ATTITUDE CHANGE AND TIME AS MEASURES OF EFFECTIVE EXHIBITS

by

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Dedicated to my family

I dedicate my dissertation to my wife, Karen, and our sons Conlon, Samuel, and Caleb. They never wavered in their love and support and I could not have done it without them. Thank you.

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ABSTRACT

This dissertation consists of three journal articles that examined the effectiveness of using attitudinal change and time as measures of exhibit effectiveness. The introduction discusses using Lev Vygotsky's zone of proximal development (ZPD) and Jean Piaget's stages of cognitive development as frameworks for organizing exhibit content (DeVries, 2000). The first article presents a study that measured exhibit visitors' reported attitudes as measured by an early iteration of the attitudinal learning inventory (ALI) (Watson et al., 2018). The study, which was conducted at the Indiana State Fair and measured visitors' self-reported attitude changes after visiting an exhibit about hellbender salamanders, found that 73% of survey respondents claimed they would change their behavior and 70% claimed they would tell others what they learned by visiting the exhibit. The second article presents a study that measured visitors' time spent at the exhibit to calculate holding power. Holding power was calculated by dividing the amount of time spent at the exhibit by the minimum amount of time it takes to read the text and interact with the exhibit. The holding power for the *What's Bugging Belva?* exhibit was favorable at .67 and is compared with exhibits with holding powers of .47 (Boisvert et al, 1995) and .69 (Peart, 1984). The third study gathered visitor data using the validated ALI and analyzed the data using the FREQ procedure (SAS 9.4). The study was conducted at the Indiana State Fair and Purdue Springfest and measured visitors' responses to an exhibit about animal welfare. At both events, visitors had positive perceptions in the categories of cognitive and general learning, affective learning, behavioral learning, and social learning. Measuring holding power and using the ALI to measure reported attitudinal learning are found to be effective measures for assessing exhibits and the author suggests using the ZPD and the stages of cognitive development for developing exhibit content.

CHAPTER 1: INTRODUCTION

Purdue University's Exhibit Design Center (EDC) started in a 1200 ft^2 space in the basement of a campus general-purpose building. In 1999, the college hired a manager with experience at the Rock and Roll Hall of Fame Museum in Cleveland, Ohio, and the Smithsonian Museums in Washington, D.C. The new manager was charged with expanding services offered by the EDC to include traveling exhibits that could be marketed to museums throughout the United States. As part of that expansion, the center moved to a new location with over 10,000 ft^2 for the design and fabrication of exhibits.

I worked for the EDC for 13 years. For 7 years, I was an exhibit fabricator and production coordinator. For my last 6 years with the center, I was the manager of exhibits and the manager of the Purdue Traveling Exhibit Program. In my time as a production coordinator, I collaborated with graphic designers and programmers to develop exhibit signage, infographics, hands-on interactive elements, and video games. Content for the exhibits was provided by university faculty and spanned a broad range of topics. For most projects, the content experts worked closely with the graphic designers and the designers made choices about how content was presented within the exhibition. While the exhibitions we created were generally well-received, they sometimes fell flat. For instance, a 3,000 ft^2 exhibition on genomics was well-funded, was anchored by a beautiful, walk-through, tensioned-fabric plant cell, and included striking exhibit furniture with edge-to-edge graphics that caught and held the eye. However, we never recovered the fabrication cost of the exhibition because museums did not rent it. Although I wasn't yet managing the exhibit center or traveling exhibit program, I knew why the exhibition fizzled; we had failed to identify and follow a framework for targeting the exhibit content to the appropriate audience.

In 2010, I started a master's degree in educational technology and curriculum at Ball State University in Muncie, IN. The courses in the program introduced me to traditional instructional design frameworks, such as ADDIE and Keller's ARCS model (Keller, 2010; Molenda, 2015). In addition, I studied Lev Vygotsky's Zone of Proximal Development and Jean Piaget's Stages of Development theories (DeVries, 2000). The ADDIE model is a commonly used framework that includes analysis, design, development, implementation, and evaluation stages. ADDIE appears to be a generic term for listing the 5 steps of instructional systems design

and its origins are nebulous, with a general agreement that it grew from work performed in the US armed forces in the 1970s (Molenda, 2015). The ARCS model is intended to foster learner motivation and is comprised of four components: attention, relevance, confidence, and satisfaction (Keller, 1987). Lev Vygotsky was a psychologist who developed a sociocultural theory of cognitive development, which included as one component the zone of proximate development (ZPD) (DeVries, 2000). The ZPD is considered social learning and is defined as the distance between what learners can understand on their own and what they can understand with help from someone with more knowledge of the subject (DeVries, 2000). Jean Piaget's stages of cognitive development theory describes learners as falling into four progressive stages that are associated with learners' ages: sensorimotor (birth through 2 years), pre-operational (2-7 years), concrete operational (7-11 years), and formal operational (11- years and older) (Oogarah-Pratap et al., 2020). These frameworks and theories made sense for developing educational experiences for a variety of learners in a classroom or online course, but they also struck me as a better way to develop and organize exhibit content.

In December of 2012, I graduated from Ball State University. In January of 2013, I became manager of the EDC and immediately began to transition the center toward an instructional design (ID) -focused approach to exhibit design and evaluation. We began using ADDIE, ARCS, and the theories from Vygotsky and Piaget to guide the development of text for exhibits. The first exhibitions designed with this new approach debuted at the 2015 Indiana State Fair.

Exhibits designed at the EDC using ID frameworks were evaluated and visitors responded favorably when compared to responses to similar exhibits (Rollins et al, 2017). Two other groups responded positively to using ID models for exhibit development: museum staff looking for temporary exhibitions to lease and the EDC staff responsible for creating exhibits. The exhibitions were marketed to museums throughout the US and leased to several museums, indicating a positive response to the exhibit content from museum staff. The EDC staff found the instructional design models useful for writing, organizing, and designing exhibit content and graphics. Next, we considered a strategy for evaluating exhibits that could be performed by practitioners with little or no training or resources.

While museums are the most common venue for exhibits, other settings, such as fairs, expositions, and libraries, are also places where the public frequently interacts with exhibits. In

each of these settings, the constraints of time and funding can make even basic evaluation difficult (Bamberger et al, 2019). In an era where funding opportunities for informal education have become increasingly driven by outcome-based evaluation (Adams, 2012), practitioners require evaluation methods that produce data with a minimum investment of funding, human resources, and time.

Past studies of exhibits have measured cognitive change, problem-solving, motivation, and creativity (Donald, 1991). Other studies have examined the connections between interest, cognitive change, and emotion (Dahl et al., 2013). These studies require an investment of resources and expertise that may be unavailable to practitioners in informal education settings. It was important to the EDC that any strategies used to evaluate exhibits could also be used by museum staff and other informal educators, such as Cooperative Extension Service (CES) agents and library staff. These groups had much in common that could make exhibit evaluation problematic. Museum staff report that they are overworked, under stress, and serving in multiple roles within the organization (Ephithite, 2019). CES agents report similar concerns, citing overwork and unrealistic expectations pertaining to the roles they perform (Benge et al, 2015) and librarians report lack of role clarity as a common stressor (Salyers et al, 2019). As practitioners in each of these fields voice their concerns related to work stress, particularly related to overwork, it was important for the EDC to identify assessment methods that could be performed without large investments in time and human resources.

After reviewing past evaluation methods and considering the resources available to the EDC, we chose two strategies to measure the effectiveness of exhibits: measuring attitude change and holding power. Measuring attitude change was chosen because it encompassed areas important to the EDC mission: cognitive change, affective change, and behavioral change. Holding power was chosen because of the unobtrusive nature of measuring visitors' time in the exhibit space; direct observation and a timer are all that is required to gather data.

Gagne et al (1992) describe attitude change as a person's response to an object, person, or event. A change in attitude can be further distilled into three categories: affective, behavioral, and cognitive change (Kamradt et al, 1999). The affective component of attitude change involves the emotional response a person has to some situation, while the behavioral component of attitude change consists of a person's intent to act in a certain way after being exposed to an object, person, or event (Simonson et al, 2001). The cognitive component of attitude change

simply reflects what a person knows about a topic. Social learning is also a component of attitudinal learning and learners' attitudes may be affected by their interactions with others in their social group (Watson et al., 2018). To measure attitude change, visitors' responses to exhibits were collected using an early version of the Attitudinal Learning Inventory (ALI). The ALI was chosen as the specific instrument for gathering data because it is a validated instrument consisting of 15 scale items that measure the cognitive, affective, behavioral, and social dimensions of attitudinal learning (Watson et al, 2018). That social dimensions of attitudinal learning were measured by the ALI was important because museum educators incorporate Vygotsky's ZPD, especially in docent or tour guide roles (Shaby et al, 2017). Holding power is calculated as the amount of time spent at an exhibit divided by the minimum amount of time it takes to read any text and interact with any hands-on activities (Donald, 1991; Peart, 1984). Past studies have shown a positive correlation between time and gains in motivation, interest, and cognition (Falk, 1983; Peart, 1984). This dissertation presents three published articles. The first article presents a study that measured exhibit visitors' reported attitudes as recorded by an early iteration of the ALI (Watson et al., 2018). The second article presents a study that measured visitors' time spent at the exhibit to calculate holding power. The exhibit's holding power was then compared to data from previous studies. The third study gathered visitor data using the validated ALI and analyzed the data using the FREQ procedure (SAS 9.4) and specified the exact Chi square/Fisher's exact test to measure whether frequencies of respondents were equally distributed among the demographic categories.

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CHAPTER 2: A SALAMANDER TALE: EFFECTIVE EXHIBITS AND ATTITUDE CHANGE

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Abstract

Little information exists regarding intention behind the design and development of Extension outreach and educational exhibits. An evaluation of response to the exhibit A Salamander Tale indicates that the methods used to develop the exhibit resulted in an effective way to present information to an adult audience. Survey questions were based on research literature on attitudinal learning, especially literature discussing cognitive, affective, and behavioral learning components. Of 409 survey respondents, 69% or more reported positive changes in attitude about eastern hellbender salamanders and their habitats. Perhaps most important to hellbender conservation efforts, 73% of survey respondents claimed they would change their behavior and 70% claimed they would tell others what they learned from the exhibit.

Introduction

The Purdue University Exhibit Design Center (EDC) develops science-based exhibits for Purdue's College of Agriculture and Purdue Extension. EDC exhibits typically premiere at the Indiana State Fair then travel to museums throughout the US. The EDC developed the exhibit *A Salamander Tale* (Figure 1) to educate the public about the eastern hellbender salamander, the largest amphibian native to North America. Misconceptions about the species may lead to antagonistic behavior from humans and hinder conservation efforts (Mullendore et al, 2014). The exhibit's goal is to raise awareness about amphibians in general and hellbenders in particular with the hope of positively affecting the public's attitude about this unique species.

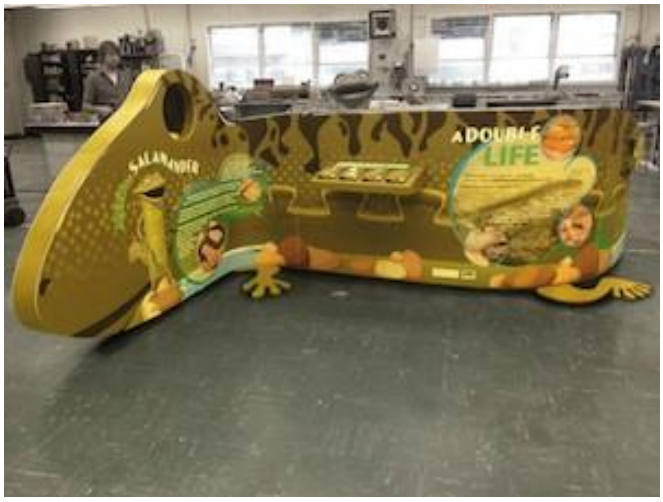

Figure 1. A Salamander Tale Exhibit

In August 2015, the exhibit was part of Purdue Extension's presence at the Indiana State Fair. For most attendees, the Indiana State Fair is simply entertainment, but fairs also provide significant opportunities for education (Looker, 2011). During the exhibit's time at the state fair, visitors were surveyed to examine their reactions to the exhibit, their understanding of hellbenders and their habitats, their feelings toward hellbenders, and possible changes in their behavior after learning about hellbenders.

Exhibit Development

Theoretical Framework

Exhibits are often used for Extension outreach and education. Past studies on the effectiveness of Extension exhibits use tools such as a logic model to design the evaluation (McCurdy et al, 2010). Others used quantitative methods for analyzing data (Carrozzino et al, 2008). However, there is little information available about the intention behind the design and development of the exhibits. The EDC developed *A Salamander Tale* on the basis of the work of two socio cognitive theorists: Lev Vygotsky's zone of proximal development (ZPD) and Jean Piaget's stages of cognitive development (DeVries, 2000). The exhibit's content was written in three layers. The first, or bottom, layer was developed for young learners in the K-2nd grade range. This content focused on matching images with labels. For instance, amphibians were compared with reptiles by showing images of reptiles' feet with claws on their toes and amphibians' feet without claws. This first-level information was developed to appeal to the abilities of learners described in Piaget's preoperational stage; learners at this stage are expected to understand symbols and shapes. The second, or top, layer of content was developed for the adult learners that typically accompany younger learners and includes content focused on Piaget's formal operations stage. Learners at this stage are expected to understand abstract ideas and be capable of strategy and planning. Information presented at this stage is about threats to hellbender habitat, the range of the species, and what may be done to help protect the hellbender. The third, or middle, layer of content was developed to address Vygotsky's ZPD. This content encourages adult learners to interact with younger learners to help them understand more complex ideas of space (habitat) and quantity (dwindling numbers of hellbenders) and elevate them to Piaget's concrete operational stage. These layers of content are not abstractions; the printed text and images on the exhibit are also layered, with the lower-level content near the bottom, the upper-level content near the top, and the content targeted at ZPD in the middle. In addition to images and text, the exhibit included a diorama showing a life-sized replica of the hellbender, hinged flip labels (Figure 2), and a video game.

Figure 2. Hinged Flip Labels

A Multimedia Approach

Combining text, images, and hands-on interactivity appeals to learners on many levels and it makes sense that learners gain more from images and text than from text alone. This idea is supported by theories on multimedia learning (Mayer, 2009). Larger exhibits with concrete characteristics such as tactile elements, sound, and visually attractive three-dimensional shapes are best at attracting visitors; exhibits with smaller, hands-on, interactive elements have a higher holding power (Boisvert et al, 1995). Holding power (the time visitors spend at an exhibit) is important and can be used as a measure of an exhibit's effectiveness. According to John Falk, holding power is bimodal (1982). Visitors either spend very little time with an exhibit (30 s or less) or a lot of time (120 to 180 s) (Falk, 1982).

Extension programming has little value unless it is effectively communicated to the public and it is important to deliver content in various formats (Stafne, 2015). The video game developed for the exhibit (Figure 3) is titled "Hellbender Havoc" and incorporates the learning objectives of the exhibit into the gameplay. The game addresses the following objectives:

- Learn how large the eastern hellbender can grow.
- Learn what the eastern hellbender eats.
- Learn what hellbender habitat looks like.
- Learn what pollutants negatively affect hellbenders.
- Learn what to do if you catch a hellbender with a fishing pole.

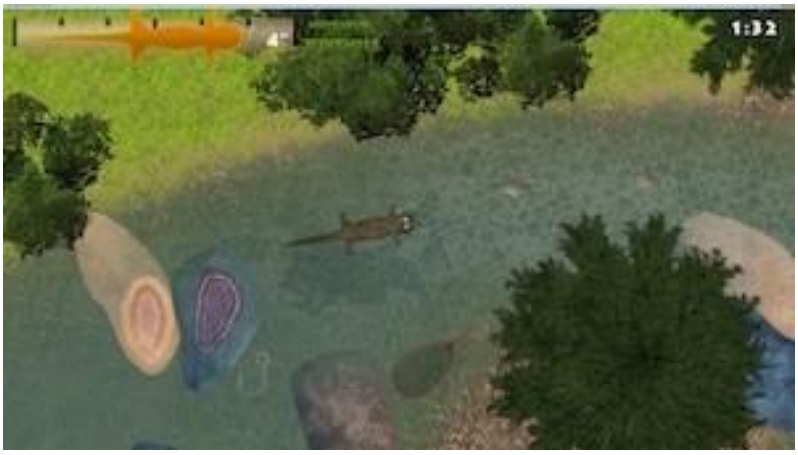

Figure 3. Hellbender Havoc

Anthropomorphism

As noted above, large, attractive, three-dimensional exhibits are effective for attracting visitors and *A Salamander Tale* has those traits (Boisvert et al, 1995). The exhibit also incorporates some degree of anthropomorphism. Anthropomorphism is a tool frequently used by designers to attract younger visitors (Horowitz et al, 2007). In the case of the eastern hellbender, it is particularly useful. The hellbender is not an attractive animal; greenish-brown, mottled, slimy, and somewhat aggressive-looking, it doesn't have endearing qualities. The exhibit diorama shows a lifelike replica of the hellbender so that visitors can see what they really look like. The exhibit furniture shows a hellbender with human-like eyes and a smiling mouth along with a softer, more approachable, shape. Aside from being an effective design technique, anthropomorphism can be useful in other ways. The anthropomorphism of wildlife creates empathy among exhibit visitors toward exhibit subjects (Chan, 2012). For the hellbender, increased empathy is especially important. Like many creatures, erroneous information about them is common and often passed on from one generation to the next (Muris et al, 2009). One often-repeated myth is that the hellbender's bite is poisonous. Increased knowledge and empathy may decrease the spread of misinformation. Raising awareness of and changing attitudes about hellbenders has significance in another critical area: affective factors may have more influence on public perceptions than scientific or environmental factors. People are more willing to support funding for conservation if the subject of the funding is something they feel strongly about (Martín-López et al, 2007).

Purpose and Methods

Exhibit Survey

The purpose of the author-created survey was to measure the attitudinal effect the exhibit had on state fair visitors regarding the eastern hellbender. The survey questions were based on research literature on attitudinal learning, especially literature discussing cognitive, affective, and behavioral learning components (Kamradt et al, 1999; Simonson et al, 2001). The survey was administered for 9 days via a touchscreen computer kiosk at the Indiana State Fair.

Data Collection

The kiosk had signage asking visitors passing through the Purdue exhibits area to take a brief survey. An introduction screen asked whether participants were 18 years old or older and explained how their input was valuable in helping with future exhibits at Purdue's EDC. The introduction screen explained that the survey was voluntary. The participants agreed to take the survey and confirm their age. If participants indicated that they were not 18 years of age or older, interaction ceased and a screen appeared explaining that a person must be 18 or older to participate. For those who chose to participate in the survey, onscreen instructions provided directions for how to participate in the survey by touching checkboxes. Subjects could stop participating in the survey at any time. Following questions designed to collect basic demographic information were 9 questions about the cognitive, affective, and behavioral effects of the exhibit on respondents.

Results and Discussion

During 9 days at the 2015 Indiana State Fair, 409 visitors completed the survey. The data is presented here (Table 1). Slightly less than half of survey respondents became aware of eastern hellbenders for the first time. The Indiana State Fair staff estimates attendance at the Purdue Extension building to be 95,000 (B. Blackford, personal communication, August 2013). Although the percentage of building attendees who took the survey is unknown, given the estimated attendance numbers the impact of the exhibit likely is significant.

The responses to questions 1 through 8 indicate that *A Salamander Tale* had a positive effect in informing the public and changing attitudes about hellbenders. Though 49% of survey

respondents didn't know what a hellbender salamander was before visiting the exhibit, in all categories 69% or more reported positive changes in attitude or understanding about hellbenders and their habitats. Perhaps most important to hellbender conservation efforts, 73% of survey respondents claimed they would change their behavior and 70% claimed they would tell others of what they learned by visiting the exhibit.

Table 1. Survey Data from the 2015 Indiana State Fair. N=409.

Question	Responses Yes	%	Responses No	%
Did you enjoy the salamander exhibit?	330	81	79	19
Did you know what a hellbender was before visiting the exhibit?	202	51	207	49
Has your perspective towards hellbenders changed as a result of visiting this exhibit?	162	80	40	20
My feelings about hellbenders have changed as a result of this visit	283	69	126	31
I feel more connected to hellbenders and the environment as a result of this visit	298	73	111	27
I feel that protecting hellbender habitat is important	320	78	89	22
I plan to change my behavior to help protect hellbenders and their habitats	301	74	108	26
I plan on telling others about what I've learned about helping hellbenders and their habitats	287	70	122	30

What part of the exhibit did you find most informative?	Video Game Responses/(%)	Images Responses/(%)	Text Responses/(%)
	172/(42)	150/(37)	87/(21)

The positive response to the video game as the most informative part of the exhibit reinforces the effectiveness of presenting information by using a multimedia approach (Mayer, 2009). Whereas other methods are somewhat effective, "multimedia materials other than games do not usually require the rapid responding that is typical of action games, nor do they evoke the

same levels of motivation" (Mayer, 2005, p. 776). Compared to a simple multimedia lesson, playing games was demonstrated to increase learning by 69% (Coe et al, 2003; Mayer, 2009).

Video games may or may not be the best tool for conveying exhibit content; the constraints of some exhibit designs may dictate that an exhibit use no electricity, or the exhibit budget and timeline may not allow for the development of an electronic interactive. When conditions for a video game do exist, the learning objectives of the exhibit or the learning objectives from the specific exhibit area can serve as a guide for game design.

Conclusions

Large, one-topic exhibits are effective vehicles for communicating natural science topics and using text, images, and video games reinforces simple learning objectives. The survey was limited to respondents 18 years of age or older and the positive responses to the survey indicate that the content directed at learners in the formal operational stage was very effective. Extension professionals interested in using learning theories to guide the development of exhibits should consider the design process tested by the EDC as an effective way to present information to an adult audience. Using Piaget's stages of development and a scaffolded delivery of content focused on Vygotsky's ZPD should be effective for exhibits with one message or in each area of exhibits with multiple messages. In addition, inserting language about any Extension topic can modify the survey questions for use in various exhibit settings.

To test the effectiveness of the scaffolding of content, further evaluation of the exhibit should include input from the target learners in the preoperational and concrete operational stages of development. Future evaluations should be conducted to reach younger learners through the use of face-to-face survey techniques. Conducting face-to-face surveys will provide an opportunity to ask parents and guardians to sign consent forms giving permission for their children to speak to evaluators. Collecting the responses of those in the lower age ranges will give the EDC and Purdue Extension information critical for making design decisions for content targeted at that audience. Outcome evaluation is important, but process evaluation is the key to improving future projects (Adedokun et al, 2011). Face-to-face interaction will also provide an opportunity to do pre-and post-visit surveys. By observing families as they move into the exhibit area, evaluators can ask pre-visit questions of children and their families and ask post-visit questions after the exhibit visit. Although the current survey is valuable as a measurement of

overall increases in awareness and changes in attitude, a pre- and post-survey format in future studies would provide more insights into specific exhibit features and elements.

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CHAPTER 3: USING TIME TO ASSESS EXTENSION EXHIBITS

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Abstract

In addition to other evaluation methods, the amount of time visitors spend at an exhibit may indicate visitors' level of interest and engagement with the exhibit content. We describe methods from the museum field where time is used as a measurement of exhibit effectiveness and discuss findings from a study in which we used time to evaluate an Extension exhibit. This information has implications for Extension professionals interested in using time as a method of evaluating visitors' level of interest and engagement in their exhibits.

Introduction

Extension has delivered research-based information to the public since the beginning of the 20th century (Purdue University Agricultural Experiment Station, 1912). County Extension agents and campus-based specialists deliver information on a wide variety of topics to farmers,

consumers, business owners, homeowners, young people, and families. In 1912, Indiana's Purdue Extension presented exhibits at 25 county fairs and the Indiana State Fair and used three freight trains to deliver exhibits about wheat improvement and livestock (Purdue University Agricultural Experiment Station, 1912). The delivery methods, scope, and sophistication of Extension exhibits have changed since then. An example of an Extension exhibit developed with deliberation and intentionality is *A Salamander Tale* (Rollins et al, 2017). *A Salamander Tale* is based on learning theories and models and designed for a specific audience (Rollins & Watson, 2017). These traits make it similar to museum exhibits (Danilov et al, 2010).

For measuring the effectiveness of Extension exhibits at a state or county fair or other informal setting, Extension professionals must look outside their field for ideas that will improve their evaluation methods. In this article, the authors present a review of the exhibit evaluation literature, briefly discuss methods from the museum field related to using time as a measurement of exhibit effectiveness, and discuss findings from a study of an exhibit using time to assess holding power.

Assessing Extension Exhibits

In past evaluations of Extension exhibits, researchers used logic models to guide evaluation design (e.g., McCurdy et al., 2010). The National 4-H Science Logic Model was introduced in 2007 and updated in 2010 and includes a section focused on outcomes such as improved attitudes, increased awareness, and improved science skills and knowledge (4-H Science Logic Model, 2010). The National 4-H Common Measures take assessment a step further by offering scales designed to measure attitude, skill, interest, and application (Lewis et al, 2015). Others used quantitative methods for analyzing exhibit evaluation data, but included data collected in a formal classroom setting (Carrozzino et al, 2008).

Museum Evaluation Practices

In museum settings, the focus of evaluation is generally directed at learning or engagement. The effectiveness of museum exhibits can be measured in a variety of ways. Some commonly used measures are cognitive change, problem solving, motivation, and creativity (Donald, 1991). Some studies tie interest and cognition change resulting from engagement with

museum exhibits to emotion (Dahl et al, 2013). When visitors find an exhibit pleasurable, interest increases. Dahl et al. (2013) used a 17-question survey to understand how visitors' overall interest in an exhibit were related to ease of comprehension, cohesion, vividness, engagement, emotiveness, and prior knowledge.

Other authors categorize measures differently. According to Diamond, Luke, and Uttal (2009), evaluation measures fall into the categories of knowledge retention, implicit memory, conceptual change, task analysis using think-aloud protocols, and visual-spatial memory. Researchers who conducted a study at the Lawrence Hall of Science on the campus of the University of California Berkeley defined exhibit effectiveness as "measurable transmission of information about scientific principles from the exhibits to visitors" (Eason et al, 1976, p. 46).

Regardless of the measure used, situational constraints can make evaluation problematic. Finding the time, human resources, and funding can make even simple studies challenging (Bamberger et al, 2012). The resources required to gain consent and survey minors can add an additional challenge to evaluating exhibits. On the other hand, measuring time spent at an exhibit or engaged with exhibit elements is unobtrusive and can reduce the barriers to exhibit evaluation.

Time as a Measure of Exhibit Effectiveness

Time as an Unobtrusive Method of Assessment

Using time to measure exhibit effectiveness is an unobtrusive method for assessing interest, motivation, and cognition (Falk, 1983). Time is considered an unobtrusive measure because the researcher needn't interact with the subjects to record the data. Through direct observation or indirect observation (video cameras), researchers may measure the time visitors spend in an exhibit space or engaged with specific exhibit features (Sanford, 2010).

Time and Visitor Behavior

Independent studies show that visits to individual exhibits usually last between 30 s and 90 s regardless of the exhibit type and setting. Visitors to live animal exhibits at zoos averaged about 1 min when the animals were active and about 30 s when the animals were inactive (Bitgood et al, 1988). Whether exhibits include high or low interaction, convey concrete or abstract concepts, or are simple or complex in their presentation, the average time spent at the

exhibit is about 1 min (Boisvert et al, 1994). Falk (1983) too observed average visit times of 1 min, among 123 visitors, but also found that visitors who tried to see as many exhibits as possible in a museum spent less time at each exhibit. Sandifer (1997) found that the time spent at an exhibit was nearly the same whether the museum visit occurred on a weekday or a weekend, with an average of 1.4 min and 1.3 min respectively. The preceding examples lead to the conclusion that museum visitors typically spend very little time at each exhibit.

Holding Power

Holding power is another value used to measure exhibit effectiveness. Holding power is defined as the amount of time spent at an exhibit divided by the minimum amount of time it takes to read any text and interact with any hands-on activities (Donald, 1991; Peart, 1984). Peart's 1984 study of holding power categorized exhibits as more concrete or more abstract. Exhibits that consisted mostly of written or spoken text were considered more abstract and exhibits with more sensory involvement, such as sound, simulations, hands-on interactive elements, or artifacts, were considered more concrete. Using a questionnaire to measure changes in knowledge and attitude and visitor tracking to assess time and engagement, Peart found that concrete exhibits produced more gains in knowledge and higher holding power. Boisvert and Slez (1994) found that highly interactive, concrete exhibits had a holding power more than 50% higher than that of any other exhibit type in their study.

Purpose and Methods

Participants and Setting

The purpose of the study was to assess the holding power of the exhibit *What's Bugging Belva?* Participants were visitors to a free, outdoor, science festival held on Purdue University's campus. The exhibit was housed in a 20' x 20' tent. The tent had only one doorway through which visitors entered and exited.

Exhibit Description

What's Bugging Belva? is a 400ft^2 exhibit about insects. The exhibit was developed by Purdue University's Exhibit Design Center. The exhibit is presented as a children's book, with an

introductory panel and four stations. The first station discusses monarch butterflies, the second station discusses dragonflies, the third station discusses burying beetles, and the fourth station defines true bugs. Stations 1 through 3 have hands on interactive elements consisting of small panels that visitors lift to find more information about insects. The fourth station includes a hand-operated knob that extends an insect's proboscis. The exhibit furniture is large and colorful. This trait, combined with the interactivity at each station, places it in the category of highly interactive, concrete exhibits as described by Boisvert and Slez (1994).

Data Collection

A camera was mounted above the doorway with a view of the entire exhibit space. Signs outside and inside the tent informed visitors that they were being recorded on video for research that would be used to improve future exhibits. The authors reviewed 2 hours of video and recorded the times of groups beginning when the first group member walked into the space and ending when the last member of the group left the space. The number of visitors in each group was recorded and, if present within a group, the number of children was recorded.

Results and Discussion

During the 2-hour period, 112 groups moved through the space. A total number of 352 individuals moved through the exhibit space, of which 166 were children. The average time spent viewing and interacting with the exhibit was 124 s. The minimum amount of time it takes to read any text and interact with any hands-on activities within the exhibit is 185 s. Using the formula for holding power of amount of time spent at an exhibit divided by the minimum amount of time it takes to read any text and interact with any hands-on activities, the holding power for *What's Bugging Belva?* is .67 (Donald, 1991; Peart, 1984). *What's Bugging Belva?* meets the definition of a simple, concrete, exhibit with high interaction (Boisvert et al, 1994; Peart, 1984). Exhibits studied by Boisvert and Slez (1994) that had similar characteristics had an average holding power of .47. Exhibits studied by Peart (1984) that had similar characteristics had an average holding power of .69. The holding power of *What's Bugging Belva?* compares favorably with the exhibits in these studies of museum exhibits and indicates that the exhibit's design was well-executed.

Limitations of Using Time as a Measure of Exhibit Effectiveness

Time as a measure of exhibit effectiveness is easy to record but requires an understanding of the myriad factors that may influence how exhibit visitors behave. Size of the social group and visitors' scheduled activities beyond the museum visit can contribute to length of stay at an exhibit (Falk, 1982; Sandifer, 1997). Other conditions not directly connected to the exhibit design or interactivity can also influence time spent with an exhibit. Studies of visitors' traffic patterns show that the museum layout can force visitors to spend more or less time in certain areas of the museum (Klein, 1993). While day of the week doesn't seem to make a significant difference in time, the time within the visit does make a difference; toward the end of the time allotted for the museum visit, less time is usually spent with each exhibit (Bohnert et al, 2014; Sandifer, 1997).

Conclusions

The exhibits discussed in this article are 3-dimensional exhibits that visitors view by walking through and around the exhibit furniture. However, the methods discussed for measuring time and holding power could also apply to poster presentations or tabletop displays. Calculating the holding power of individual posters, displays, and exhibits could be useful for comparing different styles and approaches for presenting content. For instance, 4-H participants could use holding power to assess poster projects and use the results to improve future presentations. Measuring the time visitors spend at an exhibit may provide Extension professionals with data that indicate interest, knowledge gain, or the possibility of the application of the exhibit content beyond the exhibit visit.

However, any assessment of time may be more effective if combined with at least one other measurement to establish a meaningful correlation. Combining the measurement of time with a simple, kiosk-based survey with questions about a specific exhibit station would provide a correlation between time and reported interest. For instance, Extension evaluators could observe visitors in aggregate for a period of time while running the kiosk-based quiz simultaneously. Once the observation is concluded, the kiosk could be shut down. The Extension evaluators would then have the two measures to compare to determine the relationship between time spent at the exhibit and interest. The same methodology could then be used to collect data on a

different exhibit station. By using this approach, evaluators could discover patterns that may indicate what exhibit characteristics are more effective than others. Ideally, evaluators would collect more than one additional source of data. A study similar to Sanford's (2010) study of three different behaviors is an example that's not overly complicated and could record visitors' time at the exhibit, holding power, and visitors' reported interest. If performed using a stand-alone kiosk, such a study would provide a clearer picture of what's happening in the exhibit environment while requiring limited human and material resources.

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CHAPTER 4: VISITORS' SELF-REPORTED KNOWLEDGE AND ATTITUDES ABOUT AN ANIMAL- FREE EXHIBIT ON ANIMAL WELFARE

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Abstract

Public events such as state fairs provide valuable opportunities to provide informal animal welfare education, possibly changing people's decisions regarding animal welfare. This study evaluated whether an interactive animal-free exhibit increased visitors' self-reported knowledge and stated behavioral intentions related to animal welfare. The exhibit featured information about the behavior and welfare of cattle, sheep, pigs, goats, poultry, horses, cats and dogs. Survey data were collected at two events in the Midwestern United States (Purdue University Spring Fest (FEST): n = 32; Indiana State Fair (FAIR): n = 49 valid responses). Most people agreed and strongly agreed (FEST: 60.00%; FAIR: 74.47%) that they learned new information and would consider this information when making decisions (FAIR: 70.37%; FAIR: 76.19). Most people (FEST: 67.86%; FAIR: 71.11%) also stated that they had a better understanding of animal welfare after visiting the exhibit. These findings indicate that an animal welfare exhibit can positively influence visitors' self-reported knowledge and stated decisions about animal welfare. Future research is needed to examine the long-term impacts of animal welfare exhibits on knowledge retention, decisions and behavior.

Introduction

Public interest in animal welfare has increased in recent years, affecting legislation, certification programs and standards pertaining to nonhuman animal housing and management (Rushen et al, 2011). Public attitudes can also affect the sustainability of animal agriculture (Coleman, 2010). Some studies have indicated that individuals' self-reported understanding of farm animal welfare is poor (Coleman, 2010; Cornish et al, 2016; Knight et al, 2015) and that generally, people's experience with agriculture has decreased, with fewer people participating in agriculture (Millman, 2009). However, interpretations, attitudes and opinions of animal welfare are not consistent among individuals and groups (Vanhonacker et al, 2007), and factors such as area of residence, pet ownership, gender and age influence people's attitudes toward and perceptions of animal welfare (e.g. Bir et al, 2019; Mckendree et al, 2014; Vanhonacker et al, 2007). Knowledge of agricultural production practices and animal welfare is another factor that can influence people's attitudes (e.g. Erian et al, 2017), which are comprised of beliefs, emotional responses and behaviors (Coleman, 2010). However, people's attitudes about animal welfare are "often based on limited knowledge" (Coleman, 2010). Unlike other factors, knowledge is something that educators, scientists and policymakers can try to change through targeted educational approaches to influence attitudes and enable people to make informed decisions about animal use and production. Educational approaches that include positive attitudinal change as an outcome have the potential to benefit learners and society (e.g. Bizjak et al, 2010; Watson et al, 2018). The effectiveness of educational approaches in changing attitudes, beliefs and decisions about agricultural production practices and animal welfare are complex and varied, but previous research supports the use of some educational approaches to change aspects of animal related attitudes and knowledge. For example, classroom and humane education interventions can lead to increased consideration for welfare needs (Jamieson et al., 2012) and changes in attitudes (Nicoll et al, 2008) in school children. For adults, providing informational materials can influence people's views (e.g. Hötzel et al, 2017) and attitudes (e.g. Ryan et al, 2015) pertaining to agricultural production practices, and informal educational events such as farm tours can influence their knowledge and perceptions about farming practices (e.g. Ventura et al, 2016).

One way to introduce large numbers of people of various ages to information about animal welfare, and possibly increase their knowledge about animal welfare and animal

agriculture, is through outreach at public events (Loizzo et al, 2016). In the United States, state and county fairs have a long history of providing visitors with both entertainment and educational opportunities (e.g. Laflin et al, 2010). Using exhibits at public events such as state fairs presents a unique opportunity to educate the public about animal welfare. Firstly, state fairs attract a large number of visitors of all ages. Secondly, in today's digital world, communicating science-based information can be challenging, particularly as consumers of information rely on the internet (Capper et al, 2015). Today, people have access to a wide variety of information online (Donath, 2014) which can be tailored to the individual's own interests. However, exhibits at state fairs provide an opportunity to educate visitors about a topic that they may not otherwise learn about if it is not something they are necessarily interested in, or know about, to begin with.

Exhibits at public events are particularly interesting as an animal welfare education tool because exhibits provide opportunities for informal learning and free choice learning to a broader public (Loizzo et al., 2016). Free choice learning, where people make choices regarding "what, where, when and with whom" they learn, is especially important because it contributes to people's comprehension of science (Falk et al, 2007). Notably, Falk et al. (2007) report that free-choice science learning occurs throughout people's lives and in diverse contexts, with people using a variety of informal education resources (for example, museums, books, television, and their life experiences); and sometimes using these informal education resources more frequently than formal education resources. Fair visitors develop attitudes about the particular exhibit they are visiting during these informal learning opportunities, which can ultimately affect their lifestyle choices (Loizzo et al., 2016); this is especially important in the context of animal welfare. Using exhibits that do not involve live animals has an additional advantage of providing animal welfare education without adversely affecting the welfare of the animals featured in the exhibit. The objectives of this preliminary study were to evaluate whether an animal-free exhibit focusing on animal welfare can increase visitors' self-reported knowledge of animal welfare and potentially change visitors' attitudes and behavioral intentions as a result of interacting with the exhibit.

Materials and methods

The Purdue University Institutional Review Board approved this study (Protocol number 1707019406).

Exhibit and Location

The exhibit (2.67 m long x 1.19 m wide x 2.04 m high) was created at the Purdue University Exhibit Design Center (EDC) and featured information about the behavior and welfare of farm and companion animal species, including poultry, pigs, cattle, sheep, goats, horses, cats and dogs (Figure 4).

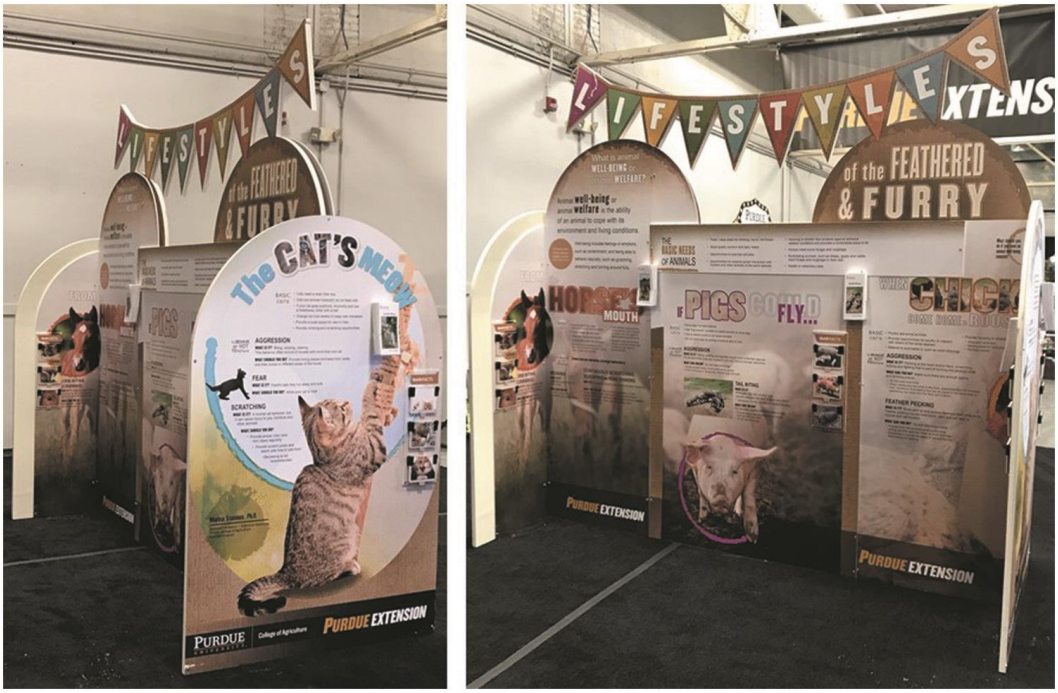

Figure 4. The Lifestyles of the Feathered and Furry animal welfare exhibit (2.67 m long x 1.19 m wide x 2.04 m high) consisted of 4 panels (sides) with information about the behavior and welfare of farm and companion animal species, including poultry, pigs, cattle, sheep, goats, horses, cats and dogs.

The exhibit was titled "lifestyles of the feathered and furry" and included the following information:

1. (1) A definition of animal welfare (based on Fraser et al, (1997) three approaches); featured on the front panel
2. (2) Basic needs of animals (e.g. fresh, clean water, protection from predators, veterinary care); featured on the front panel
3. (3) Some causes of poor welfare (e.g. cruelty, neglect, abuse, abandonment, illness, crowding); featured on the back panel

4. (4) General indicators of illness or injury (e.g. eating or drinking less than usual, more or less social than usual, hiding or sleeping more than usual); featured on the back panel

The following were provided for each of the featured species on the side panels of the exhibit:

1. (1) Quick facts (interesting facts about that species; for example, sheep have one stomach with four chambers)
2. (2) Basic care tips (e.g. provide high quality hay and grain for horses, provide cats with climbing and scratching opportunities)
3. (3) Behavior (e.g. fear, aggression, feather pecking (poultry)) and what to do about it (e.g. allow fearful cats to hide; provide poultry with appropriate environmental enrichment)

The exhibit was designed using a multimedia approach because multimedia learning theories support the use of a multimedia approach to engage audiences (Mayer, 2009). The exhibit included flaps that could be lifted, a smaller standalone display (1.21 x 0.89 m, height diameter) containing litter materials for poultry and bedding for horses that visitors could interact with (Figure 5), as well as tri-fold brochures that visitors could take home with them (the brochures are hosted on a public website (Erasmus, 2020), and peer-reviewed, printer-friendly versions of the brochures are available: (Erasmus, 2018a, 2018b, 2018c, 2018d, 2019a, 2019b; Jacobs et al, 2019a, 2019b). The exhibit was on display in 2019 at Purdue University's Spring Fest (FEST) and at the Indiana State Fair (FAIR). Spring Fest is an annual event that is hosted by the Purdue University College of Agriculture and takes place in April on the Purdue University campus. The event includes numerous activities and exhibits aimed at providing the public with information about scientific disciplines and agriculture (Ambrose, 2019). The exhibit was housed within its own tent on the lawn in front of the Agriculture Administration Building. Spring Fest is open to the public and there is no central entrance enabling the number of visitors to be tracked, but visitor attendance was estimated to be 40,000.

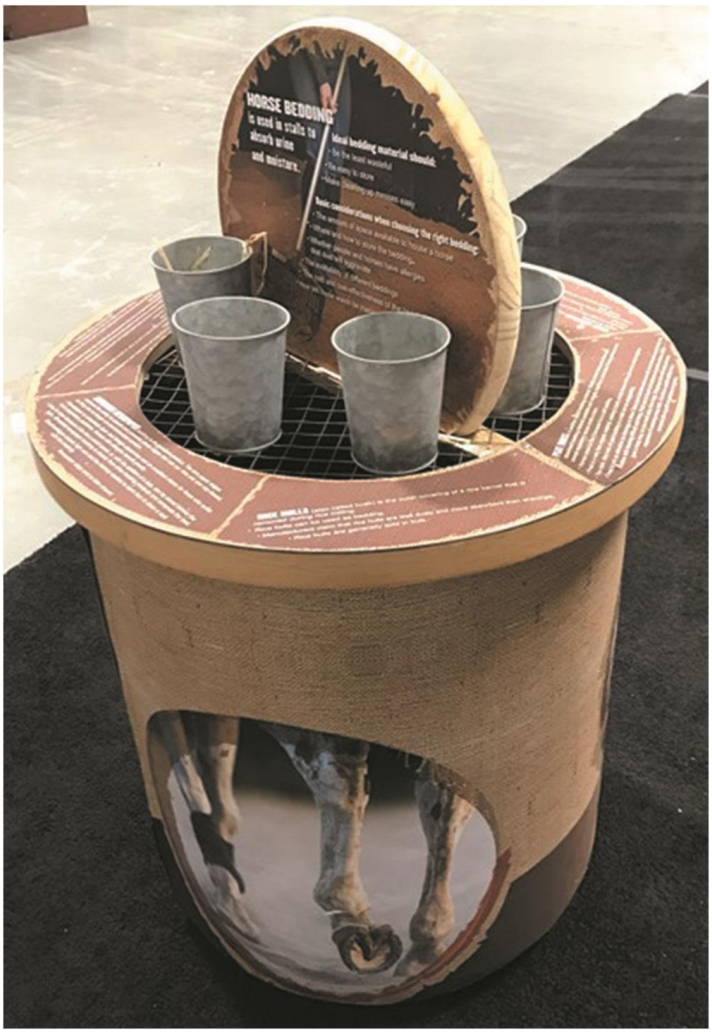

Figure 5. The exhibit featured a standalone interactive display (1.21 m high x 0.89 m diameter) with six containers filled with different bedding materials, including peat moss, rice hulls, wood shavings, shredded newspaper, straw and wood pellets with descriptions for each bedding material.

The Indiana State Fair is an annual fair that runs for 17 days in August, featuring various activities, events and exhibits such as livestock shows, games, rides and food. The exhibit was housed in the Ag/Hort Building among other exhibits. The number of visitors that enter the Ag/Hort Building every year is not tracked, but the number that enter that building has been estimated to be between 9 and 10% of the total number of fairgoers (Rollins et al, 2017). A total of 878,857 people visited the state fair in 2019 (Mack, 2019).

Survey Design and Implementation

The survey was first piloted at the 2018 Indiana State Fair, administered using a touch screen kiosk (iPad) that was available for a four-day period. Thereafter, data were collected in 2019 when the survey was administered via two touch screen kiosks (iPads) over a 2-day period at Purdue Spring Fest (April 6 and 7) and over 6 days (2–5 August and 13–14 August) at the State Fair. Survey questions were modified from Watson et al. (2018b) and an earlier version of the since- validated Attitudinal Learning Inventory (Watson et al., 2018a) to evaluate aspects of respondent attitude, including cognitive learning, behavioral learning, affective learning and social learning (Table 1). The survey was modified from that piloted in 2018 such that basic demographic questions were included. Following Spring Fest, the survey was shortened for the 2019 State Fair (Table 1) to reduce frustration and attrition associated with longer surveys (e.g. Maniaci et al, 2014) and to obtain a larger sample size. Survey questions had different response categories, such as selecting age or gender (FEST) or strongly agree (SA), agree (A), neither agree nor disagree (N), disagree (D) and strongly disagree (SD) (Table 2). The first question asked respondents whether they were 18 years of age or older. Respondents who selected yes received further questions, whereas the survey ended with no further questions if respondents selected no. Research staff did not recruit participants and participants did not receive any incentives for completing the survey. The survey was voluntary; participants self-selected and could access the iPads on their own volition and stop participating at any time. No identifiable information was collected from respondents and the Purdue Institutional Review Board did not require participants to complete consent forms.

Table 2. Overview of survey questions (response choices in parentheses) and their associated themes or constructs used at each event (Spring Fest (FEST) and Indiana State Fair (FAIR)).

Theme/construct		Survey question	Event
Demographics	ɣ	Are you at least 18 years old? (yes, no)	FEST, FAIR
	ɣ	Please select the category below that includes your age (18–	FEST
	ɣ	35, 36–50, 51–65, 66 and older)	
	ɣ	Please select the category below that best describes your gender (male, female)	FEST
	ɣ	Please select the category below that best describes the area you live in (rural, urban, suburban)	FEST, FAIR
	ɣ	I currently own or raise animals (A, D)[a]	FEST, FAIR
	ɣ	I am a student or employee of Purdue University (yes, no)	FEST
Belief	ɣ	Animal welfare is important (SA, A, N, D, SD)[a]	FEST, FAIR
Prior knowledge	ɣ	Before visiting this exhibit, I had a good understanding of what animal welfare is (SA, A, N, D, SD)[a]	FEST, FAIR
	ɣ	The following questions are based on your experience while visiting this exhibit (SA, A, N, D, SD)[a]	
Cognitive learning	ɣ	I learned new information from this animal welfare exhibit[2]	FEST, FAIR
Cognitive and	ɣ	I became more knowledgeable about the topics presented in	FEST
general learning	ɣ	this animal welfare exhibit[b,c]	FEST
	ɣ	I was intellectually stimulated with new information from this animal welfare exhibit[b]	FEST
		I considered multiple aspects related to the topics in this animal welfare exhibit[b]	
Affective learning	ɣ	I feel comfortable expressing my opinion about the exhibit topics in the exhibit[b]	FEST
	ɣ	I feel confident expressing my opinion about the exhibit topics in the exhibit[b]	FEST
	ɣ	I feel comfortable expressing my opinion about the exhibit topics outside the exhibit[b]	FEST
	ɣ	I feel confident expressing my opinion about the exhibit topics outside the exhibit[b]	FEST
Behavioral	ɣ	I will consider the new information I have learned while	FEST, FAIR
learning	ɣ	making decisions related to these topics outside of this	FEST
	ɣ	exhibit[b]	FEST
	ɣ	I will consider the new information I have learned when taking action related to these topics[b]	FEST, FAIR
		I will consider doing something related to these topics outside of this exhibit that	
		I have not done before[b]	
		I will make changes in my behavior related to these topics[b]	
Social learning	ɣ	I am likely to tell others about what I learned at this exhibit[c]	FEST, FAIR
Knowledge change	ɣ	After visiting this exhibit, I have a better understanding of what animal welfare is	FEST, FAIR

[a]SA: Strongly Agree, A: Agree, N: Neither Agree nor Disagree, D: Disagree, SD: Strongly Disagree

[b, c] Questions were modified from [b]Watson et al. (2018a) and [c]Watson et al. (2018b)

Analyses

This study was designed to evaluate visitors' perceptions of an exhibit and not designed to examine the effects of measured variables on visitors' responses; nonetheless, possible relationships between demographic factors (gender and age (FEST), and pet ownership and rural or urban/suburban residence at both events) and survey responses to exhibit questions were examined. For each survey question, the FREQ procedure (SAS 9.4, specifying the exact Chi square/Fisher's exact test), was used to determine whether frequencies of respondents were equally distributed among the demographic categories.

Analyses were also conducted to determine whether response categories (SA, A, N, D and SD) were selected with equal frequency for each question. The FREQ procedure (SAS 9.4), specifying the Chi square test and equal proportions (e.g. 0.20 for each of the five response categories) was used for each survey question.

If the Chi square tests resulted in $P < 0.05$, pairwise comparisons (PROC FREQ, specifying the exact binomial test) were conducted (a) among demographic variables within response categories to identify which demographic factors within a response category, and (b) among response categories for each survey question to identify which response categories within a question differed from each other. The Bonferroni correction was used for multiple pairwise comparisons.

Results

Purdue Springfest

Results are presented in Table 2. A total of 182 people accessed the survey, of which 40 indicated that they were 18 years of age or older. The number of people who responded to each question ranged from 26 to 34 (of 40 eligible). The majority of respondents were between 18 and 35 years of age (50.00%), followed by those in the 36–50 age category (33.33%), then 51 and older (16.67%). Most respondents were female (62.86%) and lived in suburban areas (50.00%; urban: 29.41%, rural: 20.59%). Most respondents (60.00%) indicated that they owned or raised animals and were not employees of, or students at, Purdue University (65.71%).

Spring Fest Demographic Differences in Survey Responses

There were no differences due to gender, employee/student status or area of residence for any of the survey questions. Animal owners differed from non-animal owners for Q13 (I feel confident expressing my opinion about the exhibit topics in the exhibit; Fisher's exact test, $P = 0.046$); however, pairwise comparisons did not reveal differences among animal owners and non-animal owners for the percentages of respondents who selected a particular response (SA, A, or N; no respondents selected D or SD). Respondents aged 18–35 and 36–50 differed for Q15 (I feel comfortable expressing my opinion about the exhibit topics outside of the exhibit, Fisher's exact test, $P = 0.048$); however, pairwise comparisons did not reveal significant differences among these age categories for survey response categories (SA, A, N and D).

Spring Fest Differences Among Survey Response Categories for Each Survey Question

Numerically, the majority of respondents agreed and/or strongly agreed with all questions asked. The frequencies of responses in each category (SA, A, N, D, SD) differed for all questions (Table 3), except for Q11 (I was intellectually stimulated with new information; $\chi^2 = 9.45$, $P = 0.051$), Q14 (I feel confident expressing my opinion about the topics in the exhibit; $\chi^2 = 2.32$, $P = 0.31$) and Q 16 (I feel confident expressing my opinion about the exhibit topics outside of the exhibit; $\chi^2 = 8.74$, $P = 0.068$). Pairwise comparisons revealed no differences among response categories for Q20 (will make changes in behavior). For Q7 (animal welfare is important), the percentage of respondents that selected SA was higher than any other response category and for Q8 (good understanding of animal welfare before visiting the exhibit) the percentage of respondents who selected A and SA were higher than the percentage who selected SD. For Q7 (learned new information), Q10 (became more knowledgeable), Q12 (consider multiple aspects), Q13 (comfortable expressing opinion in the exhibit), Q17 (consider new information when making decisions), Q19 (consider new information when doing something new), and Q22 (better understanding of animal welfare after visiting), more respondents selected A than D. For Q15 (comfortable expressing opinion outside the exhibit), more respondents selected A than N or D. The percentage of respondents who selected A was higher than those who selected N for Q18 (consider new information when taking action). Lastly, a higher percentage of respondents selected A for Q21 (likely to tell others) than D or SD.

Table 3. Differences in the percentages of responses to the survey at Purdue University's spring fest.

Survey item/question	n	Response category and % responses					
(1) Are you at least 18 years old	182	Yes: 21.98				No: 78.02	
(2) Age	34	18 to 35 50.00	36 to 50 33.33	51 to 65 11.11		66 and older 5.56	
(3) Gender	34	Male: 37.14				Female: 62.86	
(4) Area of residence	33	Urban: 29.41	Suburban: 50.00			Rural: 20.59	
(5) I currently own or raise animals	34	Agree: 60.00				Disagree: 40.00	
(6) I am a student or employee of Purdue University	34	Agree: 34.29				Disagree: 65.71	
Questions relating to the exhibit		SA*	A*	N*	D*	SD*	χ^2, *P*
(7) Animal welfare is important	32	69.75^{a}	12.50^{b}	9.38^{b}	6.25^{b}	3.13^{b}	48.31, < 0.0001
(8) Before visiting this exhibit, I had a good understanding of what animal welfare is	31	35.48^{a}	41.94^{a}	$19.35^{a,b}$	-	3.23^{b}	11.19, 0.011
(9) I learned new information from this animal welfare exhibit	30	$16.67^{a,b}$	43.33^{a}	$33.33^{a,b}$	6.67^{b}	-	9.73, 0.021
(10) I became more knowledgeable about the topics presented in this animal welfare exhibit	30	$23.33^{a,b}$	53.33^{a}	$16.67^{a,b}$	6.67^{b}	-	14.53, 0.0023
(11) I was intellectually stimulated with new information from this animal welfare exhibit	29	20.69	37.93	24.14	13.79	3.45	9.45, 0.051
(12) I considered multiple aspects related to the topics in this animal welfare exhibit	28	$17.86^{a,b}$	50.00^{a}	$25.00^{a,b}$	7.14^{b}	-	11.14, 0.011
(13) I feel comfortable expressing my opinion about the exhibit topics in the exhibit	28	$35.71^{a,b}$	42.86^{a}	$14.29^{a,b}$	7.14^{b}	-	9.71, 0.021
(14) I feel confident expressing my opinion about the exhibit topics in the exhibit	28	28.57	46.43	25.00	-	-	2.32, 0.31
(15) I feel comfortable expressing my opinion about the exhibit topics outside of the exhibit	28	$28.57^{a,b}$	50.00^{a}	10.71^{b}	10.71^{b}	-	11.71, 0.0084
(16) I feel confident expressing my opinion about the exhibit topics outside of the exhibit	27	29.63	37.04	14.81	11.11	7.41	8.74, 0.068
(17) I will consider the new information I have learned when making decisions related to these topics outside of this exhibit	27	$22.22^{a,b}$	48.15^{a}	$25.93^{a,b}$	3.70^{b}	-	10.78, 0.013
(18) I will consider the new information I have learned when taking action related to these topics	27	$22.22^{a,b}$	59.26^{a}	18.52^{b}	-	-	8.46, 0.015
(19) I will consider doing something related to these topics outside of this exhibit that I have not done before	26	$19.23^{a,b}$	50.00^{a}	$26.92^{a,b}$	3.85^{b}	-	11.54, 0.0091
(20) I will make changes in my behavior related to these topics	27	14.81	37.04	40.74	7.41	-	8.70, 0.034
(21) I am likely to tell others about what I learned at this exhibit	28	$14.29^{a,b}$	42.86^{a}	$35.71^{a,b}$	3.57^{b}	3.57^{b}	18.79, 0.0009
(22) After visiting this exhibit, I have a better understanding of what animal welfare is	28	$21.43^{a,b}$	46.43^{a}	$28.57^{a,b}$	3.57^{b}	-	10.57, 0.014

* SA: Strongly Agree, A: Agree, N: Neither Agree nor Disagree, D: Disagree and SD: Strongly Disagree
^{a,b,c}Within questions, ^{a,b,c} indicates significant differences ($P < 0.05$) among individual response categories (SA, A, N, D, SD)

Indiana State Fair

Results for the 2019 state fair are presented in Table 4. A total of 126 people accessed the survey, of which 50 were over 18. The number of people who completed each question ranged from 42 to 48 of the 50 who indicated they were over 18. Responses generally reflected those obtained at Purdue Spring Fest. The majority of respondents (54.17%) were from suburban areas and owned or raised animals at the time of the fair (62.50%). Questions about age, gender and whether respondents were employees of or students at Purdue University were not included in the State Fair survey.

State Fair Demographic Differences in Survey Responses

Neither area of residence nor animal ownership influenced responses to any survey question.

State Fair Differences Among Survey Response Categories for Each Survey Question

Similar to Spring Fest, the majority of respondents agreed and/or strongly agreed with each question and overall frequencies of responses differed across response categories for all questions with the exception of Q8 (Make changes in behavior) (Table 4). Pairwise comparisons indicated that response categories differed for all questions (except Q8). Specifically, the percentage of respondents who selected SA was higher than the percentage who selected A, N, D or SD in response to Q4 (animal welfare is important). For Q5 (understand animal welfare before visiting), a higher percentage of respondents selected A and SA than SD. In response to Q6 (learned new information), more respondents selected A than D and SD, and more respondents selected SA than SD. In response to Q7 (consider information when making decisions) more respondents selected SA and A compared to D (no respondents selected SD). A higher percentage of respondents selected A, SA, and N compared to D for Q9 (likely to tell others). Lastly, for Q10 (better understanding of animal welfare after visiting), more respondents selected A than D and SD, and SA than SD.

Table 4. Differences of percentages of responses to the survey at the Indiana State Fair.

Survey item/question	n	Response category and % responses					
(1) Are you at least 18 years old	126	Yes: 39.68	No: 60.32				
(2) Area of residence	48	Urban: 16.67	Suburban: 54.17	Rural: 29.17			
(3) I currently own or raise animals	48	Agree: 62.50		Disagree: 37.50			
Questions relating to the exhibit		SA*	A*	N*	D*	SD*	χ^2, *P*
(4) Animal welfare is important	45	73.33[a]	13.33[b]	6.67[b]	4.44[b]	2.22[b]	81.56 < 0.0001
(5) Before visiting this exhibit, I had a good understanding of what animal welfare is	47	44.68[a]	34.04[a,b]	17.02[a,b]	-	4.26[b]	18.11 0.0004
(6) I learned new information from this animal welfare exhibit	47	34.04[a,b]	40.43[a]	12.77[a,b,c]	10.64[b]	2.13 [c]	25.23 < 0.0001
(7) I will consider the new information I have learned when making decisions related to these topics outside of this exhibit	42	42.86[a]	33.33[a]	19.05[ab]	4.76[b]	-	14.00 0.0029
(8) I will make changes in my behavior related to these topics	45	17.78	33.33	31.11	17.78	-	3.80 0.28
(9) I am likely to tell others about what I learned at this exhibit	45	28.89[a]	33.33[a]	35.56[a]	2.22[b]	-	12.87 0.0049
(10) After visiting this exhibit, I have a better understanding of what animal welfare is	45	28.89[a,b]	42.22[a]	20.00[a,b,c]	6.67[b]	2.22[b,c]	24.00 < 0.0001

* SA: Strongly Agree, A: Agree, N: Neither Agree nor Disagree, D: Disagree and SD: Strongly Disagree
[a,b,c]Within questions, [a,b,c] indicates significant differences ($P < 0.05$) among individual response categories (SA, A, N, D, SD)

Discussion

Interactive exhibits have a rich history of providing science education and outreach at various locations and events (e.g. Feher et al, 1985; Fernández et al, 2000; Rennie et al, 2010) and this study utilized two community events to examine visitors' responses to an animal welfare-themed exhibit. After visiting the exhibit, respondents at both events indicated that they learned new information and had a better understanding of animal welfare after visiting the exhibit. The majority of survey respondents also agreed that animal welfare is important and that they would consider the information they learned when making decisions related to the topics presented in the exhibit.

Respondent Demographics

There do not appear to be any other publications examining public interactions with animal welfare exhibits, or animal welfare-related exhibits that do not involve live animals. While the main purpose of this study was not to examine demographic differences in survey responses, the survey included some questions about basic demographic information. It is important to note that survey respondents and visitors to the exhibit were not randomly selected from a population, so the people who completed the survey may generally have a more positive attitude about animal welfare. At Spring Fest, 62.86% of people who completed the survey were female. At both events, the majority of people lived in suburban areas (FEST: 50.00%, FAIR: 54.17%) and reported that they owned or raised animals (FEST: 60%; FAIR: 62.50%). Unlike other studies (Bir et al., 2019; Mckendree et al., 2014; Morgan et al, 2016; Vanhonacker et al., 2007), no differences in gender, animal ownership or area of residence were found, but the relatively low numbers of non-animal owners, males and people from rural areas that completed the surveys may partly explain the lack of demographic effects on survey responses. Presumptively, people who own or raise animals possess more knowledge, or believe that they possess more knowledge, related to animal behavior and welfare and the species featured in the exhibit, especially if they own one or more of the featured species. The survey did not specifically ask which species people owned or raised, and the exhibit featured several commonly owned animal species, so respondents likely had experience with at least one of the featured species. Unlike previous work (Bir et al., 2019; Mckendree et al., 2014), the survey

asked whether people owned or raised animals, rather than pets *per se* because the exhibit featured both companion animals (traditionally viewed as pets) as well as farm animals. Therefore, it is possible that people who view themselves as pet owners may respond differently compared to people who raise or own farm animal species and who may not view themselves as pet owners *per se*. Previous work demonstrated that there are differences in farmers' and citizens' (people with little or no farming experience or background) evaluations and opinions of animal welfare (Vanhonacker et al, 2008), people's attitudes differ among animal species (e.g. Bir et al., 2019; Byrd et al, 2017; Driscoll, 1995), and people's views of animals are based on their experience with those particular species of animals (Driscoll, 1995). Thus, it is possible that future work may find distinctions among pet owners, owners of farm animals and people who do not own animals in their perceptions of animal welfare and how they learn from an animal welfare exhibit. Further research is needed to (a) examine how animal welfare related information should be adapted for audiences of different ages and backgrounds, and (b) to understand the importance of animal ownership, and experiences with different species of animals, on animal welfare perceptions and animal welfare related knowledge acquisition.

Respondents' Attitudes and Knowledge

The survey questions used in this study have been used to examine students' attitudes in relation to Massive Open Online Courses (MOOCS) (e.g. Kim et al, 2016; Loizzo, Watson, & Watson, 2018; Watson et al, 2016) but there does not appear to be any other research examining visitors' responses and attitudes pertaining to an animal behavior and welfare exhibit. The majority of respondents strongly agreed or agreed that animal welfare is important (combined SA and A FEST: 82.25; FAIR: 86.66%); however, previous research has demonstrated that animal welfare is ranked below other social issues, such as poverty, food safety and food prices (Prickett et al, 2010) and it is important to recognize the people's attitudes and perceptions of a topic change depending on the context. Animal welfare is a complex issue that has continued to gain public interest in recent years and it is important that all stakeholders are educated about animal welfare as they make decisions and take action based on their knowledge, perceptions and attitudes surrounding animal welfare.

At both events, the majority of respondents agreed or strongly agreed with survey questions representing various aspects of attitudinal learning. In particular, visitors had positive

perceptions of (a) learning new information, becoming more knowledgeable and considering multiple aspects (cognitive and general learning), (b) feeling comfortable in expressing their opinions both inside and outside the exhibit (affective learning), (c) considering the new information when taking action and making decisions (behavioral learning), (d) having a better understanding of animal welfare after visiting the exhibit (knowledge change) and (e) telling others about what they learned (social learning). Taken together, the positive responses to the survey questions indicated that visitors perceived some attitudinal learning occurring as a result of visiting and interacting with the exhibit. However, at Spring Fest Q11 (I was intellectually stimulated with new information from this animal welfare exhibit) and Q14 and Q16 (confidence in expressing my opinion inside (Q14) and outside (Q16) the exhibit were the exceptions to the overall positive response to the exhibit, with respondents not having a strong positive reaction relative to the other response categories. This may indicate that although visitors learned new information, the information was not necessarily intellectually stimulating. Possible explanations are that the method in which information was conveyed may not have enhanced intellectual stimulation (more interactivity could be beneficial), or that respondents were seeking additional information. Intellectual stimulation influences learning and is associated with both cognitive and affective learning (e.g. Bolkan et al, 2010; Bolkan et al, 2011). Since no information was collected about which aspects of the exhibit visitors found most or least interesting or stimulating and why, or how respondents perceive confidence, it is not possible to draw conclusions about why visitors responded in this manner. Learning could possibly be enhanced if future research can identify ways to make the exhibit more intellectually stimulating.

Although a large percentage of respondents agreed and strongly agreed (combined SA and A FEST: 77.42%; FAIR: 78.72%) that they had a good understanding of animal welfare before visiting the exhibit, 67.86% (FEST) and 71.11% (FAIR) of people still responded (combined SA and A) that they had a better understanding of animal welfare after visiting the exhibit, which provides promising support for using interactive exhibits such as this one for increasing visitors' perceived knowledge. Despite agreeing that they would consider the information they learned while making decisions, there were no differences among individual SA, A, N, D, and SD categories for Q8 (I will make changes in my behavior related to these topics), indicating that exhibit visitors did not feel as strongly that they were likely to change their behavior as a result of visiting the exhibit. Nonetheless, it is notable that over 50% of

respondents reported that they would make changes in their behavior related to the topics in the exhibit. Behavioral change is regarded as being more difficult to accomplish than other aspects of attitude (Loizzo et al., 2018) such as knowledge. Furthermore, knowledge transfer is not adequate to change behavior and multi-faceted approaches and interventions are needed to bring about behavior change (Cornish et al, 2019). Questions about visitors' reasons for visiting the exhibit were not included in the survey, so it is possible that visitors were interested in learning more about the topic of animal behavior and welfare without necessarily intending to use the information for a particular purpose or behavioral change.

Limitations, Conclusions and Future Work

Education about animal welfare, and in particular, the welfare of production animals, is important as societal beliefs and values change and as fewer people are familiar with agricultural practices. State and county fairs provide valuable opportunities for informally educating visitors of all ages about animal welfare. This study was a preliminary study, focusing on a specific animal behavior and welfare exhibit, and there are several limitations of this study that influence generalizability of the results. Specifically, participants completed the survey voluntarily, and the relatively low sample size combined with the high percentage of women (FEST), suburban residents and animal owners who participated reduce the generalizability of results to the general public. Furthermore, the survey did not include follow up questions about behavioral learning, such as which decisions, actions and changes respondents plan to make or take, respectively. Questions about specific behavioral intentions would help inform how respondents plan to use information, providing further evidence of whether the exhibit is successful in affecting behavioral learning and ultimately, behavioral change.

Visitors to the exhibit at both events responded positively and the findings of this study suggest that an animal behavior and welfare exhibit that does not use live animals can be used as a source of information to positively influence visitors' self-reported knowledge of animal welfare and decision- making, but the effects on visitors' behavioral intentions are less clear. This study highlighted the need for much more research into animal behavior and welfare knowledge transfer and attitude change and identified several areas for future research. Further work is needed to examine visitors' reasons and motivations for visiting the exhibit, such as whether some exhibit visitors were merely interested in information or actually sought out

information in order to change their behavior. Additionally, research is needed to examine the long-term effects of an animal welfare exhibit on knowledge retention and whether an animal welfare exhibit can influence people's purchasing and other animal-welfare related choices. Additional questions about the influence of an animal welfare exhibit on different age groups and demographic factors remain; future research with more diverse audiences will provide valuable information.

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CHAPTER 5: CONCLUSIONS, LIMITATIONS, AND IMPLICATIONS FOR FUTURE RESEARCH

Conclusions

The purpose of these studies was to consider whether measuring holding power and surveying visitors using the ALI are effective methods for evaluating exhibits for practitioners with little to no training. It is important that practitioners have access to methods for combining low-cost, easy-to-understand methods for gathering data that can be useful for evaluating the effectiveness of their work, whether the object being evaluated is an exhibit or other informal education object, such as informational posters. Since funding for future projects is frequently tied to evidence of past performance, using the ALI and holding power to assess their work can provide practitioners with an effective method for gathering data that's critical to their ongoing efforts. The first and third study used an early and validated version of the ALI, while the second study focused on using time as a measure of exhibit effectiveness. The results of each study are summarized below.

Chapter 2 describes the first study, which was conducted at the Indiana State Fair and measured visitors' self-reported attitude change after visiting an exhibit about hellbender salamanders. Visitors' responses to were positive across all questions. Although 49% of survey respondents reported that they didn't know what a hellbender salamander was before visiting the exhibit, 69% or more reported positive changes in attitude or understanding about hellbenders and their habitats. Perhaps most important to hellbender conservation efforts, 73% of survey respondents claimed they would change their behavior and 70% claimed they would tell others of what they learned by visiting the exhibit. Only visitors 18 and older were surveyed and the positive responses indicate that the scaffolding of exhibit content was engaging for learners in Piaget's formal operational stage (Oogarah-Pratap et al., 2020).

Chapter 3 describes the second study, which was conducted at Purdue Springfest, an informal science education event held annually at Purdue University. Holding power was calculated by dividing the amount of time spent at the exhibit by the minimum amount of time it takes to read text and interact with the exhibit. Past studies have shown a positive correlation between gains in knowledge and holding power (Falk, 1983; Peart, 1984). The holding power for

the *What's Bugging Belva?* exhibit was .67, which compared favorably with past studies of similar exhibits that reported holding powers of .47 (Boisvert et al, 1995) and .69 (Peart, 1984).

Chapter 4 describes the third study, which was conducted at the Indiana State Fair and at Purdue Springfest and examined visitors' responses to an exhibit about animal welfare. At both events, visitors had positive perceptions in the categories of cognitive and general learning, affective learning, behavioral learning, and social learning. Although behavioral change is considered more difficult to accomplish than other aspects of attitude such as cognitive change (Loizzo et al., 2019), 50% of respondents reported that they would make changes in their behavior related to the topics in the exhibit.

Limitations

Measuring the amount of time visitors spend at an exhibit and then calculating holding power is a useful method for assessing exhibits but is not generalizable, nor does it account for other conditions that may influence visitor behavior. Group size, time of day, and visitors' itineraries can affect time spent at an exhibit ((Bohnert et al, 2014; Sandifer, 1997).

The studies conducted with the ALI were preliminary, and there are limitations that affect the generalizability of the results. The sample size for both studies was relatively small, and participants belonged to groups who chose to attend the Indiana State Fair and Springfest and do not represent the general public. Neither study included follow up questions that would collect data on visitors' motivations, actions, and intentions. While the ALI is a validated instrument and results from exhibit visitors' self-reported attitude change are not generalizable, the ALI is useful for comparing exhibits to one another (Watson et al, 2021).

Implications for Future Research

Combining the measurement of time and holding power with the results from the ALI would provide a correlation between time and attitude change. Researchers could observe visitors, record times, and calculate holding power concurrently with administering the ALI to provide data that may reveal more about visitors' behavior and help researchers understand how visitors may or may not use the information contained in the exhibit. Visitors could also be observed, and time recorded at specific exhibit stations, providing researchers with data that

applies to subsets of content within the larger exhibit. Using the ALI and time may also be useful for assessments in other informal education settings, including the broad variety of free-choice learning.

Free-choice learning occurs through websites, broadcast media, print media, parks, and historic sites (Falk, 2002). Falk (2002) defines free-choice learning as "lifelong learning that is intrinsically motivated and largely under the choice and control of the learner" (p. 62). Visits to parks and nature trails have increased in the past few years and site managers reacted by adding more interpretive signage to communicate site features (Janeczko et al, 2021). Correlating time and data from the ALI may provide site managers with information for improving interpretive content that improves the interplay between text and graphics (Vičič et al, 2018) and could be useful for comparing the efficacy of signage within a given park.

Websites align with other free-choice learning activities by presenting information in a hierarchy that's designed to gain and hold visitors' attention (Xing et al, 2004). Time on page and time on site are used to gauge visitor interest in web content (Hofgesang, 2006), and research comparing holding power with data from the ALI may offer further insights into website visitors' attitudes, behavior, and intent.

In both the first study and the third, visitors' relatively low percentage of positive responses to questions designed to elicit data regarding their affective and social change after visiting the exhibits may have less to do with demographics or the exhibit content and more to do with where they fall in Falk's Visitor Experience Model (Falk et al, 2008). Falk's work produced a 20-item instrument designed to identify visitors as falling into one of five categories (Falk et al, 2008):

- Explorers: generally interested in museums and curious; prefer unstructured visits
- Facilitators: visit purpose is primarily to accompany others, such as parents, grandparents, and caregivers
- Experience Seekers: attend museums as a social event and drawn by a specific exhibit or, in the case of iconic institutions, the museum itself
- Professionals/Hobbyists: those with a professional or personal interest in the exhibits, such as school teachers or museum professionals; usually visit with specific goals in mind

- Rechargers: visitors for whom the experience itself is seen as restorative and a value the site as a resource in its own right

As the demographic makeup of society in the US continues to evolve, categorizing visitors according to traditional methods based on sex, race, education, etc., and designing learning based on those characteristics may not be useful (Farrell et al, 2010). The Visitor Experience Model recognizes that visitors are better defined by their intention than by their demographic makeup and that visitors' intent can and does change within the same visit (Falk et al, 2008). Triangulating data using the Visitor Experience Model, holding power, and the ALI may provide more useful correlations that better explain visitors' attitudinal changes.

While the methods discussed in chapters 2, 3, and 4 provide practitioners with exhibit evaluation methods that are effective and require few additional resources, the strategies for exhibit development discussed in chapter 1 provide practitioners with methods for organizing exhibit content. For example, the Purdue EDC successfully used Vygotsky's ZPD and Piaget's stages of cognitive development to scaffold exhibit content (DeVries, 2000).

Vygotsky's ZPD and Piaget's stages of cognitive development were combined to develop the content for an exhibit about how food gets to consumers called *The Edible Journey*. One panel within the exhibit was about food processing (Figure 6) and the learning objectives for this panel were broken into three categories:

- *Adult:* identify key positives and negatives of food processing
    - Positive: convenience, safety, nutrition, shelf life
    - Negative: elevated levels of sodium and sugar, nutrition for some products
- *Zone of Proximal Development:* explain how boiling and freezing preserve food
- *Youth:* explain that boiling is getting food hot (212) and freezing is getting food cold (32)

The target learners for *The Edible Journey* were pre-K through 6th grade students and their families. To reach learners across such a broad range, decisions for arranging the text on The Edible Journey were based on Lev Vygotsky's ZPD and Jean Piaget's stages of cognitive development (DeVries, 2000). The exhibit's text was layered with the bottom layer targeted at learners in pre-K through 2nd grade who are in Piaget's pre-operational or concrete operational stages of development. The text briefly stated the temperatures at which water freezes and boils.

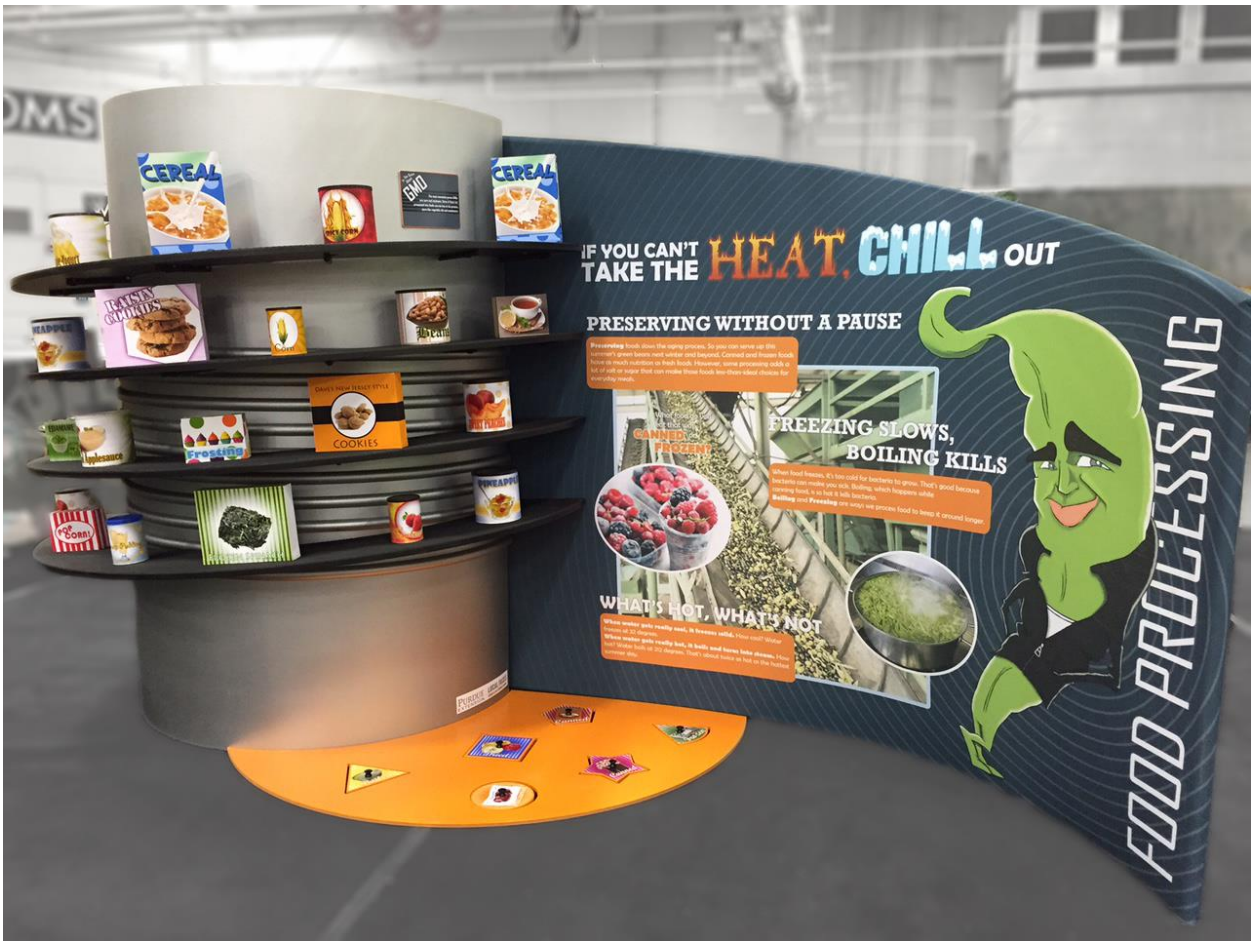

Figure 6. Food Processing station

The top layer of content was targeted at the adult learners that accompany younger learners and uses concepts appropriate for learners in Piaget's formal operations stage. The third, or middle, layer of content was designed to activate Vygotsky's ZPD and encourages adult learners to help younger learners comprehend new concepts. The text on the panel was as follows:

Adult:

Preserving Without a Pause:

Preserving foods slows the aging process. So you can serve up this summer's green beans next winter and beyond. Canned and frozen foods have as much nutrition as fresh foods. However, some processes add a lot of salt or sugar that can make those foods less-than-ideal choices for everyday meals.

ZPD:

Freezing Slows, Boiling Kills:

When food freezes, it's too cold for bacteria to grow. That's good because bacteria can make you sick. Boiling, which happens while canning food, is so hot it kills bacteria. Boiling and freezing are ways we process food to keep it around longer.

Youth:

What's Hot, What's Not:

When water gets really cool, it freezes solid. How cool? Water freezes at 32 degrees. When water gets really hot, it boils and turns into steam. How hot? Water boils at 212 degrees. That's about twice as hot as the hottest summer day.

The text on the exhibit panel was arranged so that the layering of content is applied on the physical space; content for younger learners was nearer to the floor, while content for older learners was at the eye level of an adult. This method for organizing content was useful for the exhibit development team and well-received by visitors and by museum staff responsible for leasing exhibits.

The methods discussed here for applying ID theories and models to exhibit evaluation and development have potential for practitioners with little or no training. Measuring attitudinal learning using the ALI and a stand-alone kiosk requires few resources and is effective for comparing exhibits with one another or for comparing stations within an exhibit. Similarly, recording time spent in the exhibit space and calculating holding power can give practitioners a way to compare exhibits with those assessed in past studies or to compare individual stations within an exhibit. Finally, using Vygotsky and Piaget to develop exhibit content can provide practitioners with a prescriptive method for organizing text that scaffolds content and activates social learning.

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