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Changes in Elementary Student Perceptions of Science, Scientists and Science Careers after Participating in a Curricular Module on Health and Veterinary Science

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Abstract

This study examined to what extent a curriculum module that uses animal and human health scientists and science concepts to portray science and scientists in a relevant and authentic manner could enhance elementary students' aspiration for science careers, attitudes to science, positive perceptions of scientists, and perceived relevance of science. The curriculum was developed by a research-based university program and has been put into practice in two early elementary classrooms in an urban school in the Midwest. An attitudinal rating survey and the Draw-A-Scientist Test (DAST) were used to assess pre to post changes in student attitudes toward science, perceptions of scientists, perceived relevance of science, and aspiration for science careers. Findings indicated that the implementation of this curriculum contributed positively to student attitudes toward science, decreased students' stereotypical images of scientists, and increased student aspirations to become a scientist.

The United States continues to face the challenges of a dwindling Science, Technology, Engineering, and Mathematics (STEM) workforce. This problem is compounded by the lack of gender and ethnic diversity in STEM students enrolled in four-year post-secondary institutions (Buldu, 2006; Elmore, 2003; Miller, Blessing, & Schwartz, 2006; National Science Foundation, 2013). Even more troubling, is that interest in science subjects and aspiration for science careers is declining at the elementary level, as well (Barmby, Kind, & Jones, 2008; Dalton, Ingels, Downing, & Bozick, 2007; Osborne, Simon, & Collins, 2003). This decline may be due, in part, to the decline of science instruction in elementary classrooms owing to pressure from federal and state policies that evaluate schools and teachers based on standardized tests in reading and mathematics (Shaver, Cuevas, Lee & Avalos, 2007; Griffith & Scharmann, 2008). Additionally, schools and classrooms under the most pressure to replace science instruction with additional reading and mathematics instruction are often those serving students who are underrepresented in STEM careers.

The consensus is growing—among scientists, educators, and other science and technology stakeholders—about the critical need to intervene early to recruit diverse students into careers in the sciences in order to ameliorate workforce shortages (Ainley & Ainley, 2011;

Archer, Dewitt, Osborne, Dillon, Willis & Wong, 2010; Chen, Wang, Lin, Lawrenz & Hong, 2014; Maltese & Tai, 2009; Moskowitz & Thompson, 2001; Willis et al., 2007). Recruiting students from populations already well represented in the STEM fields is not sufficient to solve the problem. The Corporation for National and Community Service (CNCS) has also emphasized the enhancement of STEM education and workforce development programs for students from low-income and other underrepresented groups in STEM fields (CNCS, 2013).

One cause of the current shortage of students studying science at advanced levels is negative student perceptions of science, scientists and science careers. Traditionally, science has been taught as a body of knowledge, rather than the active pursuit of knowledge (France & Bay, 2010; Painter, Jones, Tretter, & Kubasko, 2006; Zhao, Jocz, & Tan, 2013) and without acknowledgement of its relevance to students' lives and current society (Buldu, 2006; Christidou, 2011; Hurd, 2002; Jarvis & Pell, 2002; Luehmann, 2009; Siegel & Ranney, 2003). Students are more likely to have positive attitudes toward science when they are aware of and understand the relevance of science to their daily lives (Jarvis & Pell, 2002; Laursen, Liston, Thiry, & Graf, 2007; Osborne et al., 2003). The dearth of relevant connections to students' lives and interactions with practicing scientists in science curricula has exacerbated students' lack of interest in science and science careers, and their stereotypic perceptions of science and scientists (Buldu, 2006; Christidou, 2011; Finson, Beaver, & Cramond, 1995).

Pedagogical Strategies for Improving Perceptions of Science, Scientist and Science Careers

Building on the growing research evidence, national and local efforts to expand and diversify the STEM workforce have focused on devising programmatic initiatives and strategies for increasing K-12 students' interests in and attitudes toward science and mathematics, with the expectations that these students will study STEM majors in college and eventually choose careers in STEM disciplines (Altschuld, 2003; CNCS, 2013). Many of these interventions emphasize the work of scientists and have been shown to enhance students' interests in science and their perceptions of scientists (e.g., Finson et al., 1995; Laursen et al., 2007; Painter et al., 2006). Providing experiences for students to interact with practicing scientists has been demonstrated to be particularly effective at fostering realistic perceptions of scientists and science careers, helping students to see scientists as normal people and transcending the misconceptions and stereotypical descriptions of scientists that often prevail among students (e.g., France & Bay, 2010; Laursen et al., 2007; Luehmann, 2009; Painter et al., 2006). In the same vein, Hodson and Freeman (1983) argued that student attitudes toward science and aspirations for science careers are greatly influenced by the images of science and of scientists they encounter. According to Niemitz and colleagues (2008), student-scientist connections enhance student perceptions of scientists and encourage their enthusiasm and interest in learning science and aspirations for science careers.

While student-scientist connections have produced positive outcomes, these practices (e.g., fieldtrips to universities and scientists' visit to schools), are not without limitations. A common limitation is that the visits are often stand-alone activities and rarely incorporated into the science curriculum. Similarly, the opportunities for student-scientist connections are often short-term visits to a scientist's lab or short, isolated visits by a scientist to an elementary science classroom. Overall, there are often no partnerships or curricular collaborations between the scientists and the science teachers.

To support student-scientist interactions in elementary classrooms, it is important for university scientists to partner with elementary science teachers such that these interactions can be sustained and meaningfully incorporated into high quality science curriculum that portrays scientists, science and science careers authentically and with relevance to students' lived experiences. The elementary school years are important in developing students' educational and career interests; it is in elementary school where students start identifying and associating personal and professional qualities and obstacles with particular careers (Farland-Smith, 2009). Also, even while their scientific knowledge is at a very minimum level, their interests in science and science careers can be positively changed through instruction (Hodson & Freeman, 1983). Thus, elementary students should have plenty of opportunities to develop positive perceptions of scientists, science, and science careers (Buldu, 2006; Finson, et al., 1995). The purpose of this study is to examine the impact of a university-teacher partnership and associated curriculum module on elementary students' perceptions of science and scientists and aspirations for science careers. The curriculum module, focused on animal health, was co-developed by a team of elementary teachers and university scientists.

Curriculum Description and Study Conceptual Framework

This elementary science curriculum module was developed as part of Purdue University's "*Fat Dogs and Coughing Horses: Animal Contributions towards a Healthier Citizenry*" project—a partnership among Purdue university scientists, outreach educators, school corporations, and museums to promote interest in and knowledge of health sciences. San Miguel and colleagues (2013) provide a detailed description of the program and its various components. Briefly, the elementary school curriculum module, titled "Pets, Vets, and Me" was developed by a team of early elementary teachers and veterinary educators for students in grades one through three.

The curriculum uses animals, animal sciences, and health sciences to introduce students to science and science careers. Students explore health and wellness by engaging in activities that allow them to see the similarities and differences among people and their pets. Over four to six weeks, students engage in activities related to the problem of keeping animals healthy. Through the use of interactive classroom activity centers, the curriculum module provides experiences and activities through which the students can: (a) explore the needs and wants of children and pets; (b) develop scientific observation and animal care skills using live animals in the classroom; (c) explore and compare nutritional needs for people and their pets; (d) learn about preventive medical care; (e) discover the benefits of exercise programs; (f) explore animal care professions; (g) research medical issues; and (h) add up the costs of owning various pets (San Miguel et al., 2013).

The curriculum module functions on two levels: (a) it provides engaging learning experiences that meet the Indiana Academic Standards for Science and Health and (b) it provides students with access to positive, authentic examples of current science and scientists to assist in the development of positive attitudes toward science. Figure 1 displays the goals, expected learning outcomes and associated Indiana Academic Standards for Science and Health. While the efficacy of the curriculum module for advancing student content knowledge in science and health is of importance, this study concerns itself with the curriculum module's effect on student attitudes and aspirations. As described by the theoretical framework below (Figure 2), changes in student attitudes and aspirations can contribute to changes in career development choices.

The *Fat Dogs and Coughing Horses* program views the inclusion of health science topics and health science careers in science curricula as a promising strategy to increase elementary students' interest, motivation and awareness of science careers. Animals provide convenient analogs with which to introduce health science concepts and discuss health science. Similarly, animals and animal models are critical to the advancement of health science, and many health scientists work directly with or study animals. Using health science topics and scientists to illustrate important science concepts should allow students to easily connect science to their interests and everyday experiences.

Theoretical Framework

Social cognitive career theory provides a useful theoretical framework for understanding the impact of student-scientist interactions on students' attitudes toward science, perceptions of scientists, and aspirations for science careers. According to social cognitive career theory (SCCT), career interests and behaviors develop over time as individuals process information received through direct and indirect experiences to develop perceptions about their abilities (self-efficacy), expected results of their actions (outcome expectations), attitudes toward and interests in subjects and professions, and aspirations (career goals) are interconnected during career development (Lent, Brown, & Hackett, 1994). Individuals are constantly taking in information and using it to evaluate their abilities and shape their interests. Bandura (1977) has defined four sources for this efficacy and interest forming information: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal. Each is described briefly below.

The category of efficacy information termed performance accomplishments is composed of "personal mastery experiences" (p. 195) that are acquired by individuals as they attempt successful mastery of a task. This information includes both positive and negative experiences and is considered the strongest, most influential source of efficacy information (Bandura, 1994). Mastery accomplished by overcoming challenge produces a more enduring level of perceived self-efficacy than does mastery without adversity (Bandura, 1994). Efficacy information also stems from vicarious experience—the observation of others who are successful at a certain activity or task. This type of efficacy information is most influential when the group of individuals observed includes those with whom the observer identifies. Two other sources of efficacy, verbal persuasion and emotional arousal, are related to the social or emotional environment in which the performance or observation occurs. These last two sources of efficacy are primarily descriptors of the mastery or vicarious experiences and are much weaker sources of efficacy information than the prior two. Verbal persuasion information is acquired through the positive encouragement of a student through social interactions. This source of efficacy generally influences the person's motivation or effort toward achieving mastery. Emotional arousal information is assessed by students as they attempt to accomplish a task. Stress or other reactions can be interpreted as either positive or negative efficacy information. Supportive environments allow students to attempt tasks and assist them in positively processing the fear or anxiety associated with new tasks.

The *Fat Dogs and Coughing Horses* program was guided by SCCT. Specifically, the curriculum module provides learning experiences that are designed to draw upon all four of the sources of efficacy to produce cognitive and affective changes in students' perceptions of science and in their aspirations for science careers. The conceptual framework for the study is displayed in Figure 2. The curriculum provides learning experiences designed to support the creation of positive attitudes toward, interest in, appreciation of and aspiration for science and science careers. These cognitive and affective changes are connected, through SCCT to expected behavioral changes regarding choices in career preparation such as course selection in high school and enrollment in a science degree program at college. Next, we describe how the curriculum module reflects each of the four sources of efficacy posited by the SCCT theory, and how the curriculum provides opportunities to develop interests, positive attitudes toward and aspirations for science and science careers by supporting students as they acquire positive efficacy information.

Performance Accomplishments

The curriculum module includes many opportunities for elementary students to practice skills related to science at an appropriate level. For example, students create their own science notebook, perform and record observations (both with their naked eyes and with the assistance of a microscope), practice using labeling conventions for their drawn observations, and perform proper animal care and handling as individuals and as a collective group of student scientists. Additionally, the students practice scientific reasoning through the diagnoses of "cases" of sick animals. Students work in small groups as veterinary scientists to diagnose, document and present their findings to the class. Electronic games are also available that allow students to practice caring for, diagnosing illness, and treating companion, farm and zoo animals. The students communicate as scientists to each other and the teacher throughout the module, and also create posters, videos, or podcasts regarding the science of animal and human health which are presented at a science colloquium that is attended by the entire school. This accomplishment is the culminating experience of the curriculum.

Vicarious Experience

The curriculum module provides two different types of access to vicarious experience through which students encounter role models who are working scientists. The first type of vicarious experience is direct interaction with local scientists. The module includes visits by veterinarians, veterinary technicians, doctors, nurses and animal scientists throughout the unit. During these visits the scientist discusses his or her work, describes how the work that they do helps keep animals and people healthy, and highlights how their work uses the tools, knowledge, and habits of mind of science. Students have ample time to ask questions of the scientist. The second type of access to vicarious experience is through multiple media sources. The module incorporates dozens of books (including three developed by the project's curriculum development team) that describe the lives and work of human health and animal health scientists. Video and electronic games are used as an additional media through which to introduce students to scientists' lives and work. The curriculum provides time for students to play electronic games that simulate animal care, diagnosis, and treatment. Demonstration and "day in the life of" videos of veterinary scientists are available on to stream from the curriculum's website.

Verbal Persuasion

Verbal persuasion is information received in a social setting about an individual's performance or capabilities. Verbal persuasion perceived as realistic and credible can encourage individuals to exert greater effort (Wood & Bandura, 1989). As described above, the curriculum module provides many opportunities for students to perform, communicate, and demonstrate their knowledge and interests related to science. The supportive environment of the school and classroom then provide students with positive feedback regarding their work and aspirations. Additionally, the scientists, or experts, who visit the classroom, are positive in their encouragement of students' interests in science and science careers. Because the curriculum modules provide opportunities for authentic experiences, the verbal feedback students receive from their peers, teachers and scientist role models is based on demonstrable effort and accomplishment which allows it to be interpreted as serious and credible by students (Wood & Bandura, 1989).

Emotional Arousal

This source of efficacy information includes physiological arousal that is typically associated with stress (Bandura, 1977). By encountering stressful situations and coping with the stress in a positive way, individuals can develop positive perceptions of the situation or task and of their own aptitude. Circumstances that create such stress are different for each individual, however, stress-inducing situations commonly associated with learning and performing science such as public presentations, receipt of feedback from an instructor, asking questions of a more knowledgeable peer or practicing scientist are threaded throughout the curriculum module. While the curriculum provides opportunities for students to stretch their abilities and experience stress positively, it is the learning community created by teachers and students that is key in assisting students in experiencing stress in a positive way.

This study examines how the curriculum described above affects student interests related to science and scientists and aspirations for science careers. This is a newly developed curriculum module using an innovative and largely untried vehicle for sparking student interest in science—veterinary medical science. Thus, this study is preliminary—aimed at examining the potential of this new approach for enhancing student interest in and aspiration for science careers within this local context.

We have operationalized interests as “attitudes toward science” and “perceived relevance of science.” “Attitudes toward science” captures student interest in science and their positive perceptions of science. “Perceived relevance of science” captures student perception of science as an integral, useful, and positive aspect of their daily lives. The sections below will further detail the study methods.

Methodology

Research Questions

The research question for this study is: To what extent does the innovative curriculum module described above enhance (a) student attitudes toward science, (b) perceptions of scientists, (c) perceived relevance of science, and (d) student aspiration for science careers?

Design, Participants and Procedures

This study uses a single group, pre-post design to examine the influence of participation in the novel curriculum modules on the areas of interest listed above. Participants in this study are 81 students from an urban school who participated in the implementation of the early elementary curriculum. The students were enrolled in two multi-age classrooms that implemented the curriculum modules and were in second or third grade during the time of the study. The time spent on the curriculum module varied somewhat depending on the classroom’s schedule, but typically students and their teacher spent an hour each school day on the curriculum for approximately six weeks. Data were collected over three iterations of the curriculum during three academic school years. Because the classroom was multiage, some students experienced the curriculum twice; only data from students’ first experience with the curriculum module was included in this study. Table 1 describes the demographic characteristics of the students. The school is a magnet option school where inquiry, critical thinking, and problem solving skills are used in classroom practice. It is located in an urban area in the Midwest and the racial composition of the students is: 48% African American, 43% White, 6% Hispanic/Latino/Latina, 2% Asian, and less than 1% Native American. 58% of students at the school were eligible for free or reduced-price lunch in 2009.

Study Design

The evaluation design focused on the extent to which the program enhanced student aspiration for science careers, attitudes toward science, perceptions of scientists, and perceived relevance of science. Data for the evaluation come from the two instruments described below:

- We administered a pre-post survey consisting of demographic variables and Likert-type attitudinal rating scales related to student aspiration for science careers, attitudes to science, and perceived relevance of science. Items in the survey were modified from an existing instrument previously developed and validated with elementary-aged students by Jarvis and Pell (2002). Response categories for the items ranged from “strongly disagree” = 1 to “strongly agree” = 4.
- The Draw–a-Scientist Test (DAST) (Chambers, 1983; Finson et al., 1995) was used to examine student perceptions of scientists. The DAST has been used in previous

> studies (e.g., Adedokun, Parker, Loizzo, Burgess & Robinson, 2011; Bodzin & Gehringer, 2001) to assess the impact of pedagogical interventions on students' perceptions of scientists. It was chosen for this study because it allows students to describe their perceptions of scientists freely in multiple modes (words and pictures). It also asks students what career they would like when they grow up and allows for a free, written response. As one purpose of the module was to expose students to scientist role models that differ from prevailing stereotypes of scientists, we selected the DAST because it allowed students to explicate their perceptions of how scientists look and behave. An updated version of the DAST and scoring rubric has been published (Farland-Smith, 2009; Farland-Smith, 2012); however, data collection for this study began prior to the publication of the validation study for the modified DAST.

Both instruments were administered immediately before implementation of the curriculum and immediately following completion of the curriculum which spanned approximately six weeks.

The variables derived from these two instruments are discussed next. Table 2 provides descriptive statistics for each variable. We conducted paired sample t-tests to examine pre-post differences in aspiration for science careers, attitudes to science, perceived relevance of science, and perceptions of scientists.

Description of Variables

Aspiration for science careers—In this study, science career aspiration is measured by a single survey item, “I would like to become a scientist.”

Attitudes toward science—This variable is a summated rating scale consisting of students' responses to 4 items: “science is fun,” “science is interesting,” “I like to study science in school,” and “I like learning about science.” We conducted factor analysis to establish the unidimensionality of the items. Table 2 presents the factor loadings of each of the items and shows that all factor loadings were substantial and statistically significant for both the pre- and post- measures of the variable. We also examined the internal consistency of the scales, measured by Cronbach's alpha. Cronbach's alpha for the items included in the variable was 0.75 and 0.80 in the pre- and post-tests, respectively indicating high internal consistency.

Perceived relevance of science—The variable, perceived relevance of science consists of four items, “scientists use tools and technology to help people and animals,” “science helps keep people healthy,” “science affects everyone, including me,” and “science can help make our lives better.” Table 2 presents the factor loadings and reliability of the items. Cronbach's alpha was 0.75 and 0.80 in the pre- and post-tests, respectively.

Perceptions of scientists—The DAST (Chambers, 1983; Finson et al., 1995) asked the students to “Make a drawing of a scientist” and provide short descriptions of what was happening in their drawings. Students were also asked to respond to two open-ended questions: “What is a scientist?” and “What do scientists do?” Impact of pedagogical interventions in changing students' views of scientists was effectively assessed in many previous studies (e.g., Adedokun et al., 2011; Bodzin & Gehringer, 2001). The drawings were analyzed based on 14 common stereotypical views of scientists including lab coat, eye glasses and facial hair (Chambers, 1983; Finson et al., 1995). The variable, perceptions of scientists, was created by summing up the total number of stereotypical items on students' DAST.

Findings and Discussion

Below we discuss the findings regarding each variable of interest outlined in the research question.

Attitudes Toward Science

Table 3 presents the results of the paired sample t-tests. This table shows statistically significant pre-post increases in students' attitudes toward science during participation in the curriculum module. This result is supported by previous studies (e.g., Farland-Smith, 2009; Oh & Yager, 2004; Osborne & Collins, 2001; Shepardson & Pizzini, 1994), which showed that students' attitudes toward science can be enhanced when science instruction presents science and scientists authentically. This finding also extends the prior research and answers calls to demonstrate the efficacy of a longer-term intervention that is integrated over the course of a month-long, coherent curricular unit (Laursen et al., 2007; Oh & Yager, 2004; Osborne & Collins, 2001).

Perceived Relevance of Science

Table 3 reveals statistically significant pre-post increases in students' perceptions of relevance of science. Students in this study reported enhanced perceptions of the relevance of science at the end of the curriculum module. This result is similar to other studies that examined student changes in perceptions of the relevance of science in response to curricular intervention (e.g., Jarvis & Pell, 2002; Painter et al., 2006). As discussed at the beginning of this article, research indicates that science should be directly linked to students' lives (Hurd, 2002; Jarvis & Pell, 2002; Luehmann, 2009; Siegel & Ranney, 2003); this study provides evidence for the efficacy of animal and human health sciences as a vehicle for presenting science in a relevant context. We are unaware of any other studies that have shown veterinary medical sciences to be an effective way to enhance student perceptions of the relevance of science.

Perception of Scientists

Analysis of the DAST data collected at the beginning and end of the curriculum module indicates that students' perceptions of scientists were enhanced. Table 3 shows statistically significant pre-post decrease in the total number of stereotypical depictions of scientists in students' drawings. To further examine how students' perceptions of scientists changed, we also conducted McNemar tests on the proportions of students that included each stereotypical feature in their drawings of scientists. Table 4 presents the results of this analysis. We observed a statistically significant reduction in 5 out of 14 common stereotypical features in students' drawings. At the end of the curriculum module, students were less likely to draw standard research symbols such as bubbling test tubes, less likely to draw standard knowledge symbols such as equations, less likely to include stereotypical technologies (e.g., LASERs), less likely to include only male scientists in their drawings, and less likely to draw their scientist working in an indoor laboratory. Thus, this study contributes to students' positive perceptions of scientists through presenting scientists' work authentically. This result is similar to previous studies (e.g., Chambers, 1983; Finson et al., 1995; Laursen et al., 2007; Painter et al., 2006). Additionally, this study examined the effect of presenting a holistic array of scientists who all work in complimentary fields (e.g., veterinary medicine, animal sciences, clinical research) to advance a common goal of improving animal and human health. Previous studies have only examined more discipline-based approaches to presenting science and scientists (Hurd, 2002).

Aspirations for Science Careers

We observed statistically significant pre-post increases in students' aspirations for science careers. Additionally, qualitative analysis of students' responses to the open-ended question regarding their career interests suggested that approximately 20 percent of student expressed a shift from non-scientist aspiration in the pre-test to science related aspirations in the post-test. Exemplars of this change for five students are:

- Movie Maker → Vet
- I don't know → Teacher and vet
- Ninja → Bearded Dragon Scientist
- Scuba Diver → Scientist

Many studies have been conducted to investigate impact of curriculum intervention on students' attitudes towards science, their perceptions of scientists, or their understanding of relevance of science (e.g., Finson et al., 1995; Laursen et al., 2007; Oh & Yager, 2004; Osborne & Collins, 2001; Painter et al., 2006). However, little research has examined changes in students' aspirations for science careers explicitly as a result of curricular interventions. This study is not currently able to test the mechanisms through which student aspirations for science careers are enhanced. However, it is noteworthy that all constructs included in the conceptual model measured in the study showed statistically significant associated positive change, and analysis of the open –ended item also indicate an impact of the curriculum on student career aspirations.

Conclusions

The results of this study have significant implications for research and practice. We believe that the opportunities for authentic science learning and student-scientist interactions supported by the program provided the students with access to career role models. In line with SCCT, these opportunities are proximal environmental factors that support the development of student career aspirations through the cultivation of positive perceptions of science and scientists. Previous studies have shown that access to, and personal interactions with, science career role models enhance students' aspirations and interests in science careers (Buck, Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008; Farland-Smith, 2009).

This study supports these results and explicates a theoretical framework that unites student perceptions and career aspirations. The study also demonstrates the efficacy of a human and animal health science curriculum for enhancing student perception of the relevance of science to their daily lives and promoting positive attitudes toward science. Finally, the study illustrates the positive impact of partnerships between university and K-12 school, as a bridge between research and practice, on elementary science learning.

Although findings show that the study enhances student cognitive and affective changes, the study is not without limitations. First, the study uses a pre-post method and is not able to examine the long-term impact of the curriculum on student outcomes. As described previously, this study is preliminary in nature and provides evidence that can be considered toward “proof of concept” for this innovative type of curriculum module; thus, the results should not be overgeneralized. The study design was a one-group-pre-post where the students are both the control (pre-test) and experimental (post-test) groups. Although obviously not as rigorous as two-group pre-post designs with randomly assigned or matched control groups, this method (and other less rigorous designs), “play a key role in a larger research agenda” (Coalition for Evidence-Based Policy, 2007, p. 6) and are very useful for generating preliminary and exploratory data on which more rigorous designs are built. Although our study design limits our ability to generalize the findings of the study, the fact that analysis of the qualitative data supports the findings of the pre-post assessment of student career aspirations also lends credence to our study. Another limitation is that the pre-post surveys are only able to measure immediate responses after implementation of the curriculum; attitudes, perceptions, and aspirations may regress with time (Finson, 2002). Additionally, our use of a single item to operationalize “aspiration for science careers” may limit the validity of this construct in this study. Future studies should follow student perceptions of science and science careers longitudinally and examine the impacts of the curriculum module in a more controlled manner. Similarly, our study did not explore possible links among the constructs examined. Future research may further test the relationships among the constructs measured in this study.

All students do not need to become scientists. However, it is critical for all students to have a realistic understanding of how scientists work. Understanding student perceptions of science and scientists and how positive perceptions are developed is an important research goal; such understanding is essential to developing future curricular partnerships that will assist in creating the next generation of scientists and scientifically literate citizens. This preliminary study indicates that a relatively short-term curriculum module that uses animals and diverse role models to build on student interest and lived experiences can improve student aspirations for and perceptions of science and science careers. We recommend that future studies extend this work to examine this or similar curricula under more controlled conditions. We also recommend the development of related curricular modules that utilize social cognitive career theory as a guiding framework.

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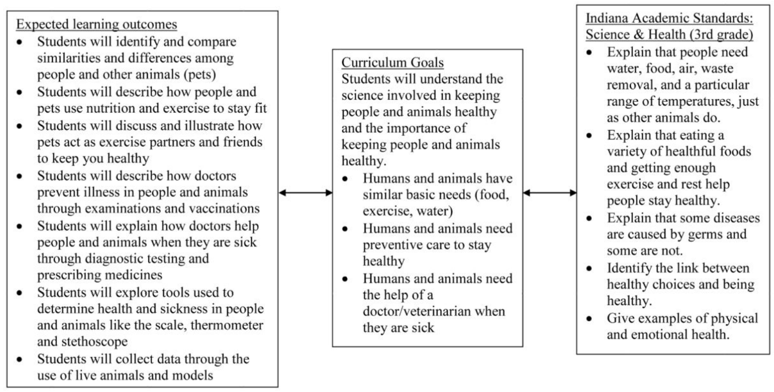

Figure 1.

The curricular objectives of Fat Dogs and Coughing Horses: Animal Contributions towards a Healthier Citizenry

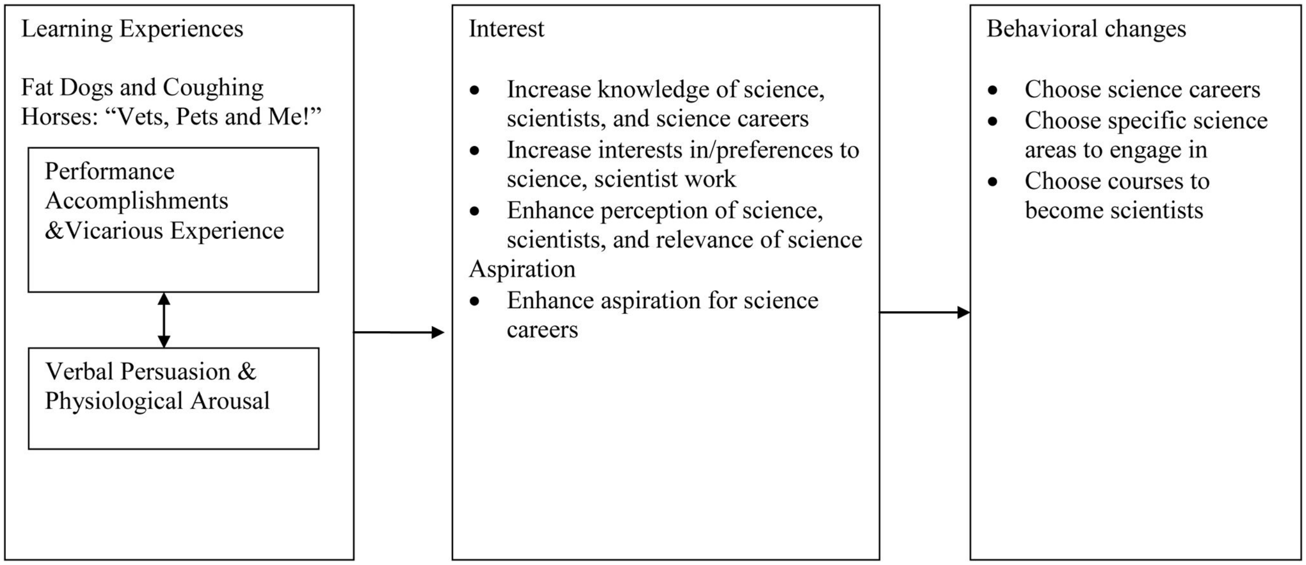

Figure 2.
Conceptual Framework of Fat Dogs and Coughing Horses: Animal Contributions towards a Healthier Citizenry

Table 1

Demographic characteristics of the students

Descriptions	Participants (n=81)
Gender	
Male	43
Female	38
Race/Ethnicity	
White	36
African American	25
Hispanic/Latino/Latina	6
Asian American	0
Native American	0
Mixed	7
N/A	7
Grade	
2	19
3	62

Table 2

Descriptive Statistics for Variables

		Pre		Post	
Variables	**Items**	**Factor loadings***	α	**Factor loadings***	α
Perceived relevance of science	Scientists use tools and technology to help people and animals.	0.69		0.68	
	Science helps keep people healthy.	0.77		0.78	
	Science affects everyone, including me.	0.84		0.85	
	Science can help make our lives better.	0.72	0.75	0.85	0.80
Attitudes to science	Science is interesting.	0.78		0.77	
	Science is fun.	0.78		0.82	
	I like to study science in school.	0.70		0.83	
	I like learning about science.	0.79		0.75	
			0.75		0.80

Note: α = Cronbach's alpha; and

* all factor loadings were significant at $p < 0.05$.

Table 3

Analysis of the pre-and post-changes in the outcome variables

Variables	Pre-Participation		Post-Participation		t
	M	**S.D**	**M**	**S.D**	
Perceived relevance of science	3.15	0.67	3.57	0.50	6.17***
Attitudes to science	3.47	0.46	3.65	0.46	3.60***
Aspiration for science careers	2.25	1.23	2.92	1.16	4.81***
[Negative] perceptions of scientists	4.00	1.48	2.53	1.52	8.01***

Note: S.D. = standard deviation;

*** $p < 0.001$.

Table 4

Analysis of the pre-post comparison of the DAST items

	Pre- participation		Post- participation		Post-Pre Difference	
Items	**F**	**%**	**F**	**%**	**F**	**%**
Lab coat	28	34.6	18	22.2	−10	−12.4
Eyeglasses	12	14.8	5	6.2	−7	−8.6
Facial Hair	1	1.2	0	0	−1	−1.2
Research symbols	64	79	34	42	−30	-37^{***}
Knowledge symbols	27	33.3	17	21	−10	-12.3^{*}
Technology	17	21	5	6.2	−12	-14.8^{**}
Captions	5	6.2	0	0	−5	−6.2
Male only	53	65.4	43	53.1	−10	-12.3^{**}
Caucasian only	74	91.4	69	85.2	−5	−6.2
Middle-aged/elderly	4	4.9	2	2.5	−2	−2.4
Mythic stereotypes	8	9.9	2	2.5	−6	−7.4
Secrecy	1	1.2	0	0	−1	−1.2
Working in lab	30	37	10	12.3	−20	-24.7^{***}
Danger	2	2.5	0	0	−2	−2.5

Note: F = frequency;

*** $p \le 0.001$;

** $p \le 0.01$; and

* $p \le 0.05$.