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# The Relationship Between Bonding with Nonhuman Animals and Students' Attitudes Toward Science

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## Abstract

This paper examines the relationship of bonding with nonhuman animals during an interactive, animal-in-the-wild science program (Talking Talons) and the science attitudes of 358 young children between the ages of 8 and 14. Talking Talons utilizes typically wild animals such as raptors, reptiles, and bats in a school-based educational science curriculum. Qualitative data from interviews with students in the program indicated that “bonding with animals” (BWA) and the educators (BWE) within the program were related to increased positive attitudes toward science. The program used quantitative methods to examine these dual relationships—with animals and with educators—on student attitude toward science. The program performed a step-wise multiple regression with “Attitude toward Science” as the dependent variable and “Gender,” “Age,” and “Bonding with Animals” as independent variables. Both “Bonding with Animals” and “Bonding with the Educator” contributed significantly to prediction of the participants’ science attitudes. Altogether 28% of the variance in “Science Attitude” was predicted by both “Gender” and “Age” (10%), “Bonding with Animals” (16%) and “Bonding with Educator” (2%). Bonding with the animals had a large quantifiable relationship with student attitudes toward science.

## Keywords

attitude toward science, bonding with animals, classroom based science outreach, middle school science

## Introduction

Attitudes toward science have long been examined as an important factor in student science education. Researchers have found that attitudes toward science affect future course selection (Farenga & Joyce, 1998), motivation to study science (Slate & Jones, 1998), achievement in science (Mattern, 2000; Papanastasiou & Zembylas, 2002; Reynolds & Walberg, 1992), math achievement (Ellis, 1993), and general attitudes toward school (Jarvis & Pell, 2002). Improving student’s attitudes toward science could therefore be said to have many positive outcomes.

However, as students enter the middle school years, their generally positive attitudes about science decrease (Backes, 1994; Baker, 1985; Catsambis, 1995; Lee & Burkam, 1996; Mattern, 2000; Weinburgh, 1995; Willson, 1983); especially for girls (Backes, 1994; Lee & Burkam, 1996; Oliver, 1987; Papanastasiou & Zembylas, 2002; Warburton, Jenkins, & Coxhead, 1983; Weinburgh, 1995). Educators have attempted to use various methods to improve science attitudes. Counseling met with some success for males but little for females (Aremu, 1999). Utilizing computer based instruction also was found to lead to small changes in attitude (Chang, 2002). Of particular relevance is research examining changes in attitudes exhibited after exposure to “hands on” or inquiry-based science. These programs have been found to improve attitudes toward science (Bilgin, 2006; Gibson & Chase, 2002; Ornstein, 2006).

The current study examined the extent to which bonding with nonhuman animals was associated with science attitudes among a group of students who participate in the Talking Talons program. The students all experience the same “hands on” program, but the level of attachment they indicate towards the animals varies. Bonding with the animals (BWA) was chosen as an indication of the emotional investment level of the participants in the program.

In broad terms, research on the impact of bonding with animals has examined both physiological effects and emotional influence. Bonding with animals has been found to affect the general emotional well being of people (Levinson, 1984; Mason & Hagan, 1999; Poresky, Hendrix, Mosier, & Samuelson, 1988; Risley-Curtiss, Holley, & Wolf, 2006). Animals have specifically been shown to reduce anxiety and fear prior to patients undergoing medical treatment (Barker, Pandurangi, & Best, 2003; Barker, Rasmussen, & Best, 2003) and for health care professionals (Barker, Pandurangi et al., 2003). Contact with animals has also been shown to have positive physiological effects (Hoffman, 1991; Wells, 1998) and to provide companionship for the elderly (Banks & Banks, 2005) and especially for children of single parents (Bodsworth & Coleman, 2001).

Obviously, contact with animals has some impact on attitudes and behavior but research on the effect of animals in the classroom specifically is startlingly scant. This is surprising, since as many as 38% of elementary classrooms contain companion animals (Rud, Jr. & Beck, 2003). Animals are used as part of academic studies, for creative writing prompts, and for enjoyment in classrooms. (Rud, Jr. & Beck; Rud & Beck, 2000). Literature on classroom animals often focuses on the debate over whether classroom pets should be allowed due to allergies (Allow Classroom Pets?, 2007; Sack, 2003), practical considerations of keeping pets in the classroom (Bartlett, 2006; Zasloff & Hart, 1999) or general assertions that classrooms pets help social growth and

responsibility (Rud & Beck, 2000). One small research study found the presence of a dog in a classroom of six emotionally disturbed children had a positive impact on emotional stability and attitudes toward school (Anderson & Olson, 2006).

However, little research into the connection of bonding with animals and attitudes toward other factors such as science or school was found. This relationship deserves further attention. If bonding with animals is related to factors in the schoolroom such as science attitudes, then exposure to animal-based programs may have influential positive outcomes. This article examines the relationship between bonding with animals and bonding with the Talking Talons educator with science attitudes.

### **Introduction to the Talking Talons Program**

The Talking Talons program is located in Tijeras, New Mexico. The program's stated mission is, "To elevate youth to become effective advocates and ethical stewards of themselves, wildlife and the environment." Talking Talons has received recognition as an "exemplary program" from the Department of Health and Human Services.

The program utilizes non-releasable wild animals as teaching tools to engage student participation. Birds of prey are primarily utilized as well as bats and reptiles. The students do not handle bats because of concern for the transmission of rabies.

The Talking Talons educators inform the students which animals will be attending the next session. Students are allowed to absent themselves from the room if they are in anyway uncomfortable or if they have religious objections to viewing the animal (some Native Americans do not want to be in close proximity to owls).

These animals are unable to be returned to their natural environments, usually due to injury or imprinting on humans. The animals are brought to the classroom on a weekly basis; the students are taught about the biographies (the injuries and stories) of the individual animals as well as the scientific information relating to the animals. During these training sessions, the students are offered a mission to be youth spokespeople for the animals, whose injuries represent larger environmental problems such as the destruction of wild habitat and the disappearance of species. The students undergo formal training and practice in public speaking, animal handling, and providing a positive personal impression. Using the live animals, they then give presentations to younger students in lower grades in their school. These presentations cover the

biographies of the individual animals, including the factors that led to the acquisition by the Talking Talons program and the injuries or imprinting that caused the animal to be non-releasable.

Scientific knowledge about the species—such as habitat, diet, endangered status, and behaviors—is also included. The youth presenters serve as positive role models, learn and teach information, and acquire important public speaking skills. The curriculum is delivered to participating groups every week throughout the school year. Along with presentation skills, other activities such as role-playing exercises, team building, and animal handling are included.

The participants were from seven schools—three elementary schools and four middle schools. The number of schools served was based on available funding. The schools were selected based on both proximity and scheduling concerns. The school must be close enough to the Talking Talons center to make transportation of the animals feasible. The school administrators also agreed to provide both weekly time required for the program and teachers who were interested in participating. Students were offered the program based upon the membership in the participating teachers' classes. The parents and students both signed a permission slip allowing involvement in the program. The program was offered weekly, for approximately one hour, over the course of the school year. Groups received between 30-35 sessions, depending upon the schedule of the school.

## **Methods**

### *Participants*

Data were collected from 358 students between the ages of 8 and 14. The mean age of the students was 11.43 years with a standard deviation of 1.09 years.

The sample consisted of 175 (49%) females, 183 (51%) males. The students attended seven public schools in a semi-rural area outside Albuquerque, New Mexico, and received the Talking Talons program throughout the school year.

### *Qualitative Data Collection*

The qualitative data consisted of student interviews by an independent researcher at the end of the program. These interviews were conducted in small groups (5-8 students) for about a half hour. The students were allowed to comment on any aspects of the program.

Open-ended qualitative interviews are an important aspect of research in the relationship between humans and animals. Herzog (1993) values the use of qualitative methods to help researchers understand complex relationships. Qualitative methods applied to the human-animal bond also allow researchers to develop new theories in areas of little preexisting knowledge (Rennie, Phillips, & Quartaro, 1988). Open-ended qualitative research is less constrained by the preexisting factors determined by the researcher, and thus allows the students to articulate their feelings about the animals without constraint inherent in multiple-choice or fixed-answer questions.

### *Quantitative Data Collection*

The quantitative data were collected individually, prior to the qualitative data, in order to minimize the effect of the students interacting during the qualitative interviews.

All questions were scored on a Likert scale from 1-6 ranging from Very False to Very True. All questions and scales were renormed so that a higher value indicates a more desirable outcome. Therefore, a value of "5" indicates better science attitudes or more bonding with animals than a score of "3."

The Science Attitude scale consisted of 10 items designed to evaluate the participants' feelings and attitudes about science such as "Science is fun" and "I would like to learn more about science." This instrument was based on the classic 40-item instrument by Moore (Moore & Foy, 1997; Moore & Sutman, 1970) and was field tested three years prior to this study. However, item analysis indicated that only the 10 items retained were needed to preserve reliability. Thus, the instrument was shortened to reduce survey time.

The Bonding with Animals scale consisted of 8 items related to the participants' feelings about the animals in the program such as "I think about the Talking Talons animals when I am not in science class" and "I have a favorite Talking Talons animal."

This instrument was developed specifically for the Talking Talons program. During the creation of this instrument, several articles on developed surveys were consulted. The Companion Animal Bonding Scale (Melson, Peet, & Sparks, 1991) and The Attitude to Animals Scale (AAS) (Herzog, Betchart, & Pittman, 1991), were both considered as bonding surveys. However, the items included questions about direct physical contact, such as petting or cuddling the animal. As noted by Zasloff (1996), many attitude instruments assume direct physical contact with the animal in question. These instruments are really designed to measure attachment to pets rather than animals in general.

The animals in the Talking Talons program (with the exception of the snakes) are not the type of creatures who can be snuggled by the participants or handled without large leather gloves.

Therefore, two instruments with more general questions about animals were also consulted to develop the survey. These were the Animal Rights Scale (Wuensch, Jenkins, & Poteat, 2002) and the Attitudes toward Animals: Scales for Empirical Research (Kafer, Lago, Wamboldt, Harrington, & Bryant, 1989). Both scales contained questions more applicable to wild animals. However, the Talking Talons animals are not exactly wild, nor are they pets; therefore, the questions were modified somewhat to reflect the types of experiences the students would have with the Talking Talons animals.

The Educator Bonding scale consisted of 8 items related to the participants' feelings about the Talking Talons educators assigned to their classroom such as "If [I] saw my Talking Talons educator [teacher] at the store I would say hi to him or her" and "My Talking Talons educator [teacher] treats me fairly." This instrument was originally designed to simply provide feedback about the educators and thus was not piloted or derived from an existing instrument. Although the reliability proved to be good, no proof of validity is currently available.

Cronbach's alpha was calculated for each subscale using the overall sample. A reliability greater than  $\alpha = .7$  is considered good (Nunnally, 1978). The Bonding with Animals Scale had a reliability of  $\alpha = .79$ , the Science Attitude of  $\alpha = .96$  and the Educator Bonding of  $\alpha = .91$

## Results

### *Qualitative Results: Comments about the Talking Talons Animals*

Qualitative year-end interviews of the participants in the program indicated the bond the students had with the animals was crucial to the program. This bond with the animals was frequently mentioned by the students to the qualitative researcher. The students expressed views such as those taken from taped interviews below:

I liked seeing and learning the animals because I'm a big animal fan of all types. These are animals that you don't get to see close up, like the hawks they brought in for us, that was pretty cool. At Talking Talons they take really good care of their animals and just thinking that they trusted us with them, well, that made me feel proud to learn about them.

I liked that we were up close with the animals; we get to see them and hold them. It gave us a chance to learn more about them and that they aren't just pictures in

a book. They are moving and breathing, and what we learn about them makes it more real.

Doing the presentations and learning about the animals was my favorite thing about the program. Being able to see them up close because I've never been able to do that and it's much better than just hearing a teacher talk about them or reading about them in a book. I've seen some of the animals in a zoo, but it's not the same when they are in a cage.

The students in the quotations above often mention being “close” physically to the animals. This ability to see the animals in an environment where they were not separated by a cage or large distances was mentioned frequently by the students. The fact that the students were meeting the animals in close proximity seemed to facilitate the attachment. Contact with pet animals has been shown to have positive effects—such as effecting self esteem—on children (Trivedi & Perl, 1995); to help with stress (Siegel, 2004; Spence & Kaiser, 2002); and to have a role in the quality of life for children (Melson, Wilson, & Turner, 1998). With respect to wild animals, one study found that visibility, proximity, and physical touch were the most important factors in affecting the children's attitudes toward wildlife (Kidd, Kidd, & Zasloff, 1995). Thus, physical closeness to the animals is supported by research as a major factor in bonding with the animals. Both boys and girls in this study were open about their feelings about the animals. In general, pet care is considered gender neutral and thus is one of the few outlets for males for affection (Melson, 2001). Perhaps caring for the Talking Talons animals also follows this gender-neutral pattern.

#### *Qualitative Results: Comments about Science*

The students also made it clear that they enjoyed science much more after the Talking Talons program. Many of the students expressed appreciation for the hands-on nature of the program and indicated that the Talking Talons program increased their appreciation for science class. Samples of such views from the taped year-end interviews are included below:

It's more fun to study science now. I used to think science was boring but now I'm more interested in it and I read my science book. Before I wasn't interested in reading about science, but now since we get to interact with the animals I'm more interested.

For me, science was always a drag; I could never really understand it. I never really go the whole environment thing, but with Talking Talons, when they bring the animals in—they actually make it fun—we do activities, and what I learn in Talking Talons has improved my science understanding and it really has improved my grades.

I've always liked science. I like it even better now. Interacting with the animals makes me understand that science isn't just hard science. There is animal science too. My favorite day in school is when Talking Talons comes to our class.

I like science better now because we got so tired of learning from a book, but when (Talking Talons educator) comes in we know we are going to have hands on learning.

These quotations illustrate a common theme in the interviews. The students often mention "interaction," "hands-on activities," and not having to answer questions from a textbook. Hands-on activities have large support in the literature in increasing science attitudes (Bilgin, 2006; Hubisz, 2004; Miller, 1991; Ornstein, 2006; Pine et al., 2006). The interactive nature of this program was clearly important to the participants, and they mentioned this often in the interviews.

Clearly, the qualitative data indicate that the students enjoyed both the animals and science class during the Talking Talons program. The students experienced positive feelings about both science and the animals and expressed these emotions clearly in the interviews. The relationship between bonding with animals and science attitude is explored further in the following quantitative section.

### *Quantitative Results*

Stepwise multiple regression was performed with the participants' Attitude toward Science as the dependent variable and Age along with Gender as the first step in the hierarchy. Bonding with Animals was entered second and Bonding with the Educator was entered third and stepwise as independent variables. Analysis was performed using SPSS 11.5.

The assumption of no multicollinearity was met with no problematic variance inflation factor (VIF). The VIF indicates strong linear relationships between the predictor variables. Values greater than 10 are cause for concern (Field, 2005). The average VIF for this data was close to one. Casewise, diagnostics found no influential cases based on Cook's distances (maximum of .075). Examination of the residual plots indicated that assumptions of linearity were met. No suppressor variables were found.

The full model accounted for 28% of variance  $F(4, 353)=34.158 p<.001$ . Age and Gender contributed significantly to prediction of the participants' science attitudes. Nearly 10% of the variance (9.8%) in science attitude was predicted by Age and Gender together  $F(2,355)=19.26, p<.001$ . Gender alone did not have a large impact on science attitudes. Age, however negatively affected science attitude, with each increase in one standard deviation of age (about 1.09 years) yielding a  $-0.31$  standard deviation decrease in science atti-

tudes when the other effects were held constant. As the students aged their attitudes toward science decreased.

The second step of the regression (Bonding with Animals) accounted for 15.8 % of the variance alone  $F(3,354)=40.5$   $p<.001$ . For one standard deviation increase in Bonding with Animals, a .414 standard deviation increase in attitudes toward science was observed with the other factors held constant. Students who expressed higher levels of bonding with the animals also indicated more positive attitudes toward science. Thus, Gender, Age, and Bonding with Animals together accounted for 25.6% of the variance in Science Attitudes. Adding Bonding with Educator in the third step of the regression equation accounted for a further 2.3% change. For each increase in one standard deviation in Bonding with Educator, a 0.12 standard deviation in Attitude toward Science was observed with the other factors held constant. Students who expressed higher levels of Bonding with Educator had slightly more positive Attitudes toward Science. With this last step, a total of 27.9% of variance in Science Attitudes was accounted for by the full model,  $F(4, 353)=34.158$   $p<.001$ .

**Table 1. Stepwise Regression for Gender, Age & Bonding with Animals and Bonding with Educator with Attitudes toward Science**

Regression Model		Unstandardized Coefficients		Standardized Coefficients
		Beta	Std. Error	Beta
Step One	(Constant)	8.23	.717	
	Age	-.373	.060	-.311**
	Gender	.109	.133	.041
Step Two	(Constant)	2.17	.956	
	Age	-.234	.057	-.195**
	Gender	.13	.121	.049
	Bonding with Animals	.854	.098	.414**
Step Three	(Constant)	1.123	.992	
	Age	-.245	.057	-.205**
	Gender	.197	.121	.075
	Bonding with Animals	.674	.110	.327**
	Bonding with Educator	.372	.110	.117**

\*  $p<.001$

$R^2= .098$  for Step 1 and  $R^2=.158$  for Step 2 ( $p<.001$ ) and  $R^2=.023$  for Step 3 ( $p<.001$ )

## **Discussion**

The qualitative data indicated that the students were enthusiastic about the Talking Talons animals and more positive about science at the end of the program. The quantitative data also indicated that the students who were more attached to the animals had better attitudes toward science. The relationship between attitude toward science and the participants bonding with the animals is both significant and quantifiable. Age clearly affects attitude toward science, accounting for nearly 10% of the variance in science attitudes. However, bonding with animals accounted for almost 17% of the variance, a factor much larger than the impact of age. The relationship between bonding with animals and science attitudes was even stronger than the relationship between gender and science attitudes. Although the educator's impact on science attitude was significant, it was not nearly as large (2%) as the relationship of the bonding with animals (17%). Based on this—both the qualitative and quantitative research—the animals are in fact a crucial part of the relationship of the program, and the student's affection for the animals and positive attitudes toward science are related.

Certain weaknesses in this study are apparent. First, the Talking Talons animals fall into an area not visited often by research, as much of the current animal-human bonding studies focus on household pets. Very little research addresses the use of typically wild animals in the classroom. The snakes, bats, and raptors are not pets in archetypal manner, nor are they truly wild animals. Thus, research into pets or wild animals does not fit well, and measuring bonding can be a difficult undertaking.

The quantitative data indicate that a higher level of bonding with the animals is correlated with more positive attitudes toward science, and the qualitative data support the hypothesis that participation in the program increased attitudes toward science. Proof of this causality would require more involved data collection, perhaps of science attitudes prior to the program and general attitudes toward wild animals before exposure to the Talking Talons program. Nevertheless, taken together, these two research methods indicate a strong relationship between science attitudes and bonding with the Talking Talons animals.

## **Summary**

As previous research has shown, bonding with animals has many positive outcomes (Benda, 2005; Crawford, Worsham, & Swinehart, 2006; Kaminski, Pellino, & Wish, 2002; Melson, 2001; Melson et al., 1991; Rusk, Brubaker, Balschweid, & Pajor, 2005; Shafer, 2006). Attitude toward science is also a

good predictor of science achievement (Mattern, 2000; Papanastasiou & Zembylas, 2002, 2004; Reynolds & Walberg, 1992; Willson, 1983), with more positive attitudes yielding better achievement. These birds, reptiles, and insects may influence the participants from the program beyond learning scientific facts about the Talking Talons animals; they may change students' feelings about science and perhaps their future involvement in science.

More research into these areas is merited to determine if non-typical animals such as snakes, raptors, and bats have different impacts on students' attitudes. The exposure to the Talking Talons animals is different from the typical experience of a classroom pet. Handling a raptor is quite different from holding a guinea pig. It is quite possible a difference exists for students between exposure to a typical classroom pet and the animals in the Talking Talons program. It would be also worthwhile to examine which of the animals produced the most bonding for the students. Such information would be useful in targeting students for inclusion in a program involving exposure to non-releasable wild animals. The further exploration of the relationship between bonding with animals and science attitudes may yield more information about impact of non-typical wild animals in the classroom.

## References

- Allow Classroom Pets? (2007). *Scholastic News-4*, 69 (22), 7.
- Anderson, K. L., & Olson, M. R. (2006). The value of a dog in a classroom of children with severe emotional disorders. *Anthrozoös*, 19 (1), 35-49.
- Aremu, O. D. (1999). Gender differential in the effect of two group counseling approaches on attitude toward science: Implications for manpower development. *IFE Psychologia: An International Journal*, 7 (1), 160-172.
- Backes, J. S. (1994). Bridging the gender gap: Self-concept in the middle grades. *Schools in the Middle*, 3 (3), 19-23.
- Baker, D. R. (1985). Predictive value of attitude, cognitive ability, and personality to science.
- Banks, M. R., & Banks, W. A. (2005). The effects of group and individual animal-assisted therapy on loneliness in residents of long-term care facilities. *Anthrozoös*, 18 (4), 396-408.
- Barker, S. B., Pandurangi, A. K., & Best, A. M. (2003). Effects of animal-assisted therapy on patients' anxiety, fear, and depression before ECT. *Journal of ECT*, 19 (1), 38-44.
- Barker, S. B., Rasmussen, K. G., & Best, A. M. (2003). Effect of aquariums on electroconvulsive therapy patients. *Anthrozoös*, 16 (3), 229-240.
- Bartlett, C. (2006). Classroom companions. *Teaching PreK-8*, 37 (1), 59.
- Benda, W. (2005). The therapeutic nature of the human-animal bond. *International Journal of Therapy & Rehabilitation*, 12, (2), 284.
- Bilgin, I. (2006). The effects of hands-on activities incorporating a cooperative learning approach on eighth grade students' science process skills and attitudes toward science. *Journal of Baltic Science Education*, 1 (9), 27-37.
- Bodsworth, W., & Coleman, G. J. (2001). Child-companion animal attachment bonds in single and two-parent families. *Anthrozoös*, 14 (4), 216-223.

- Catsambis, S. (1995). Gender, race, ethnicity, and science education in the middle grades. *Journal of Research in Science Teaching*, 32 (3), 243-257.
- Chang, C.-Y. (2002). Does computer-assisted instruction + problem solving = improved science outcomes? A pioneer study? *Journal of Educational Research*, 95 (3), 143-150.
- Crawford, E. K., Worsham, N. L., & Swinehart, E. R. (2006). Benefits derived from companion animals, and the use of the term "attachment". *Anthrozoös*, 19 (2), 98-112.
- Ellis, R. S. (1993). Impacting the science attitudes of minority high school youth. *Science and Mathematics*, 93 (8), 400.
- Farenga, S. J., & Joyce, B. A. (1998). Science-related attitudes and science course selection. *Roeper Review*, 20 (4), 247.
- Field, A. (2005). *Discovering statistics using SPSS* (Vol. 2). London: Sage.
- Gibson, H. L., & Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education*, 86 (5), 693-705.
- Herzog, H. A., Betchart, N. S., & Pittman, R. B. (1991). Gender, sex role orientation, and attitudes toward animals. *Anthrozoös*, 4 (3), 184-191.
- Herzog Jr., H. A. (1993). "The movement is my life": The Psychology of animal rights activism. *Journal of Social Issues*, 49 (1), 103-119.
- Hoffman, R. G. (1991). Companion animals: A therapeutic measure for elderly patients. *Journal of Gerontological Social Work*, 18 (1), 195-205.
- Hubisz, J. L. (2004). Hands-on middle school experience: Middle school science with computers: science experiments using vernier sensors with logger pro: Don Volz and Sandy Sapatka. *The Physics Teacher*, 42 (4), 256.
- Jarvis, T., & Pell, A. (2002). Changes in primary boys' and girls' attitudes to school and science during a two-year science in-service programme. *The Curriculum Journal*, 13 (1), 43.
- Kafer, R., Lago, D., Wamboldt, P., Harrington, F., & Bryant, S. (1989). Attitudes toward animals: *Scales for empirical research publication* <http://www.personal.psu.edu/djl/Attitudes%20Toward%20Animals%20English.htm>.
- Kaminski, M., Pellino, T., & Wish, J. (2002). Play and pets: The physical and emotional impact of child-life and pet therapy on hospitalized children. *Children's Health Care*, 31 (4), 321-335.
- Kidd, A. H., Kidd, R. M., & Zasloff, R. L. (1995). Developmental factors in positive attitudes toward zoo animals. *Psychological Reports*, 76 (1), 71-81.
- Lee, V. E., & Burkam, D. T. (1996). Gender differences in middle grade science achievement: Subject domain, ability level, and course emphasis. *Science Education*, 80 (6), 613-650.
- Levinson, B. M. (1984). Human/companion animal therapy. *Journal of Contemporary Psychotherapy*, 14 (2), 131-144.
- Mason, M. S., & Hagan, C. B. (1999). Pet-assisted psychotherapy. *Psychological Reports*, 84 (3), 1235.
- Mattern, N. P. G. (2000). Relationships between attitudes toward and achievement in science for rural middle school students: Patterns across gender. *Dissertation Abstracts International Section A: Humanities & Social Sciences*, 60 (12-A), 4319.
- Melson, G. F. (2001). *Why the wild things are: Animals in the lives of children*. Cambridge, MA: Harvard University Press.
- Melson, G. F., Peet, S., & Sparks, C. (1991). Children's attachment to their pets: Links to socio-emotional development. *Children's Environments Quarterly*, 8 (2), 55-65.
- Melson, G. F., Wilson, C. C., & Turner, D. C. (1998). *The role of companion animals in human development*. Thousand Oaks, CA: Sage.
- Miller, A.-C. S. (1991). *Effects of hands-on, activity-based science and a supportive instructional environment on at-risk sixth-grade students' attitude toward science, achievement in science, goal orientation, and cognitive engagement in science*. ProQuest Information & Learning, U.S. Thesis (Ed. D.), University of North Carolina at Greensboro. Doctoral dissertation. Abstracts International Vol 52 p 1703-1713.

- Moore, R., & Foy, R. (1997). The scientific attitude inventory: A revision. *Journal of Research in Science Teaching*, 34 (4), 327-336.
- Moore, R., & Sutman, F. (1970). The development, field test and validation of an inventory of scientific attitudes. *Journal of Research in Science Teaching*, 7, 85-94.
- Nunnally, J. C. (1978). *Psychometric theory*. New York: McGraw-Hill.
- Oliver, J. S. (1987). A longitudinal study of attitude, motivation and self concept as predictors of achievement in and commitment to science among adolescent students. *Dissertation Abstracts International*, 47 (8-A), 2983.
- Ornstein, A. (2006). The frequency of hands-on experimentation and student attitudes toward science: A statistically significant relation (2005-51-Ornstein). *Journal of Science Education & Technology*, 15 (3/4), 285-297.
- Papanastasiou, E. C., & Zembylas, M. (2002). The effect of attitudes on science achievement: A study conducted among high school pupils in Cyprus. *International Review Of Education*, 48 (6), 469.
- . (2004). Differential effects of science attitudes and science achievement in Australia, Cyprus, and the USA. *International Journal of Science Education*, 26 (3), 259-280.
- Pine, J., Aschbacher, P., Roth, E., Jones, M., McPhee, C., & Martin, C. (2006). Fifth graders' science inquiry abilities: A comparative study of students in hands-on and textbook curricula. *Journal of Research in Science Teaching*, 43 (5), 467-484.
- Poresky, R. H., Hendrix, C., Mosier, J. E., & Samuelson, M. L. (1988). Children's pets and adults' self-concepts. *Psychological Reports*, 122 (5), 463.
- Rennie, D. L., Phillips, J. R., & Quartaro, G. K. (1988). Grounded theory: A promising approach to conceptualization in psychology? *Canadian Psychology Psychologie Canadienne*, 29 (2), 139-150.
- Reynolds, A. J., & Walberg, H. J. C. (1992). A structural model of science achievement and attitude: An extension to high school. *Journal of Educational Psychology*, 84 (3), 371-382.
- Risley-Curtiss, C., Holley, L. C., & Wolf, S. (2006). The animal-human bond and ethnic diversity. *Social Work*, 51 (3), 257-268.
- Rud, A. G., Jr., & Beck, A. M. (2003). Companion animals in Indiana elementary schools. *Anthrozoös*, 16 (3), 241-250.
- Rud, J. A. G., & Beck, A. M. (2000). Kids and critters in class together. *Phi Delta Kappan*, 82 (4), 313.
- Rusk, C. P., Brubaker, K. M., Balschweid, M. A., & Pajor, E. A. (2005). Capitalizing on the human-animal bond to teach ethics to youth. *New Directions for Youth Development*, 2005, 10 (108), 45-56.
- Sack, J. L. (2003). Teachers' pets are not everybody's favorites. *Education Week*, 22 (39), 5.
- Shafer, D. N. (2006). Pets help in speech-language pathology sessions. *ASHA Leader*, 11 (2), 34.
- Siegel, W. L. (2004). The role of animals in education. *ReVision*, 27 (2), 17-26.
- Slate, J. R., & Jones, C. H. (1998). Fourth and fifth grade students' attitudes toward science: Science motivation and science importance as a function of grade level, gender, and race. *Research in the Schools*, 5 (1), 27-32.
- Spence, L. J., & Kaiser, L. (2002). Companion animals and adaptation in chronically ill children. *Western Journal of Nursing Research*, 24 (6), 639.
- achievement in the middle school. *Journal of Research in Science Teaching*, 22 (2), 103-113.
- Trivedi, L., & Perl, J. (1995). Animal facilitated counseling in the elementary school: A literature review and practical. *Elementary School Guidance & Counseling*, 29 (3), 223.
- Warburton, S. J., Jenkins, W. L., & Coxhead, P. (1983). "Science achievement and attitudes" and the age of transfer to secondary school. *Educational Research*, 25 (3), 177-183.
- Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching*, 32 (4), 387-398.

- Wells, M. J. (1998). The effect of pets on children's stress responses during medical procedures. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, 59 (6), 2689.
- Willson, V. L. (1983). A meta-analysis of the relationship between science achievement and science attitude: Kindergarten through college. *Journal of Research in Science Teaching*, 20 (9), 839-850.
- Wuensch, K. L., Jenkins, K. W., & Poteat, G. M. (2002). Misanthropy, idealism and attitudes towards animals. *Anthrozoös*, 15 (2), 139-149.
- Zasloff, R. L. (1996). Measuring attachment to companion animals: A dog is not a cat is not a bird. *Applied Animal Behaviour Science*, 47 (1), 43-48.
- Zasloff, R. L., & Hart, L. A. (1999). Animals in elementary school education in California. *Journal of Applied Animal Welfare Science*, 2 (4), 347.