Evoke strong negative emotions of fear, disgust or perceived danger.
[b] Attitude 2 Factor- Characteristics of animals: Popular; Evoke strong positive emotions; Do not evoke strong negative emotions of fear, disgust or perceived danger.
[c] Attitude 3 Factor- Characteristics of animals: 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.
[d] Likelihood of Incorporation 1 Factor- Characteristics of animals: Popular large vertebrate mammals.
[e] Likelihood of Incorporation 2 Factor- Characteristics of animals: 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.

[f]Likelihood of Incorporation 3 Factor- Characteristics of animals: 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.

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 varimax rotation yielded very similar structures. 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 (Curtis et al., 2004; Davey, 1994; Prokop et al. 2010; Seligman, 1971; 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 (Bjerke et al. 1998; Bjerke et al. 2001; Kellert, 1993; Prokop&Tunnicliffe, 2010; Snaddon& Turner, 2007), 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. In the model for factor 1 of attitude, the variance for the random effect for animal is estimated to be 1.016. With regard to testing research question 1 (e.g., 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., Caucasianor Hispanic/Latino) 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) (See Table 3). Thus, H_{01} is rejected for factors Age and Gender for this set of animals.

Table 3. GLM Log Odds Ratio Simultaneous Intervals for Attitude and Likelihood of Incorporation

Covariate	GLM Parameter Estimates					
	Factor 1 Attitude	Factor 2 Attitude	Factor 3 Attitude	Factor 1 Likelihood	Factor 2 Likelihood	Factor 3 Likelihood
PT (1=bio)	0.079	0.308	-0.069	0.205	0.000	0.029
Ethnicity (1=Caucasian)	-0.476	0.488	0.698	1.213	-0.321	0.105
NCBSCT	-0.039	0.197*	-0.004	-0.022	0.186*	0.390**
Age (1≤26)	-0.903**	-0.033	-0.167	0.266	-0.513*	-0.786**
Gender (1=male)	0.954**	-0.755*	-0.165	-0.455	0.019	0.497

*Pointwise statistically significant
**Familywise statistically significant

For the factor 2 model, the variance for the random effect for animal is estimated to be 0.483. 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 (See Table 3). Thus, H_{01} is rejected assuming only pointwise statistical significance for factors NCBSCT and Gender for this set of animals.

For the model for factor 3, the variance for the random effect for animal is estimated to be 0.109. In reference to the 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 (See Table 3). 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 the model for factor 1 of likelihood of incorporation, the variance for the random effect for animal is estimated to be 0.432. In reference to research question 2 (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 (See Table 3). Thus, we fail to reject H_{02} for any factor for the factor 1 animals.

The model for factor 2 had a random effect variance estimated to be 0.291. 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} (See Table 3). 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.

Factor 3 model had a variance for the random effect for animal estimated to be 0.394. 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)) (See Table 3). Thus, H_{02} is rejected for factors NCBSCT and Gender for the third set of animals.

DISCUSSION

Findings

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 (e.g., Snake, Cockroach and Spider) 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 (e.g., Butterfly, Dolphin and Monkey) 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 (e.g., Coral, Sponge and Clam)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 (e.g., Elephant, Dolphin and Monkey)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. No variables exhibit statistical significance, even with the familywise type I error rate controlled. However, the null hypothesis for this set of animals (e.g., Rabbit, Turtle and Goldfish)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 (e.g., Cockroach, Spider and Snake), 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 (Bjerke et al. 1998; Bjerke et al. 2001; Kellert, 1993; Prokop&Tunnicliffe, 2010; Snaddon& Turner, 2007; 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; Prokop et al. 2010a). Our findings are consistent with those of past studies but new to this study is the finding that beliefs and psychological tendencies are an influence (See Figure 1) that decreases the attitudes of female preservice middle school science teachers toward factor 1 animals (e.g., Snake, Cockroach and Spider). This was not the case with male preservice middle school science teachers, as they have higher attitudes toward invertebrates (e.g., insects, spiders and worms), reptiles (e.g., snakes) and amphibians (e.g., salamander) but neither male or female preservice middle school science teachers plan to incorporate information about these animal groups into their classroom.

Based on this finding teacher programs should implement activities that expose preservice middle school science teachers 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; Feldhamer, Whittaker, Monty &Weickert, 2002), efforts should focus on invertebrates, reptiles and amphibians. Special emphasis should be placed on arthropods (e.g., spiders and cockroaches) since past research has shown specific female groups have no desire to teach children about these animals (Wagler, 2010) but when they interact with living arthropods their desire to educate their future students about them increases substantially

(Wagler&Wagler, 2011). Similar activities should also be encouraged with inservice middle school science teachers.

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. This is a large positive return for the small amount of effort this entails on the part of teacher training programs and the individual preservice middle school science teacher. 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). Again, this information involves older preservice middle school science teachers incorporating reptile, amphibian and invertebrate information while their younger counterparts do not plan to incorporate this information into their classrooms. 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. Collaborations of this type have the potential to alleviate the fears that K-8th grade preservice teachers have toward most non-avian and non-mammalian animals (Wagler, 2010; Wagler&Wagler, 2011).

CONCLUSION

This study shows preservice middle school science teachers that are younger than 27 years of age or have not taken an additional college biological science course (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).

REFERENCES

Albarracín, D., Johnson B. T. &Zanna, M. P. (Eds.). (2005). *Thehandbookofattitudes***.** Mahwah, NJ: Lawrence Erlbaum.

Barney, E. C., Mintzes, J. J., & Yen, C.-F. (2005). Assessing knowledge, attitudes, and behavior toward charismatic megafauna: The case of dolphins. *Journalof Environmental Education, 36* (2), 41-55.

Bjerke, T., Odegardstuen, T. S. &Kaltenborn, B. P. (1998). Attitudes toward animals among Norwegian children and adolescents: species preferences. *Anthrozoös, 11* (4), 227-235.
Bjerke, T., Kaltenborn, B. P., &Odegardstuen, T. S. (2001). Animal-related activities and appreciation of animals among children and adolescents.*Anthrozoös, 14* (2), 86-94.
Christensen, R. H. B. (2011). ordinal---Regression Models for Ordinal DataR package version 2011.05-10 http://www.cran.r-project.org/package=ordinal/.
Curtis, V., Aunger, R. & Rabie, T. (2004). Evidence that disgust evolved to protect from risk of disease. *Proceedings of the Royal Society B (Suppl.), 271*, S131–S133.
Davey, G. C. L. (1994). The "disgusting" spider: The role of disease and illness in the perpetuation of fear of spiders. *Society & Animals, 2,* 17–25.
Eagly, A. H. &Chaiken, S. (1993). *The psychology of attitudes.*Orlando, FL: Harcourt Brace Jovanovich.
Eagly, A. H. &Chaiken, S. (1998). Attitude structure and function.In D. Gilbert, S.T. Fiske, & G. Lindsey, et al (Eds.), *Handbook of Social Psychology,* 4th Ed. (Vol. 1, pp. 269-322). Boston: McGraw-Hill.
Feldhamer, G., Whittaker, J., Monty, A. M., &Weickert, C. (2002). Charismatic mammalian megafauna: Public empathy and marketing strategy. *Journal of Popular Culture, 36,* 160-168.
Fox, J. (2010). polycor: Polychoric and Polyserial Correlations. R package version 0.7-8. http://CRAN.R-project.org/package=polycor.
Heider, F. (1958).*The psychology of interpersonal relations.*Hillsdale, NJ: Lawrence Erlbaum Associates.
Hothorn, T., Bretz, F. & Westfall, P. (2008). Simultaneous Inference in General Parametric Models.*Biometrical Journal,50* (3), 346--363.
Johnson, G. B. (2003). *The living world.* New York: McGraw Hill.
Kellert, S. R. (1993). Values and perceptions of invertebrates.*Conservation Biology, 7* (4), 845– 855.
Kellert, S.R. (1996). *The Value of Life.* New York: Island Press.
Kruglanski, A. W. &Stroebe, W. (2005).The influence of beliefs and goals on attitudes: Issues of structure, function, and dynamics. In D. Albarracín, B. T. Johnson & M. P. Zanna, (Eds.), *TheHandbookofAttitudes* (pp. 323-368). Mahwah, NJ: Lawrence Erlbaum.
Lohr, S. (1999).*Sampling: Design and Analysis.* Pacific Grove, CA: Brooks/Cole Publishing.
Marsh, K. L. & Wallace, H. M. (2005). The influence of attitudes on beliefs: Formation and change. In D. Albarracín, B. T. Johnson & M. P. Zanna, (Eds.), *Thehandbookofattitudes* (pp. 323-368). Mahwah, NJ: Lawrence Erlbaum.
National Research Council (NRC).(1996). *National science education standards.* Washington, DC: National Academy Press.
National Research Council (NRC). (2011). *A framework for k-12 science education: practices, crosscutting concepts, and core ideas.* Washington DC: National Academy Press.
Olsson U. (1979) Maximum likelihood estimation of the polychoric correlation coefficient.*Psychometrika*, *44* (4), 443-460.
Osgood, C. E., &Tannenbaum, P. H. (1955).The principle of congruity in the prediction of attitude change.*Psychological Review, 62,* 42-55.
Prokop, P., &Tunnicliffe, S. D. (2008). "Disgusting" animals: Primary school children's attitudes and myths of bats and spiders.*Eurasia Journal of Mathematics, Science & Technology Education, 4* (2), 87-97.
Prokop, P., Prokop, M. &Tunnicliffe, S. D. (2008). Effects of keeping animals as pets on children's concepts of vertebrates and invertebrates. *International Journal of Science Education, 30* (4), 431–449.
Prokop, P., &Kubiatko, M. (2008). Bad wolf kills lovable rabbits: Children's attitudes toward predator and prey. *Electronic Journal of Science Education, 12* (1), 1-16.
Prokop, P., &Tunnicliffe, S.D. (2010).Effects of keeping pets on children's attitudes toward popular and unpopular animals.*Anthrozoös, 23* (1), 21 – 35.
Prokop, P., Tolarovičová, A., Camerik, A., &Peterková, V. (2010). High school students' attitudes towards spiders: A cross-cultural comparison. *International Journal of Science Education, 32* (12): 1665 – 1688.
R Development Core Team (2010). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.ISBN 3-900051-07-0, URL http://www.R-project.org/.

Rosenberg, M. J. (1960). An analysis of affective-cognitive consistency. In M. J. Rosenberg, C. I. Hovland, W. J.McGuire, R. P. Abelson, & J. W. Brehm (Eds.), *Attitude organization and change: An analysis of consistency amongattitude components*(pp. 15-64). New Haven, CT: Yale University Press.

Seligman, M. E. P. (1971). Phobias and preparedness.*Behavior Therapy, 2,* 307–320.

Sherif, C. W., Sherif, M. S. &Nebergall, R. E. (1965).*Attitude and attitude change.* Philadelphia: W.B. Saunders Company.

Snaddon, J.L. & Turner, E.C. (2007). A child's eye view of the insect world: Perceptions of insect diversity. *Environmental Conservation,34* (1), 33-35.

Wagler, R. (2010). The association between preservice elementary teacher animal attitude and likelihood of animal incorporation in future science curriculum.*The International Journal of Environmental and Science Education, 5* (3), 353-375.

Wagler, R. (2011). The anthropocene mass extinction: An emerging curriculum theme for science educators. *The American Biology Teacher, 73* (2), 78-83.

Wagler, (2011a).The impact of human activities on biological evolution: A topic of consideration for evolution educators. *Evolution: Education and Outreach, 4* (2), 343-347.

Wagler, R. (2012). The sixth great mass extinction.*Science Scope, 35* (7), 36-43.

Wagler, R., &Wagler, A. (2011). Arthropods: Attitude and incorporation in preservice elementary teachers. *The International Journal of Environmental and Science Education, 6* (3), 229-250.

Westfall (1997) Multiple Testing of General Contrasts Using Logical Constraints and Correlations, *Journal of the American Statistical Association*, 92, (437), p. 299-306.

APPENDIX

Table 4. Animal Pictures Used in the Study, Mean Attitude and Mean Likelihood of Incorporation

PowerPoint Slide Number	Animal	Mean Attitude toward Animal[a]	Mean Likelihood of Incorporation[b]
1	Fox	3.706	2.911
2	Clam	3.366	2.887
3	Seal	4.225	3.235
4	Starfish	3.931	3.237
5	Lion	4.297	3.577
6	Crayfish	2.880	2.490
7	Bear	3.951	3.327
8	Cockroach (Madagascar)	1.990	2.170
9	Butterfly (Monarch)	4.373	3.550
10	Grasshopper	3.088	2.796
11	Elephant	4.363	3.460
12	Snake	2.840	2.842
13	Fish (Goldfish)	3.971	3.290
14	Frog	3.275	3.040
15	Fish (Freshwater Perch)	3.446	2.920
16	Bird (Sparrow)	4.119	3.384
17	Spider	2.392	2.610
18	Bird (Red-tailed Hawk)	3.980	3.392
19	Caterpillar (Monarch)	3.510	3.158
20	Salamander	3.257	2.773
21	Mouse	3.176	2.825
22	Rabbit	4.294	3.280
23	Sponge	3.451	2.990
24	Turtle	4.000	3.150
25	Lizard (Iguana)	3.373	3.000
26	Dolphin	4.578	3.673
27	Deer	3.941	3.267
28	Coral	3.451	2.860
29	Monkey	4.248	3.337
30	Worm (Earth)	2.853	2.762

[a]Likert scale: Extremely Negative [1], Negative [2], Neutral [3], Positive [4], Extremely Positive [5].
[b]Likert scale: Extremely Unlikely [1], Unlikely [2], Likely [3], Extremely Likely [4].

Selection of Animal Pictures from Wagler, 2010

The selection of the animal pictures used in the study occurred in multiple phases. Initially, during the first pilot study, a representative sample from all of the classes comprising the kingdom Animalia was to be shown to the preservice teachers. This effort produced such a large number of animal pictures it was apparent that the data collection procedure would be too time intensive and the preservice teachers would suffer from fatigue. Based on these findings it was decided that the number of animal pictures should not exceed thirty and the criteria for inclusion should be more focused.

The category criteria for including an animal picture consisted of:

Category 1: Examples of animals that US children find and want to bring into their classroom (e.g., caterpillar, spider, crayfish, frog, grasshopper, snake, fish, turtle, etc.). Based on the researchers observations these animals are usually found in higher abundance in the environment and are easier for student to catch and transport to the classroom.

Category 2: Examples of terrarium and aquarium animals that are commonly purchased by US science teachers and/or are found in elementary (i.e., 5 to 10 years of age), middle (i.e.,10 to 15 years of age) and secondary classrooms (i.e., 15 to 18 years of age) (e.g., Madagascar hissing cockroach (MHC), iguana, goldfish, caterpillar, butterfly, spider, snake, frog, rabbit, etc.). Based on the researchers observations these animals tend to be available in US science teacher supply catalogs/websites and the US pet trade.

Category 3: Examples of both invertebrate and vertebrate animals. All thirty animal pictures presented were part of this category.

Category 4: Representative examples of animals that would occur at most trophic levels in a food chain and food web (e.g. earthworm→mouse→snake→hawk; cockroach→ spider→ frog→ bird→fox; coral→fish→fish→seal; sponge→mollusk→starfish→bird; etc.). All thirty animal pictures presented were part of this category.

Category 5: Examples of animal groups that have a tendency to appear in a "traditional" US secondary biology textbook. These groups present a way for students to explore animal biodiversity, animal evolution, common ancestry and other related topics. The groups are traditionally presented based upon specific evolutionary innovations. Two examples of these evolutionary innovations are the Porifera‟s (sponge) multicellularity (approximately 550 Mya) and the more recent evolutionary innovation of hair associated with the first mammals (approximately 220 Mya) (Johnson, 2003). The groups are sponges, corals, worms, mollusks, arthropods (insects, crustaceans, and arachnids), echinoderms, fish, amphibians, reptiles (snake, lizard and turtle), birds and specific groups of terrestrial and aquatic mammals. It should be noted that some biology textbooks include or exclude other animal groups. By focusing on these groups approximately 550 million years of animal evolution can be discovered. All thirty animal pictures presented were part of this category.

Category 6: Examples of animals that have been "traditionally" studied and/or dissected in US secondary biology courses (e.g., sponge, clam, starfish, earth worm, crayfish, grasshopper, freshwater perch and frog).

After the six categories were established a second pilot study was conducted where participants viewed different species of animals, within an animal group, to assess if different specific species invoked different attitudes and different levels of likelihood of incorporation. For example, pictures of different species of primates (one of the groups of mammals) were shown, as were different species of insects, different species of worms, different species of snakes, different species of birds, different species of fish, etc. The only animal groups that were found to be statistically different were birds, fish and insects. These groups tended to show greater variability depending on what animal from this group was shown. Because of this within-group variability differences, multiple animals were included in these three groups. Two examples of birds were shown (sparrow and red-tailed hawk), two examples of fish were shown (goldfish and freshwater perch) and three examples of insects were shown (MHC, grasshopper and monarch caterpillar/butterfly). The monarch caterpillar/butterfly was chosen to assess if different attitudes and curriculum incorporation rates existed for the same animal at different metamorphic stages.

Based on the six categories and the results of the pilot studies thirty animal pictures were chosen with most animals fitting into multiple categories (Table 4 in Appendix). For example, the monarch butterfly fits into category 1, 2, 3, 4, and 5 while the lion fits into categories 3, 4 and 5. The final thirty animals chosen represent an extremely biodiverse group of animals across many trophic levels. They also include the animals that have the highest probability of students being exposed to, in some capacity, while in elementary, middle and secondary school in the US. The thirty animal pictures were randomized. Based on the true random numbers generated, the thirty animal pictures (29 animals) were placed on the PowerPoint slides and shown to the participants.

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