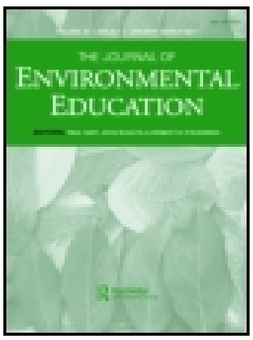

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RESEARCH ARTICLE

An educational intervention maximizes children's learning during a zoo or aquarium visit

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ABSTRACT

Children comprise many of the visitors to zoos every year, yet few studies have explored the impact of a zoo visit on children's learning. This study employed a repeated measure design using data gathered from 500 questionnaires to investigate students' knowledge, attitude, and behavior before and after visiting a zoo or aquarium in Ireland. A treatment group participated in a purposefully developed educational intervention, which included a hands-on activity, intended to enhance learning. Results indicate that learning does occur after a zoo or aquarium visit. However, students visiting the zoo and those who participated in the educational intervention showed the greatest increases in learning. A zoo visit has educational benefits for children, but to maximize this benefit an educational intervention should be offered.

KEYWORDS

children; educational intervention; evaluation; survey; zoo setting

Introduction

Zoos report that their highest priority is educating visitors, particularly school children (Roe et al.2014). Each year millions of children visit zoos, where they encounter a wide array of exotic animals and educational messages (Jensen, 2014). Therefore, zoos should be ideally positioned to play an important role in science education, specifically biological science and conservation (Jensen, 2014). However, it has proven difficult for zoos to demonstrate the impact of their education progams on visitors' learning (Moss & Esson, 2013). In fact, zoos have been criticized for failing to show evidence of their educational claims, calling into question some of their justifications for keeping animals in captivity (Jensen, 2011, 2014; Moss & Esson, 2013). Jensen (2014) summarizes that previous educational research on zoos has frequently alluded only to the actual educational impact of a zoo visit and focused instead on other variables such as visitor density and stay time at exhibits, as a means of making a connection to visitor learning. Rarely have previous studies considered the impact of a zoo visit on children's learning, even though children constitute a large percentage of visitors to zoos every year, and it is children who will make environmental decisions in the future (Davis, 1998).

Limited research on the impact of zoo's education programs has occurred. An early study at the National Aquarium in Baltimore (NAIB), which considered adults' learning, in a pre-post interview format, found that the visit positively influenced visitors' knowledge, but did not lead to a positive change in conservation actions (Adelman et al., 2000). However, the authors state that learning at a zoo or aquarium may take time to assimilate. Falk et al. (2007) also evaluated the impact of visiting a zoo or aquarium on adult visitors' learning and found a positive association between the visit and conservation attitudes, yet the authors reported no overall change in knowledge after the visit. Both studies state that

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visitors had higher than expected knowledge of ecological concepts and strong positive attitudes toward conservation upon arrival at the zoo or aquarium. A more recent large-scale global study, which evaluated zoos' ability to raise visitors' awareness of biodiversity with repeated measures pre- and post-surveys, found a significant positive association between the visit and visitors' understanding of biodiversity and knowledge of actions to protect biodiversity (Moss et al., 2015). In contrast, Balmford et al. (2007) found almost no evidence of knowledge gain at seven UK zoos in adults' conservation learning after a visit to the zoo. However, unlike the previous studies, Balmford et al. (2007) compared the knowledge of visitors arriving at the zoo with a separate group of visitors exiting the zoo, which makes detecting knowledge at an individual level difficult. Still, the discrepancies reported here highlight the need for further methodologically robust zoological education research studies (Mellish et al., 2019).

To date, the only comprehensive large-scale study involving children concerned 7–15-year-olds visiting the Zoological Society of London (London Zoo) (Jensen, 2011, 2014). The author reported significant knowledge gain in conservation related learning from pre- to post-visit in individuals, particularly in the area of understanding animal habitats. Educator-led visits showed the highest positive outcome (41%) and the lowest negative outcome (11%) compared to unguided visits (Jensen, 2014). However, Jensen (2011) did not explore children's behavior or intended actions while visiting the zoo. Instead, the study focused on conservation-related knowledge gain and attitude toward conservation. Several smaller studies have assessed the impact of a specific intervention on knowledge gain in the zoo. In general, it has been reported that students who participated in the educational program or who used the materials offered scored higher on post-visit tests than those who did not experience an educational intervention (Lindemann-Matthies & Kamer, 2006; Randler et al., 2007; Visscher et al., , 2009).

However, zoos are expected to do more than provide their visitors with facts and knowledge; they are also expected to influence visitors' attitudes toward conservation and ultimately encourage pro-conservation behavior and actions (Hungerford & Volk, 1990; Ogden & Heimlich, 2009). Yet, conservation action is challenging to accurately measure and difficult to attribute it to a specific educational experience (Smith et al., 2008). However, limited research in this area has occurred. For example, a seminal study that investigated behavior change after a zoo visit, manifested by visitors' willingness to return conservation solicitation cards, found that visitors who participated in an interactive experience with an elephant show and bio-fact program were more likely to take conservation-related action (Swanagan, 2000). In addition, Smith et al. (2008) found that after adult visitors attended a birds of prey presentation at Healesville Sanctuary, Australia, 54% of respondents stated that they intended to commence or increase their commitment to the conservation actions described during the presentation; six months later some visitors had followed through with the intended conservation action. Recently, Mann et al., (2018) discovered that over a year after a visit to an aquarium approximately 50% of adult visitors, who made a promise to penguins to become more environmentally responsible, were still carrying out their intended actions, such as not littering. Pro-conservation related behavior change after a zoo visit may be related to personal connections to animals and conservation ideas developed during the zoo visit (Skibins & Powell, 2013; Swanagan, 2000).

Thus, the current study focused on children's intended actions regarding zoo animals. This was reflective of their behavior toward animals, feasible within the constraints of working with children, and it was part of a larger study, which directly observed children's behavior and considered if captive animal welfare was affected be negative visitor behavior (Collins et al., 2019). Given the lack of information surrounding the impact of education at zoos and aquariums on children's learning, the current study developed a survey that aimed to quantify the effects of a zoo/aquarium visit on children's knowledge of two popular zoo species, attitude toward zoos/aquariums, and intended behavior toward captive animals. This study represents the first large-scale evaluation of two zoological education programs in Ireland and the dissemination of these results will enhance the efficacy of children's learning in the zoo on a broader scale. The specific aims of the present study were to investigate (1) the effect of a visit to Fota Wildlife Park or Dingle Aquarium on children's knowledge, attitude, and behavior; (2) the impact of a purposefully developed educational intervention on children's knowledge, attitude, and behavior; and (3) other variables that may affect learning outcomes in the zoo or aquarium.

Methodology

Research sites

The two institutions that participated in the research were Fota Wildlife Park (Fota) in Carrigtwohill, Ireland (51.889585° N, 8.311276° W) and Dingle Aquarium (Dingle) in County Kerry, Ireland (52.1399° N, 10.2783° W). These sites were chosen because Fota welcomes more than 15,000 students to the park every year (L. McSweeney, Head of Education at Fota Wildlife Park, personal communication, 2018) and Dingle aquarium reports 5,000 students per year (M. O'Shea, General Manager at Dingle Aquarium, personal communication, 2018), making children a readily accessible yet under-studied group. In addition, both Fota and Dingle are committed to delivering high quality education. However, their animal exhibits are uniquely different from each other, giving an opportunity to examine the effect of different enclosure designs on children's learning. At Fota Wildlife Park, which has been open to the public since 1983, some of the animals are free-ranging and most are kept in naturalistic enclosures. Dingle aquarium, open since 1996, comprises several different display areas, including a tropical marine tank, shark tank, an ocean tunnel, touch tank and otter and penguin enclosure. Throughout the study, zoo, wildlife park, and aquarium are considered sufficiently similar (because of the presence of visitors and live animals) to be referred to collectively as "zoo" when appropriate (Skibins & Powell, 2013).

Participants

The children that participated in the study attended schools that were booked in for a tour at Fota Wildlife Park or Dingle Aquarium. Ten schools consisting of 23 different classes and more than 500 students participated in the study. This included children in 3rd through 6th class, which corresponds to approximately 9–12 years of age in Ireland. Most schools were of mixed gender, however a few all girls' schools participated in the study. Class size ranged from 18–36 students.

The animal species chosen for inclusion on the survey and educational intervention were lemurs and penguins because they were listed by zoo visitors as animals they would most like to see (Carr, 2016), and they are generally considered popular by visitors at the institutions involved with this research (M. O'Shea, personal communication, November 6, 2014; T. Power, personal communication, July 27, 2016).

Reliability and validity

Zoological education research has been criticized for methodological errors and failing to meet the high standard required for robust evaluative research (Jensen, 2014; Marino, Lilienfeld, Malamund, Nobis, & Broglio, 2010; Mellish et al., 2019). The current study sought to utilize both valid and reliable methods to avoid committing some of the more common methodological flaws identified in recent zoological education research studies (Mellish et al., 2019). The current research follows a classic repeated measures experimental design (Oppenheim, 1992), which allows for the detection of "patterns of conceptual development" or changes in both positive and negative thinking to emerge as a result of an educational experience at an individual level (Jensen, 2011, p. 6; Moss et al., 2015). Throughout the research, checks on reliability occurred such as Cronbach's alpha to test for internal consistency. To ensure validity, a controlled experimental approach was employed, methodology was meticulously selected, the survey instrument was examined by experts in the field and data analysis was rigorous (Cohen et al., 2007; Wellington & Szczerbinski, 2007). Jensen (2014) reported that informal learning studies should not rely solely on "self-report" data collected from surveys. Hence, the current study gained information on children's learning in the zoo from additional methods, including behavioral observation, conversational content analysis, and the long-term impact of education (see Collins et al., 2019, and Collins, 2018, for these results). Certain variables could not be controlled, such as teacher preparedness, parental influence, previous experience at a zoo or aquarium or socioeconomic situation (Jensen, 2014). However, the study attempted to tease out some of these variables with the questions on the survey.

The survey instrument

The survey was designed in three sections to assess knowledge about lemurs (Fota only) and penguins, attitudes toward captive animals and learning, and behavior toward animals held in captivity. A mixed-methods approach to data collection was implemented (Jensen, 2011, 2014), with both quantitative and qualitative items included in the survey including thought listing, Likert scales, selected response, and open-ended questions (see Collins, 2018, for results of qualitative questions). The surveys for children visiting Fota Wildlife Park and Dingle Aquarium were almost identical. However, three additional questions about ring-tailed lemurs were included in the Fota survey. The post-survey was similar to the pre-survey to allow for direct comparisons, except that the wording of some questions differed to reflect the past tense. See Appendix 1 for the complete surveys.

Specifically, the survey included a preliminary section on demographic details: name, gender, and age. In addition, because it is known that visitors construct meaning during an informal science visit from prior knowledge and experience (Adelman et al., 2000; Falk & Dierking, 2000), two questions intended to uncover students' previous experience with nature were included: "Have you been to a zoo or aquarium before?" and "Do you like to watch nature shows on TV?" (similar to Moss et al., 2015). Next, the survey also included a section on attitude toward zoo/aquarium animals and learning with a 5-point Likert-type response scale including Strongly Disagree, Disagree, I'm not sure, Agree, and Strongly Agree. Here, the current study differed from other studies, which have investigated learners' attitudes toward conservation (Jensen, 2014; Lindemann-Matthies & Kamer, 2006), by investigating visitors' attitude toward captive animals and learning in the zoo setting. Although there is no correct or incorrect answer for the attitude section, the scale data allowed for changes in attitude to be observed between the two surveys. It is important to note that the current study allowed for the possibility that the zoo visit could have a negative impact on visitor learning (Jensen, 2014). A high score (5) was considered a favorable response (the most positive answer), which correlated to "strongly agree" when the statement was positive. Thus, when the statement was unfavorable "zoo animals are bored," scoring was reversed and (5) correlated with "strongly disagree." This was followed by a section on basic knowledge of ring-tailed lemurs (Fota students only) and penguins. The response options included one correct response, several incorrect choices, and an "I'm not sure" choice. A correct response was given a score of (3), I'm not sure (2), and incorrect (1). Where "I'm not sure" was omitted, the question was scored as either correct (2) or incorrect (1). The survey concluded with a section on self-reported behavior and preference for enrichment. It was intended to uncover visitors' willingness to comply with the rules of the zoo or aquarium and their likely behavior toward captive animals (e.g., I think it is okay to touch zoo animals or bang on the glass), with the same Likert-type response scale described previously (see Collins et al., 2019, for results of actual observed behavior). The ordering of the questions was based largely on pilot work (Oppenheim, 1992). However, to avoid response bias, the ordering of the responses varied and the introduction of a negative statement was included (Falk et al., 2010; Marino et al., 2010). Inevitably, not every student who completed the pre-survey completed the post-survey and vice versa. Because the study was concerned with tracking learning at an individual level, pre- or post-surveys that did not have a matched pair were discounted from the study. If an individual question was not answered, it was given the designation (99) and the total number of questions was adjusted for that section of an individual survey. This scoring system was used consistently throughout the research (Oppenheim, 1992). Following Ballantyne et al., (2011), it was aimed to collect at least 150 questionnaires per site; however, a total sample of 501 (242 Fota; 259 Dingle) matched-pair surveys was attained.

The educational intervention (EI)

The treatment groups participated in a purposefully designed, hour-long, hands-on educational intervention, designed to enhance students' learning in the zoo. The EI took place in the children's classroom before their visit to the zoo or aquarium. It focused on knowledge about the study species, children's attitude toward zoo-housed animals and learning in the zoo. Most important, it aimed to change behavior

toward zoo animals by minimizing incidences of negative behavior such as: feeding, touching, shouting, and banging on glass, behaviors known to disturb some captive animals (Morgan & Tromborg, 2007; Sherwen et al., 2014). The EI included a PowerPoint presentation and an activity session during which children made environmental enrichment devices for lemurs and penguins, described here as a "hands-on" activity because the children constructed the devices themselves. See Appendix 2 for specific details of the EI.

Procedure

The study took place from April–June, which corresponded to the period that most school groups visited the two study sites during 2014, 2015, and 2016. Once a school agreed to participate in the study, it was randomly allocated as a control or treatment school by the researcher. If a school brought more than one class to the zoo or aquarium, the researcher took advantage of this naturally occurring division of classes to have a control and treatment group from each school when possible. The schools did not have prior knowledge as to the contents of the survey or the details of the educational intervention. Prior to the schools' visit to the zoo or aquarium, the researcher traveled to each school to administer the survey. The classes that were selected as treatment groups participated in the one-hour educational intervention immediately after completing the pre-survey. Following the initial visit from the researcher to the school, all groups then attended either Dingle Aquarium or Fota Wildlife Park. The visit consisted of a guided tour of the park or aquarium of between 60 to 90 minutes in length, which focused on the different animal species on exhibit and conservation in general. It was presented by highly trained zoo or aquarium staff. In addition, the treatment group experienced a supervised interaction session with the lemurs and penguins during which time they observed the animals receiving the enrichment devices that they had prepared during the EI. Following their visit to the zoo or aquariums, post-surveys were administered by the schoolteacher (Ballantyne & Packer, 2002). To promote consistency, all teachers were given the same set of instructions about administering the post-survey. It was not possible to standardize the timing of the pre- and post-visit survey, but they were all completed one week before or after the visit. There was a 100% return rate of the post-surveys from the schools.

Data analysis

General demographics of the study population are shown at the beginning of the results section (Table 2), where responses are expressed as the proportion of the group that chose a given answer or were known to the researcher (see Collins, 2018, for results of individual survey questions). For results of each section (knowledge, attitude, and behavior) of the survey, data analysis was carried out with the use of R 3.1.2 (R Development Core Team, 2017). To test whether a zoo or aquarium visit had a significant impact on students' learning, linear regression models were constructed to model the scores from students' surveys against the various demographic parameters and questionnaire responses (Table 1). Separate models

Table 1. The independent variables included in the models.

Independent variables	Response options	Demographics known or self-reported on survey
Condition	Control/Treatment	Known
Site	Fota Wildlife Park/Dingle Aquarium	Known
School location	Rural/Urban	Known
Social[a]	DEIS/non-DEIS	Known
School type[b]	Mixed sex/Girls only	Known
Gender	Male/Female	Self-reported
Previously visited a zoo/aquarium	No/I'm not sure/Yes	Self-reported
Enjoy watching nature shows on TV	No/I'm not sure/Yes	Self-reported

[a]In Ireland a school may be designated as DEIS (Delivering Equality of Opportunity in Schools) by the Department of Education if it is determined to be educationally disadvantaged.
[b]No boys only school participated in the study.

Table 2. Demographic variables of the study participants presented as control and treatment groups.

Demographics Total ($n = 501$)	Control Group ($n = 214$)	Treatment Group ($n = 287$)
Site		
Fota	0.37	0.56
Dingle	0.63	0.44
Location		
Urban	0.85	0.76
Rural	0.15	0.24
Social		
Non DEIS	0.93	0.95
DEIS	0.07	0.05
School type		
Boys only	0.00	0.00
Girls only	0.19	0.15
Mixed	0.81	0.85
Age		
9	0.17	0.20
10	0.05	0.07
11	0.61	0.34
12	0.17	0.35
13	0.01	0.04
Gender		
Male	0.41	0.44
Female	0.59	0.56
Zoo/Aquarium before[1]		
No	0.15	0.09
Not sure	0.05	0.04
Yes	0.80	0.87
Nature shows on TV		
No	0.27	0.25
Not sure	0.09	0.10
Yes	0.64	0.65
Enjoyed the day		
No	0.01	0.02
Not sure	0.03	0.05
Yes	0.95	0.93

1, This question was also analyzed by site. Students at Fota reported (No 0.06, Not sure 0.01, Yes 0.93); **Dingle (No 0.17, Not sure 0.08, Yes 0.75) for having visited a zoo/aquarium before.**

were run for each section of the survey (knowledge, attitude, and behavior), in which the difference in total score for that section, between the pre- and post-visit was the dependent variable.

All assumptions of the models were met. Graphs of the models revealed that the residuals were normally distributed, the variance homogenous across the fitted values of the model and for each individual predictor, and the dependent variables are linearly related to the independent variables. To start, the maximal model, containing all variables, was fitted to the data, and backward deletion was used using the step function in R (which uses Akaike's Information Criterion [AIC] to delete terms from the model) (Crawley, 2007). The least significant parameters remaining in the model were then removed and the deviance checked using ANOVA. Where the deviance was not significantly increased by the removal of that parameter (at the $P < 0.05$ level), it remained out of the final model. This process was repeated until the Minimum Adequate Model (MAM), where only parameters significant at the $P < 0.05$ level were retained, was achieved (Crawley, 2007). Interaction terms were also fitted for condition by each of the demographic parameters to test whether there are condition-specific differences in attitude, knowledge, or behavior. Where a statistically significant effect was detected, results representing the proportion of students' scores to decrease, remain stable, or increase for each response option are shown in table format (Table 3). Decreases in learning were considered because negative outcomes of educational programs should also be considered (Jensen, 2011; Moss & Esson, 2013).

Table 3. (a)–(c). The proportion of students whose (a) Knowledge, (b) Attitude and (c) Behavior scores decreased, remained stable or increased between pre- and post-survey for the independent variables.

Survey section	Response option	Decrease	Stable	Increase
a. Knowledge				
Condition	Control	0.22	0.46	0.32
	Treatment	0.04	0.08	0.88
Site	Fota	0.07	0.14	0.79
	Dingle	0.16	0.34	0.50
Location	Urban	0.12	0.27	0.61
	Rural	0.13	0.14	0.73
School type	Girls	0.10	0.19	0.71
	Mixed	0.12	0.25	0.63
b. Attitude				
Site	Fota	0.23	0.20	0.57
	Dingle	0.35	0.23	0.42
Gender	Male	0.38	0.19	0.43
	Female	0.23	0.23	0.54
c. Behavior				
Condition	Control	0.22	0.34	0.44
	Treatment	0.17	0.32	0.51
Site	Fota	0.16	0.26	0.58
	Dingle	0.22	0.47	0.31
School type	Girls	0.17	0.26	0.57
	Mixed	0.19	0.40	0.41

Results

Cronbach's alpha was used to measure the internal consistency of the survey instrument and indicated a reliable level of internal consistency ($\alpha = 0.717$) (Cohen et al., 2007). Results of demographic questions are presented in Table 2.

Knowledge

The results of the general linear model for knowledge revealed that condition ($p < 0.001$), site ($p < 0.001$), location ($p < 0.001$), and school type ($p = 0.002$) remained as significant predictors of knowledge scores. Most children in the treatment group experienced an increase in knowledge between pre- and post-test, compared to less than half of the control group (Table 3a). In addition, students visiting Fota were more likely than those at Dingle to have an increase in knowledge after their visit (Table 3a). However, interactions occurred between condition:site ($p < 0.001$) (Figure 1a), condition:location ($p < 0.001$) (Figure 1b), condition:school type ($p = 0.024$) (Figure 1c). An interaction between condition and site indicated that more children in the Fota treatment group (94%) than the Dingle treatment group (80%) experienced an increase in knowledge from pre- to post-test (Figure 1a). Rural school students were more likely to have an increase in knowledge than urban schools (Table 3a). However, when considered together with condition, it was found that urban and rural groups were almost equally likely to experience knowledge gain, when they were in a treatment group, but rural control groups (34%) were more likely to have a decrease in knowledge than urban control groups (20%) (Figure 1b). Girls-only schools had the highest increases and lowest decreases in knowledge compared to mixed-schools (Table 3a). The interaction between the variables indicated that girls-only schools who experienced the EI had a 98% chance at increasing their knowledge level and a zero percent chance of a decrease from pre-test to post-test (Figure 1c).

Attitude

Attitude score was affected by both site ($p = 0.003$) and gender ($p = 0.031$). No statistically significant interactions occurred. Students visiting Fota were more likely to have an increase in attitude score from pre- to post-test and less likely to have a decrease in attitude, compared to students visiting Dingle

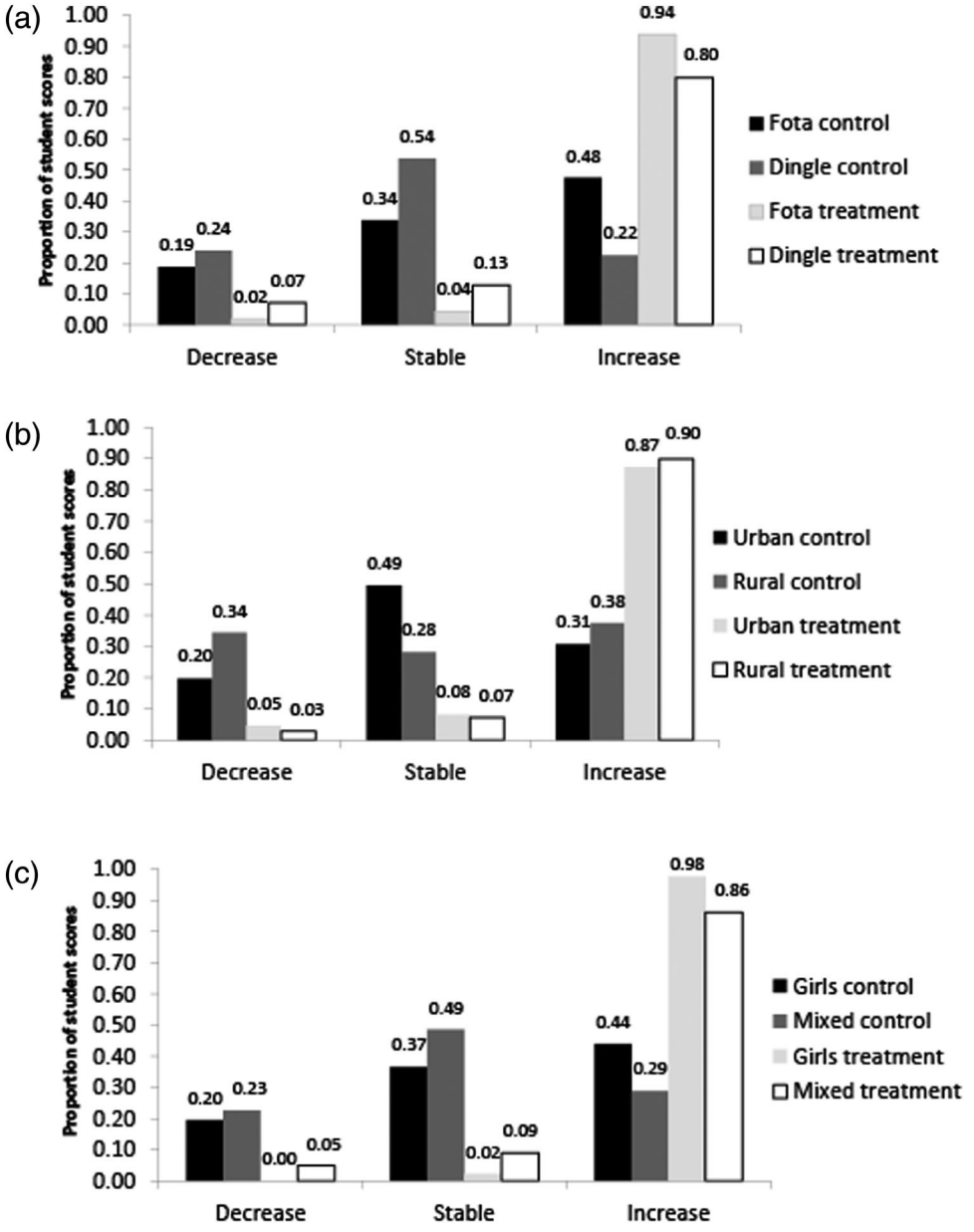

Figure 1. The proportion of students whose knowledge scores decreased, remained stable or increased for treatment and control groups between pre- and post-survey at (a) Fota or Dingle, (b) urban or rural schools and (c) girls-only or mixed-sex schools.

Aquarium (Table 3b). Girls were more likely to experience an increase and less likely to have a decrease in attitude score from pre- to post-visit compared to boys (Table 3b).

Behavior

Behavior was affected by condition ($p = 0.025$), site ($p < 0.001$) and school type ($p = 0.019$). More students in the treatment group than the control group, at Fota rather than at Dingle, and girls-only schools versus mixed schools were more likely to have an increase in behavior scores (Table 3c). A significant interaction occurred between condition:site ($p < 0.001$). Children in the treatment group at Fota were the most likely to have an increase in their behavior score and the least likely to have a decrease (Figure 2). In contrast,

72% of children in the Dingle control group experienced a decrease in their behavior score from pre- to post-test (Figure 2).

Discussion

This study found that a one-hour educational intervention before the zoo or aquarium visit significantly increased the knowledge and behavior scores of 9 to 12-year-olds. This is an encouraging, but not a surprising result. The educational intervention (EI) followed several of the recommendations outlined by Ballantyne and Uzzell (1994) for the enhancement of informal learning experiences. For example, the EI used in the current study was specifically designed for children of the study age group. It involved an interpretive presentation, including an in-depth question and answer session about the study species, as well as a hands-on activity, during which time children made enrichment devices. Furthermore, the first part of the EI took place in a classroom setting, which may be more conducive to learning compared to learning while touring the park (Ballantyne & Uzzell, 1994; Dillon et al., 2006). Furthermore, as students in the treatment group viewed the animals on their tour of the zoo, they had the opportunity to see them interacting with the enrichment device that they had made for them, allowing environmental learning to occur through direct observation and experience in a real-world setting, which is known to enhance visitors' experience (Ballantyne et al., 2011; Ballantyne & Packer, 2002; Ballantyne & Uzzell, 1994). Also, children who participated in the EI specifically learned about the behavior (e.g., not feeding zoo animals) that was expected to change (Smith et al., 2008). Interestingly, participation in the educational intervention did not affect students' attitude toward zoo animals and learning. This is in contrast to Anderson et al., (2003) who found that visitor participation in an otter training session positively affected visitors' attitude toward zoo animals. However, during the otter training session the animals became more active (Anderson et al., 2003), and in the current study the animals generally did not become more active during the viewing sessions with the treatment group than with the control group (see Collins et al., 2019, for results of animal behavior in this study), which may have affected attitude score.

That knowledge, attitude, and behavior appeared more likely to increase at Fota than at Dingle between pre- and post-test is a more complex issue, which may be attributed to the differences between the settings. The students visiting Fota Wildlife Park were more likely to have had a similar previous experience compared to those visiting Dingle Aquarium. Ballantyne and Packer (2002) reported that students were more excited about an excursion if they had not previously visited the site. However, the added excitement of a novel setting can also lead to distraction and interference with learning (Dillon et al., 2006; Falk &

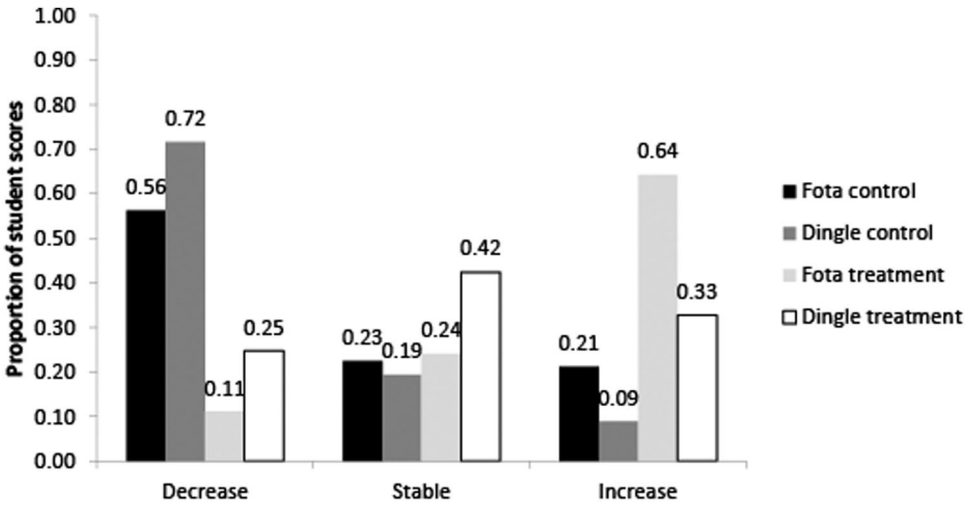

Figure 2. The proportion of students whose behavior scores decreased, remained stable, or increased at Fota Wildlife Park or Dingle Aquarium for treatment and control groups between pre- and post-survey.

Balling, 1982). It was perceived by the researcher that the students thought that Dingle was a more exotic and less familiar location than Fota (personal observation by researcher) probably because of its distance from Cork, the main location of the schools in this research. Also, the entrance to the penguin viewing area at Dingle is quite dark with UV-A lights, and this may have excited and distracted the students. Furthermore, previous research has indicated that visitors, including children, like to see animals in naturalistic enclosures (Rhoads & Goldsworthy, 1979; Tofield et al., 2003). Recently, Pavitt and Moss (2019) discovered that zoo visitors at naturalistic, walk-through exhibits made more conversational comments indicative of deeper level learning than visitors at traditional zoo enclosures. Fota Wildlife Park includes many free-ranging or semi free-ranging species, housed in enclosures similar to walk-through exhibits, and in general is an outdoors experience in a natural environment for visitors. In contrast, Dingle Aquarium is a generally indoors experience with more traditional enclosures where the study species do not have access to the outside. It is likely that this difference in enclosure design is responsible for the diminished learning detected at Dingle Aquarium (Finlay et al., 1972). Furthermore, whereas the curriculum and design of the tours and Fota and Dingle appeared similar to the researcher, differences such as teaching style may have existed that contributed to the reduced scores at Dingle Aquarium.

Location of the school also affected knowledge scores. This could be due to the different characteristics of students attending rural and urban schools. For example, it is possible that children at rural schools are more accustomed to nature and animals, and perhaps a visit to a zoo did not hold the same appeal for them as children in urban settings, although previous research tends to suggest the opposite, i.e., previous experience with nature can lead to greater affinity toward the environment (Palmberg & Kuru, 2000). Further research is required to disentangle this, but the expectations of different groups is something that teachers and staff could be made aware of in the future.

School type and gender also affected knowledge, attitude, and behavior outcomes, with children from girls-only schools most likely to have an increase in knowledge and behavior scores after the visit. Previous research has found that single-sex education can benefit students, particularly girls in regard to academics, but also school-related behavior, such as homework (Lee & Bryk, 1986). The current research has uncovered a possible advantage of a single-sex school tour evidenced by girls-only schools' increased knowledge and behavior scores. Perhaps girls are more focused on the learning experience when boys are not present. However, similar to Jensen (2011), in the current study student gender (male, female) did not have an effect on knowledge scores. In addition, it must be noted that there were no boys-only schools and the sample of girls-only groups ($n = 4$) was quite small. However, gender was also found to affect attitude at the zoo, with girls more likely to have an increase in attitude than boys after the visit. It is possible that girls and boys experience animals differently (Myers et al., 2004; Tunnicliffe, 1998). Gender difference in regard to learning in the zoo is an area that has received very little attention (Randler et al., 2007), but the results found here suggest that it is something that should be considered by zoos and future researchers.

Although the increase in knowledge, found here and in previous studies on children's learning in the zoo (Jensen, 2014; Randler et al., 2007), can be considered a positive outcome of a zoo visit, the ultimate goal of zoo education should be positive pro-conservation behavior change or action (Hungerford & Volk, 1990; Ogden & Heimlich, 2009). However, it has proven difficult not only to show a direct link between a zoo visit and a changed behavior, but also to measure the change in behavior (Dierking et al., 2004; Smith et al., 2008). Nevertheless, some studies have successfully linked zoological education to pro-conservation behavior change (Mann et al., 2018; Smith et al., 2008; Swanagan, 2000). Encouraging results from this research indicate that behavior scores, especially for children who experienced the EI at Fota, were positively affected by the experience. It should be noted that the positive results found here report children's intended, not actual, behavior. Dierking et al. (2004) caution that what people report they intend to do and their actual actions are not necessarily similar, especially in regard to conservation-related actions. However, additional data from this study (Collins et al., 2019) confirms that children who participated in the educational intervention did show improved actual behavior as they viewed animals, which corresponds to the results presented here on intended behavior. Along with behavior change, positive attitude change has also proven difficult for conservation-related studies to show (Moss et al., 2015). It is possible that a brief educational experience may not be enough to influence long-held

beliefs (Adelman et al., 2000; Falk & Dierking, 2000), and the limited change in attitude found here generally supports that.

Limitations included a small sample size of DEIS (educationally disadvantaged schools) or single gender schools. It is interesting to note that a previous visit to a zoo or aquarium or enjoying nature shows had no significant effect on knowledge, attitude, or behavior scores. This is in contrast to the findings of other studies that state prior knowledge and experience effect learning outcomes (Adelman et al., 2000; Dierking et al., 2004; Falk et al., 2007). However, in reality almost all of the children had visited a zoo or aquarium before, and it was difficult to develop a question that would adequately reveal children's concern for the environment. Perhaps watching nature shows does not indicate an overall pro-conservation attitude. Questions about pet ownership and recycling were considered but were dismissed as being more reflective of parents' beliefs than children's beliefs. It may have been better to phrase the behavior questions "I think visitors should be allowed to feed free-ranging animals" as "It is okay for me to feed zoo animals" to personalize the belief, yet it was thought that some children may be reluctant to "own up" to the action.Furthermore, responsible behavior toward zoo animals does not necessarily indicate responsible environmental behavior. However, it was thought that the considered treatment of captive wild animals might indicate concern for the protection of wildlife. The association between treatment of captive animals and conservation behavior could be an area for further research. It was not possible in the current study to differentiate between the contribution of the different parts of the educational intervention. Future research should consider exactly which part of an EI, the class, the viewing of the animals with enrichment or a combination of both, enhanced learning. In addition, this study should be replicated at other institutions and with adult visitors to make the results more generalizable to zoos and aquariums worldwide.

Informal science learning is shaped by many influences and can be difficult to measure. The current study, through rigorous research design and robust statistical analysis, offers empirical evidence that learning does occur in the zoo and aquarium setting in Ireland. Maximum results were achieved when children participated in the EI. Almost without exception, children in the treatment groups were more likely to show an increase in knowledge and behavior and were less likely to have a decrease than those in the control group. Therefore, it is recommended that zoos include more in-depth educational opportunities and hands-on experiences for visitors. Learning was also enhanced at Fota Wildlife Park, where animals are displayed in a naturalistic setting. The fact that participation in the EI, which included a supervised child-animal interaction session, led to increased learning is evidence that a limited and supervised interaction session with animals does benefit visitor learning in the zoo, something that other studies have alluded to, but not definitively shown (Anderson et al., 2003; Jones et al., 2016; Mun et al., 2013; Sherwen et al., 2015). In conclusion, learning does occur in the zoo setting, but the efficacy of zoological education programs can be improved through hands-on learning experiences, such as the EI described in this study.

Conclusions

1. The treatment groups at Fota Wildlife Park were the most likely to show an increase in knowledge scores. These results indicate that the naturalistic environment at Fota and the purposefully designed educational intervention maximized learning. Future studies should continue to explore the effect of enclosure design on visitor learning and develop curriculum to engage visitors emotionally with hands-on interactive experiences.
2. Children at Fota and girls were the most likely to have an improvement in attitude after their educational experience. The more naturalistic landscape at Fota engendered greater respect for animals and learning. Future research should continue to explore ways to develop positive environmental attitudes in children, focusing on differences between genders and connections to nature and wildlife.
3. Those most likely to have an increase in behavior scores from pre- to post-survey were girls-only schools and children at Fota Wildlife Park in a treatment group. Future research should expand on these results and consider if responsible treatment of zoo animals leads to off-site willingness toward conservation actions such as volunteering, holding a fundraising event, or donating to conservation causes.

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References

Adelman, L. S., Falk, J. H., & James, S. (2000). Assessing the National Aquarium in Baltimore's impact on visitors' conservation knowledge, attitude and behaviour. *Curator*, *43*(1), 33–61. doi:10.1111/j.2151-6952.2000.tb01158.x

Anderson, U. S., Kelling, A. S., Pressley-Keough, R., Bloomsmith, M. A., & Maple, T. L. (2003). Enhancing the zoo visitor's experience by public animal training and oral interpretation at an otter exhibit. *Environment and Behavior*, *35*(6), 826–841. doi:10.1177/0013916503254746

Ballantyne, R., Fien, J., & Packer, J. (2001). School environmental education program impacts upon student and family learning: A case study analysis. *Environmental Education Research, 7*(1), 23–37. doi:10.1080/13504620124123

Ballantyne, R., & Packer, J. (2002). Nature-based excursions: School students' perceptions of learning in natural environments. *International Research in Geographical and Environmental Education*, *11*(3), 218–236. doi:10.1080/10382040208667488

Ballantyne, R., Packer, J., Hughes, K., & Dierking, L. (2007). Conservation learning in wildlife tourism settings: Lessons from research in zoos and aquariums. *Environmental Education Research*, *13*(3), 367–383. doi:10.1080/13504620701430604

Ballantyne, R., Packer, J., & Falk, J. (2011). Visitors' learning for environmental sustainability: Testing short-and long-term impacts of wildlife tourism experiences using structural equation modelling. *Tourism Management*, *32*(6), 1243–1252. doi:10.1016/j.tourman.2010.11.003

Ballantyne, R., Packer, J., & Sutherland, L. A. (2011). Visitors' memories of wildlife tourism: Implications for the design of powerful interpretive experiences. *Tourism Management*, *32*(4), 770–779. doi:10.1016/j.tourman.2010.06.012

Ballantyne, R., & Uzzell, D. (1994). A checklist for the critical evaluation of informal environmental learning experiences. *International Journal of Environmental Education and Information. 13*(2), 111–124.

Balmford, A., Leader-Williams, N., Mace, G., Manica, A., Walter, O., West, C., & Zimmermann, A. (2007). Message received? Quantifying the impact of informal conservation education on adults visiting UK Zoos. In A. Zimmerman, M. Hatchwell, L. A. Dickie, & C. West (Eds.), *Catalysts for conservation: A direction for zoos in the 21st century* (pp. 120–136). Cambridge, UK: Cambridge University Press.

Clarke, A. G. (2003). *Factors affecting pool use by captive Humboldt penguins (Spheniscus humboldti)*. In *Proceedings of the 5th Annual Symposium on Zoo Research, Marwell Zoological Park*, Winchester, UK, 7-8 July 2003 (pp. 190–204). Federation of Zoological Gardens of Great Britain and Ireland.

Cohen, L. M., Manion, L. I., & Morrison, K. (2007). *Research methods in education, 6*. Routledge: London.

Collins, C. K. (2018). Education in the zoo: A study of the relationship between education, zoo visitors and animal behaviour (PhD thesis). University College Cork, Ireland.

Collins, C., Quirke, T., McKeown, S., Flannery, K., Kennedy, D., & O'Riordan, R. (2019). Zoological education: Can it change behaviour?*Applied Animal Behaviour Science*, (*220*), 104857. doi:10.1016/j.applanim.2019.104857

Crawley, M. J. (2007). *The R book*. West Sussex, UK: Wiley.

Davis, J. (1998). Young children, environmental education, and the future. *Early Childhood Education Journal*, *26*(2), 117–123. doi:10.1023/A:1022911631454

Davey, G., Henzi, P., & Higgins, L. (2005). The influence of environmental enrichment on Chinese visitor behavior. *Journal of Applied Animal Welfare Science, 8*(2), 131–140.

Dewey, J. (1998) [1933]. *How we think: A restatement of the relation of reflective thinking to the educational process*. Lexington, MA: Heath, *35*, p. 64.

Dierking, L. D., Adelman, L. M., Ogden, J., Lehnhardt, K., Miller, L., & Mellen, J. D. (2004). Using a behavior change model to document the impact of visits to Disney's Animal Kingdom: A study investigating intended conservation action. *Curator: The Museum Journal*, *47*(3), 322–343. doi:10.1111/j.2151-6952.2004.tb00128.x

Dillon, J., Rickinson, M., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield, P. (2006). The value of outdoor learning: evidence from research in the UK and elsewhere. *School Science Review*, *87*(320), 107–111.

Falk, J. H., & Balling, J. D. (1982). The field trip milieu: Learning and behaviour as a function of contextual events. *Journal of Educational Research*, *76*(1), 22–28. doi:10.1080/00220671.1982.10885418

Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: Alta Mira Press.

Falk, J. H., Reinhard, E. M., Vernon, C. L., Bronnenkant, K., Deans, N. L., & Heimlich, J. E. (2007). *Why zoos & aquariums matter: Assessing the impact of a visit to a zoo or aquarium*. Silver Spring, MD: Association of Zoos & Aquariums.

Falk, J. H., Heimlich, J. E., Vernon, C. L., & Bronnenkant, K. (2010). Critique of a critique: Do zoos and aquariums promote attitude change in visitors?*Society & Animals*, *18*(4), 415–419. doi:10.1163/156853010X524361

Finlay, T., James, L. R., & Maple, T. L. (1988). People's perceptions of animals the influence of zoo environment. *Environment and Behavior*, *20*(4), 508–528. doi:10.1177/0013916588204008

Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *The Journal of Environmental Education*, *21*(3), 8–22. doi:10.1080/00958964.1990.10753743
Jensen, E. (2011). Learning about animals, science and conservation at the zoo: Large-scale survey-based evaluation of the educational impact of the ZSL London Zoo formal learning program. A report to The Zoological Society of London.
Jensen, E. (2014). Evaluating children's conservation biology learning at the zoo. *Conservation Biology*, *28*(4), 1004–1011. doi:10.1111/cobi.12263
Jones, H., McGregor, P. K., Farmer, H. L. A., & Baker, K. R. (2016). The influence of visitor interaction on the behavior of captive crowned lemurs (*Eulemur coronatus*) and implications for welfare. *Zoo Biology*, *35*(3), 222–227. doi:10.1002/zoo.21291
Lindemann-Matthies, P., & Kamer, T. (2006). The influence of an interactive educational approach on visitors' learning in a Swiss zoo. *Science Education*, *90*(2), 296–315. doi:10.1002/sce.20127
Lee, V. E., & Bryk, A. S. (1986). Effects of single-sex secondary schools on student achievement and attitudes. *Journal of Educational Psychology*, *78*(5), 381–395. doi:10.1037/0022-0663.78.5.381
Mann, J. B., Ballantyne, R., & Packer, J. (2018). Penguin promises: Encouraging aquarium visitors to take conservation action. *Environmental Education Research*, *24*(6), 859–874. doi:10.1080/13504622.2017.1365355
Marino, L., Lilienfeld, S. O., Malamund, R., Nobis, N., & Broglio, R. (2010). Do zoos and aquariums promote attitude change in visitors? A critical evaluation of the American zoo and aquarium study. *Society & Animals*, *18*, 126–138. doi:10.1163/156853010X491980
McPhee, M. E., Foster, J. S., Sevenich, M., & Saunders, C. D. (1998). Public perceptions of behavioral enrichment: Assumptions gone awry. *Zoo Biology*, 17, 525–534.
Mellish, S., Ryan, J. C., Pearson, E. L., & Tuckey, M. R. (2019). Research methods and reporting practices in zoo and aquarium conservation-education evaluation. *Conservation Biology*, *33*(1), 40–52. doi:10.1111/cobi.13177
Morgan, K.N., & Tromborg, C. T. (2007). Sources of stress in captivity. *Applied Animal Behaviour Science*, *102*(3-4), 262–302.
Moss, A., & Esson, M. (2013). The educational claims of zoos: Where do we go from here?*Zoo Biology*, *32*, 13–18. doi:10.1002/zoo.21025
Moss, A., Jensen, E., & Gusset, M. (2015). Evaluating the contribution of zoos and aquariums to Aichi Biodiversity Target 1. *Conservation Biology*, *29*(2), 537–544. doi:10.1111/cobi.12383
Mun, J. S. C., Kabilan, B., Alagappasamy, S., & Guha, B. (2013). Benefits of naturalistic free-ranging primate displays and implications for increased human–primate interactions. *Anthrozoös*, *26*(1), 13–26. doi:10.2752/175303713X13534238631353
Myers, O. E., Saunders, C. D., & Birjulin, A. A. (2004). Emotional dimensions of watching zoo animals: An experience sampling study building on insights from psychology. *Curator: The Museum Journal*, *47*(3), 299–321. doi:10.1111/j.2151-6952.2004.tb00127.x
Ogden, J., & Heimlich, J. E. (2009). Why focus on zoo and aquarium education?*Zoo Biology*, *28*(5), 357–360. doi:10.1002/zoo.20271
Oppenheim, A. N. (1992). *Questionnaire design, interviewing and attitude measurement*. London, UK: Pinter Publishers.
Palmberg, I. E., & Kuru, J. (2000). Outdoor activities as a basis for environmental responsibility. *The Journal of Environmental Education*, *31*(4), 22–36. doi:10.1080/00958960009598649
Pavitt, B., & Moss, A. (2019). Assessing the effect of zoo exhibit design on visitor engagement and attitudes towards conservation. *Journal of Zoo and Aquarium Research*, *7*(4), 186–194.
Randler, C., Baumgärtner, S., Eisele, H., & Kienzle, W. (2007). Learning at workstations in the zoo: A controlled evaluation of cognitive and affective outcomes. *Visitor Studies*, *10*(2), 205–216. doi:10.1080/10645570701585343
R Development Core Team. (2017). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/.
Rhoads, D. L., & Goldsworthy, R. J. (1979). The effects of zoo environments on public attitudes toward endangered wildlife. *International Journal of Environmental Studies*, *13*(4), 283–287. doi:10.1080/00207237908709834
Roe, K., McConney, A., & Mansfield, C. F. (2014). The role of zoos in modern society: A comparison of zoos' reported priorities and what visitors believe they should be. *Anthrozoös*, *27*(4), 529–541. doi:10.2752/089279314X14072268687808
Sherwen, S. L., Magrath, M. J., Butler, K. L., Phillips, C. J., & Hemsworth, P. H. (2014). A multi-enclosure study investigating the behavioural response of meerkats to zoo visitors. *Applied Animal Behaviour Science*, *156*, 70–77. doi:10.1016/j.applanim.2014.04.012
Sherwen, S. L., Hemsworth, P. H., Butler, K. L., Fanson, K. V., & Magrath, M. J. (2015). Impacts of visitor number on kangaroos housed in free-range exhibits. *Zoo Biology*, *34*(4), 287–295. doi:10.1002/zoo.21226
Skibins, J. C., & Powell, R. B. (2013). Conservation caring: Measuring the influence of zoo visitors' connection to wildlife on pro-conservation behaviours. *Zoo Biology*, *32*(5), 528–540. doi:10.1002/zoo.21086
Smith, L., Broad, S., & Weiler, B. (2008). A closer examination of the impact of zoo visits on visitor behaviour. *Journal of Sustainable Tourism*, *16*(5), 544–562. doi:10.2167/jost817.0
Sommer, R. 1972. What do we learn at the zoo?*Natural History*, *81*, 26–27, 84–85.
Swanagan, J. S. (2000). Factors influencing zoo visitors' conservation attitudes and behavior. *The Journal of Environmental Education*, *31*(4), 26–31. doi:10.1080/00958960009598648
Tofield, S., Coll, R. K., Vyle, B., & Bolstad, R. (2003). Zoos as a source of free choice learning. *Research in Science & Technological Education*, *21*(1), 67–99. doi:10.1080/02635140308342

Tunnicliffe, S. D. (1998). Boy talk/girl talk: Is it the same at animal exhibits?*International Journal of Science Education*, *20*(7), 795–811. doi:10.1080/0950069980200704

Visscher, N. C., Snider, R., & Vander Stoep, G. (2009). Comparative analysis of knowledge gain between interpretive and fact-only presentations at an animal training session: an exploratory study. *Zoo Biology*, *28*(5), 488–495. doi:10.1002/zoo.20174

Wellington, J., & Szczerbinski, M. (2007). *Research methods for the social sciences*. London: Continuum International Publishing Group.

Wood, W. (1998). Interactions among environmental enrichment, viewing crowds, and zoo chimpanzees (Pan troglodytes). *Zoo Biology*, *17*, 211–230.

Appendix 1. Surveys

1. The pre-survey administered before visiting FWP on a school tour.

First Name:_____ **Second Name:**_____

Age: **Gender – Please circle**: Boy Girl

* * *

1. Have you ever visited a zoo before today?

Yes No I'm not sure

2. Do you like to watch nature shows on TV?

Yes No I'm not sure

3. What is your favorite subject at school?

4. How can you help animals living in zoos? Please answer with ONE idea in the box.

* * *

Please read each sentence below. Circle the answer that most closely matches how you feel.

5. Zoo animals are HAPPY.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

6. Zoo animals are BORED.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

7. During my visit to Fota, I am looking forward to LEARNING ABOUT ANIMALS.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

8. During my visit to Fota, I am looking forward to LEARNING SCIENCE.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

9. When you think of Fota Wildlife Park, what is the first thing that comes to mind? One word

In this section, if you don't know the answer, just take a guess. Choose one answer only.

***10. Ring-tailed lemurs come from…?**

Africa South America Madagascar New Zealand Sri Lanka

***11. Ring-tailed lemurs are endangered because of…?**

Drought Deforestation Global Warming Fire Hunting

***12. What do you think is the most important part of a ring-tailed lemur's diet?**

Fruit Flowers Leaves Food from visitors Meat

* * *

13. Do you think penguins are?

Marine mammals Birds Fish I'm not sure

14. Do you think penguins can fly?

Yes I'm not sure No

15. Where do you think penguins live (mostly)?

The Northern Hemisphere The Southern Hemisphere Both I'm not sure

16. Do you think penguins live in …

Warm places Cold places Both I'm not sure

* * *

Some animals at Fota live in enclosures and some are free-ranging, which means they can walk around the park. Some zoo animals have enrichment (toys), which promotes more natural behavior.

Please read each statement below and circle the answer that most closely matches how you feel.

17. I think visitors should be allowed to feed free-ranging animals.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

18. I think visitors should be allowed to touch the free-ranging animals.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

19. I like to see zoo animals that have enrichment.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

Thank you! ☺

*Note: After 2015 the lemur questions were excluded from the survey, the EI and the children did not view them while on tour at Fota.

2. The post-survey administered after visiting FWP on a school tour.

First Name:_____ **Second Name:**_____

* * *

1. Did you enjoy the day at Fota?

Yes No I'm not sure

2. What was the best part?

3. What is your favorite subject at school?

4. How can you help animals living in zoos? Please answer with one idea in the box.

* * *

Please read each sentence below. Circle the answer that most closely matches how you feel.

5. Zoo animals are HAPPY.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

6. Zoo animals are BORED.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

7. During my visit to Fota, I enjoyed LEARNING ABOUT ANIMALS.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

8. During my visit to Fota, I enjoyed LEARNING SCIENCE.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

* * *

9. When you think of Fota Wildlife Park, what is the first thing that comes to mind? One word.

In this section, if you don't know the answer, just take a guess.

***10. Ring-tailed lemurs come from…?**

Africa South America Madagascar New Zealand Sri Lanka

***11. Ring-tailed lemurs are endangered because of…?**

Drought Deforestation Global Warming Fire Hunting

***12. What do you think is the most important part of a ring-tailed lemur's diet?**

Fruit Flowers Leaves Food from visitors Meat

* * *

1. Do you think penguins are?

Marine mammals Birds Fish I'm not sure

2. Do you think penguins can fly?

Yes I'm not sure No

3. Where do you think penguins live (mostly)?

The Northern Hemisphere The Southern Hemisphere Both I'm not sure

4. Do you think penguins live in …

Warm places Cold places Both I'm not sure

* * *

Some animals at Fota live in enclosures and some are free-ranging, which means they can walk around the park. Some zoo animals have enrichment (toys), which promotes more natural behavior.

Please read each statement below and circle the answer that most closely matches how you feel.

1. I think visitors should be allowed to feed the free-ranging animals.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

2. I think visitors should be allowed to touch the free-ranging animals.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

3. I like to see zoo animals that have enrichment.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

Thank you! ☺

*Note: After 2015 the lemur questions were excluded from the survey; the EI and the children did not view them while on tour at Fota.

3. The pre-survey administered before visiting Dingle Aquarium on a school tour.

First Name:_____ **Second Name:**_____

Age: _____ **Boy/Girl**

1. Have you ever visited an aquarium before today?

Yes No I'm not sure

2. Have you ever been to Dingle Aquarium before?

Yes No I'm not sure

3. Do you like to watch nature shows on TV?

Yes No I'm not sure

4. What is your favorite subject at school?

5. How can you help animals that live in aquariums? Please answer with one idea in the box.

* * *

Please read each sentence below. Circle the answer that most closely matches how you feel.

6. Aquarium animals are HAPPY

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

7. Aquarium animals are BORED

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

8. During my visit to Dingle Aquarium, I am looking forward to LEARNING ABOUT ANIMALS

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

9. During my visit to Dingle Aquarium, I am looking forward to LEARNING SCIENCE

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

10. When you think of Dingle Aquarium, what is the first thing that comes to mind?

One Word

In this section, if you don't know the answer, just take a guess.

11. Do you think penguins are?

Marine mammals Birds Fish I'm not sure

12. Do you think penguins can fly?

Yes No I'm not sure

13. Where do you think penguins live (mostly)?

The Northern Hemisphere The Southern Hemisphere Both I'm not sure

14. Do you think penguins live in …

Warm places Cold places Both I'm not sure

* * *

Some aquarium animals have enrichment (toys), which helps to promotes more natural behavior. Please read each statement below and circle the answer that most closely matches how you feel.

15. I prefer to see aquarium animals that have enrichment.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

16. I think it is okay to bang on the glass at the aquarium to get the animals' attention.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

Thank you! ☺

4. The post-survey administered after visiting Dingle Aquariuim on a school tour.

First Name:_____ Second Name:_____

1. Did you enjoy the day at Dingle Aquarium?

Yes No I'm not sure

2. What was the best part?

3. What is your favorite subject at school?

4. How can you help animals that live in aquariums? Please answer with one idea in the box.

* * *

Please read each sentence below. Circle the answer that most closely matches how you feel.

5. Aquarium animals are HAPPY

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

6. Aquarium animals are BORED

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

7. During my visit to Dingle Aquarium, I enjoyed LEARNING ABOUT ANIMALS

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

8. During my visit to Dingle Aquarium, I enjoyed LEARNING SCIENCE

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

9. When you think of Dingle Aquarium, what is the first thing that comes to mind?

ONE Word

In this section, if you don't know the answer, just take a guess.

10. Do you think penguins are?

Marine mammals Birds Fish I'm not sure

11. Do you think penguins can fly?

Yes No I'm not sure

12. Where do you think penguins live (mostly)?

The Northern Hemisphere The Southern Hemisphere Both I'm not sure

13. Do you think penguins live in …

Warm places Cold places Both I'm not sure

* * *

Some aquarium animals have enrichment (toys), which helps to promotes more natural behavior. Please read each statement below and circle the answer that most closely matches how you feel.

14. I prefer to see aquarium animals that have enrichment.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

15. I think it is okay to bang on the glass at the aquarium to get the animals' attention.

Strongly Agree Agree I'm not sure Disagree Strongly Disagree

Appendix 2. Details of Educational Intervention (EI)

Collins (2018, p. 125-126) and Collins et al. (2019) offer the following description of the EI used during this research. Specific elements of the EI included, in question and answer format, a PowerPoint presentation which described the biology of penguins (and lemurs at Fota Wildlife Park only), threats to their existence in the wild, what life might be like for them in the zoo versus the wild. Smith et al. (2008) and Mann et al. (2018) state that for environmental education to successfully impact a specific behavior, messages about that behavior should be clearly communicated to visitors. Therefore, visitor behaviors that were intended to change were described and discussed (e.g., "you should not feed the lemurs because it could make them sick" or "you should not bang on the penguins' glass wall because you could disturb or frighten them"). In addition, emotionally engaging visitors with environmental issues and animals has a positive impact on learning and behavior (Ballantyne et al., 2001; Ballantyne et al., 2011; Mann et al., 2018; Myers et al., 2004), and infant animals elicit emotional responses (Ballantyne et al., 2007). Therefore, the PowerPoint presentation included emotionally appealing pictures, including infants, of the species studied.

Children learn by doing (Dewey, 1998) therefore part of the EI was dedicated to a hands-on activity during which children made enrichment devices for the animals included in the study. The purpose of this was twofold. First, it was intended to improve animal welfare by encouraging the penguins to swim and the lemurs to be more active by providing a non-scheduled feeding/foraging opportunity. Second, the presence of the enrichment, and more specifically the animals' interest in the enrichment device and potential increased activity, was intended to stimulate children's learning. McPhee, Foster, Sevenich, and Saunders (1998) reported that an enrichment device itself had little effect on visitors, but others assert it is the animal behavior that the device elicits that is interesting to visitors (Davey, Henzi, & Higgins, 2005; Wood, 1998). Here, it was expected that because the children made the enrichment device themselves, and then observed the reaction of the animals that general interest and thus learning would be enhanced. For the ring-tailed lemurs, the children had the opportunity to prepare a scatter feed for the animals. This involved the children cutting up pieces of fruit (apples and bananas) which they later saw the lemurs eating (Dr. Maggie Esson, personal communication, 2013). For the penguins, the children made an enrichment device that consisted of varying sizes of plastic bottles with different colored lids, which the children then filled with shiny bits of paper (Clarke, 2003). In addition, at Fota the students made bubble mix which was then blown by machine when they viewed the penguins.