Learning about animals, science and conservation: Large-scale survey-based evaluation of the educational impact of the ZSL London Zoo Formal Learning programme

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INTRODUCTION

The study described in this report represents the largest (n = 3018) and most methodologically robust investigation of the educational value of zoos for children and adolescents ever conducted worldwide. This research evaluates (1) the impact of ZSL London Zoo Formal Learning educational presentations and unguided zoo visits, (2) pupils’ development of new knowledge and (3) pupils’ perceptions of zoos, science and wildlife conservation. Using methods developed during a pilot study conducted in spring 2009 with primary school (Wagoner & Jensen 2010) and post-16 pupils (Jensen & Wagoner, under review) attending London Zoo Formal Learning presentations, both the quality and quantity of learning are directly assessed. The present study is aimed at both informing practice at the ZSL London Zoo Discovery & Learning Department and at developing robust evidence of the degree to which zoo-based science and conservation education can have a positive impact for children and adolescents.

Executive Summary

- There was a strong statistically significant increase in scientific learning about animals and habitats (increase in knowledge) from pre- to post-zoo visit. This is the strongest evidence to date of the educational impact of visiting the zoo for children and young people.

- Zoo visits supplemented by an educational presentation almost doubled the increase in scientific learning for self-guided visits. That is, the addition of an educational presentation almost doubled the aggregate level of learning that occurred during zoo visits based on a key measure used in this study.

- Overall, 91% (n=2568) of respondents showed a positive change in at least one of the educational, conservation-related, satisfaction or enjoyment outcome variables.

- Overall, 53% (n=1427) of pupils’ who visited the zoo as part of the formal learning programme evinced a positive development in at least one area pertaining to zoos’ education and conservation functions, understanding of animals and their habitats, personal concern for endangered species and empowerment to participate in conservation efforts.

- On the open-ended thought-listing measure, “Animals” and “Fun” were the top ranked concepts children associated with the zoo in both pre- and post-visit questionnaires.

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3 These positive development metrics are drawn from the subset of survey respondents (n=2691) who had not previously selected positive responses to questions in all of these areas in the pre-visit survey.
• ‘Learning’ moved up from the 11th (Before) to the 3rd (After) most mentioned concept associated with the zoo. ‘Habitats’ moved from the 9th (Before) to the 4th (After) ranked concept. This suggests that pupils increased their perception of the zoo as associated with scientific learning and concepts as a result of their visit to ZSL London Zoo.

• “Cages” moved down from the 5th (Before) to the 13th (After) ranked concept for pupils on the thought-listing measure, suggesting that negative perceptions of the zoo decreased as a result of the zoo visit. An aggregate analysis of cage-related concepts showed a decline from 365 mentions pre-visit to just 36 post-visit.

• Words associated with conservation (e.g. “saving”, “extinction”) became more prevalent in the post-visit thought-listing data. Specifically, an aggregate analysis of thought-listing data showed a 34% increase in conservation-related ideas from pre- to post-visit.

• There was a statistically significant increase in pupils’ agreement with the statements “zoos are for learning about animals” and “zoos are for saving animals from extinction” from pre- to post-zoo visit.

• There was increased appreciation for a broader range of animal species, especially invertebrates (“bugs”), revealed through qualitative analysis of pupils’ annotated drawings and quantitative analysis of thought-listing data.

Background

In the UK, hundreds of thousands of children and young people visit zoos every year, just in formal learning contexts. As such, zoos are a central point for child and youth engagement with live animals, biological science and conservation messages. Indeed “keeping animals and presenting them for the education of the public”\(^4\) is one of the fundamental activities of the contemporary zoo, required for membership in professional zoo associations (e.g. BIAZA and EAZA). Moreover, the recent emphasis on public engagement with science by government and scientific institutions (e.g. Holliman et al., 2009; Holliman & Jensen, 2009; House of Lords Select Committee on Science and Technology, 2000; Jensen & Wagoner, 2009) offers zoos the opportunity to position themselves as a key venue for public engagement with both the sciences and wildlife conservation.

However, in recent years there has been increasing criticism of zoos for failing to demonstrate their averred educational and conservation impacts. In particular, animal rights groups such as the Royal Society for the Prevention of Cruelty to Animals (RSPCA) have leveled criticisms against zoos’ educational claims on evidentiary grounds, arguing that they have not met the high burden of proof to justify holding animals in captivity.

Given that keeping animals in captivity can bring with it a cost to their welfare [...] it is not enough for zoos to aim to have an educational impact, they should

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\(^4\) http://www.eaza.net/activities/Pages/Activities.aspx
*demonstrate* substantial impact. From our review of the literature, this does not yet appear to be the case” (emphasis added; RSPCA, 2007, p. 97).5

Indeed, the RSPCA conducted a literature review evaluating the level of peer-reviewed evidence supporting zoos’ educational claims. They concluded that the current peer-reviewed literature on the educational value of zoos is very thin:

It seems that zoos are only just beginning to seriously evaluate [...] the impact their educational programmes have on visitors and whether they are fulfilling their objectives. In this respect they are lagging well behind institutions such as museums and science centres. (RSPCA, 2007, p. 97).6

Reacting to such assessments, Maggie Esson (2009), Education Programmes Manager at Chester Zoo, describes the situation as follows:

Zoos are increasingly finding themselves lodged between a rock and a hard place when it comes to substantiating claims to be education providers, and the zoo community is coming under increased pressure to evidence that learning has taken place as a result of a zoo visit. (Esson, 2009, p. 1)

When paired with bioethical criticisms (e.g. Jamieson, 2006), the lack of evidence of learning has been used to call into question the very legitimacy of the zoo as an institution. Indeed, anti-zoo activist groups have gone much further in arguing that only negative learning could result from a zoo visit (e.g. Captive Animals Protection Society, 2010). Thus, collecting evidence of educational impact is crucial if contemporary zoos are to empirically validate their role as charities delivering scientific and environmental education and promoting animal conservation.

However, as noted in the RSPCA report, prior published research on zoos often eschews fundamental questions about zoos’ ability to deliver effective science and conservation education, instead focusing on dependent (outcome) variables such as satisfaction, ‘stopping power’ and ‘implicit connectedness to nature’ which are assumed to provide some proxy information about educational impact. For example, previous studies have focused on independent (causal) variables such as viewing area size (e.g. Moss, Francis, & Esson, 2008), the relative credibility of different zoo-based personnel (e.g. Fraser et al., 2008) and ‘identity-related motivations’ (Falk et al., 2007). Amongst those previous published studies that do focus on zoo impacts, most use post-visit only or aggregate-only data (or both), thus making it impossible to identify patterns of conceptual development that can be validly applied at the level of the individual (Molenaar, 2004). Indeed, a range of methodological shortcomings such as an over-reliance on self-report data further

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undermine the conclusions (both positive and negative) of most such studies of zoos' educational impact.

Prior Research on Visitor Impacts

Perhaps the most prominent prior study of zoos' educational impact was conducted by Falk et al. (2007) at four sites in the United States. This zoo visitor study was called the multi-institutional research program or MIRP (Falk et al., 2007). In this multi-part study, Falk et al. (2007) set out to evaluate adult zoo visitors' motivations for attending and any changes in attitudes towards or knowledge about conservation. Falk defines this task in terms of ‘identity-related motivations’. The focus on these motivations is justified in positivist terms as a prerequisite for ‘prediction’ of visitor outcomes: “we need to capture the essence of what motivates visitors so we could better predict what they might gain from their visit” (Falk et al., 2007, p. 6).

Falk's (2007, p. 9) fundamental thesis is that visitors arrive at museums or zoos with "specific identity-related-motivations and these motivations directly impact how they conduct their visit and what meaning they make from the experience". He develops this thesis with his audience segmentation approach and refers to visitors as durably belonging to one of his five categories. The five visitor types Falk (2007, p. 13) proposes are; Facilitators (“desire a social experience aimed at the satisfaction of someone else” such as parents), Explorers (“visit for personal interests” such as learning), Experience Seekers (“visit as tourists are value the zoo […] as part of the community”), Professional/Hobbyists (“are tuned into institutional goals and activities”), Spiritual Pilgrims (attend zoos as “areas for reflection”). These five are said to exhaust the ‘dominant’ types of zoo visitor motivation profiles. Moreover, the kind of segmentation approach developed by Falk has been taken up by other US-based zoo researchers such as Sickler and Fraser (2009) who identify four visitor types in terms of enjoyment of zoo visits. The present study assesses this visitor segmentation approach through a pre-visit thought-listing item that captures pupils' expectations of the zoo.

The segmentation research conducted by Falk, Fraser and other zoo researchers- and indeed most other zoo visitor research in the literature- is almost universally focused on adult visitors only. As recently noted by Fraser (2009), there is a surprising paucity of evaluation research focused on children visiting zoos. Published zoo visitor studies of zoo impacts routinely exclude children from their samples. One example of this is Fraser’s (2009) research on parents’ perspectives on the value of zoo visits conducted at Bronx Zoo in New York City. Interviews and observations of zoo visits were undertaken with eight families (14 adults). The study concluded that “parents conceive of the zoo as a useful tool […] to promote an altruistic sense of self, and to transfer their environmental values. […] They could use these visits to actively support their children’s self-directed learning” (Fraser, 2009, p. 357). However, the study only discusses parents’ assumptions of the impact of zoos on their children- or what Fraser calls ‘anticipated utility'. The actual utility of visiting the zoo for these children was not investigated, leaving this issue still unaddressed in the published research literature on zoos.
This lack of direct evidence of the value of zoo-based education prompted the present study, which was commissioned and funded by the Greater London Authority (GLA) and Zoological Society of London. The specific case examined in this study is the rich variety of state and privately-funded schools visiting ZSL London Zoo in groups with teachers and sometimes with parents. State schools were funded by the GLA to attend the zoo either self-guided or with an educational presentation in addition to the self-guided visit. State schools could also receive free ‘outreach’ visits to the classroom by an outreach officer with 2-4 live animals. Independent, privately funded schools were able to access the same educational experiences at a subsidized per school group fee basis. This arrangement pre-dated the present research, but it was identified as a unique opportunity to test whether additional educational provision results in any increases or decreases in learning on enjoyment. Because the decision about whether to receive an additional educational presentation is made at the school or classroom level and the outcomes are measured at the level of the individual pupil, any differences in pupils’ outcomes can be attributed to the zoo experience they have had rather than other extraneous variables. That is, the present study takes advantage of a naturally occurring quasi-experimental framework for assessing a range of outcomes against individual variables, including deprivation, prior zoo visits, age, gender, whether pupils attended an educational presentation or not and other variables.

This manuscript reports on a large-scale \((n = 3018)\) study designed to address this lacuna in the literature by assessing whether zoos can deliver positive learning outcomes. It takes an innovative and methodologically rigorous approach to evaluating zoos’ impacts on children and adolescents’ understanding of animals and habitats, as well as other related dependent (outcome) variables. The present study draws on data collected from June to August 2009 from pupils at schools in the Greater London area. The research evaluates educational impact for unguided zoo visits, zoo visits accompanied by an educational presentation and for zoo outreach visits conducted by members of the ZSL London Zoo Formal Learning team outside the zoo in school classrooms. Overall, this study focuses on the cumulative impact of such visits, rather than the specific individual elements of such visits (cf. Marino et al., 2010)\(^8\).

**METHODS**

As indicated above, the main purpose of the present research is to collect and analyse robust evidence of learning in Key Stage 2 to Key Stage 4 pupils engaged by ZSL London Zoo. Organisations aiming to deliver information to children have often elected in the past to use proxies such as parents or teachers to assess the impact they are having on children. Although teachers can provide a reasonable assessment of the sufficiency of a teaching regime for curriculum needs, there are clear validity problems in using them as a proxy for pupil satisfaction

or impacts. As such, this study directly accesses stability or change in pupils’ attitudes and knowledge relating to key variables of interest to zoo educators.

The present research is part of a larger project at ZSL, which has included components aimed at understanding the perspectives of teachers and pilot research assessing the impact of education officer-led zoo visits. Following on from the present study, two additional studies are underway. The first will follow directly from the data collected during the present research with an additional questionnaire distributed to a stratified random selection of school groups who participated in the main phase of the research, the results of which are reported in this manuscript.

One of the methodological aims of the present research is to overcome flaws associated with prior research on educational impact. One of those flaws is the use of a fraught proxy (such as parental or teacher attributions of children’s learning) rather than employing direct measures of children’s learning. Indeed, this study does not rely exclusively on self-report measures for learning as previous studies have done (e.g. see Marino et al. 2010). Instead a mixture of quantitative and qualitative data were collected, with both quantitative and qualitative analyses conducted on this mix of data genres, which includes thought-listing, annotated drawings, Likert scales and other items designed to allow for the valid collection of relevant and reliable data, which can be robustly analysed to identify different possible forms of impact from children’s and adolescents’ zoo visits.

Survey Instrument

It is clear from both national and international zoo perspectives that a key emphasis for zoo-based education is promoting understanding of animal adaptation and “habitats” (see BIAZA, EAZA and WAZA websites). As such the methods for this study were tailored to explore this domain of pupils’ thinking through quantitative data collection, whilst also employing open-ended survey items capable of identifying a broader range of potentially unanticipated perceptions of pupils engaged by the ZSL London Zoo’s formal learning programme. To elicit pupils’ understandings of habitats and animals we asked children to draw their ‘favourite animal where it lives in the wild’ both before and after their visit or educational presentation. A drawing task, such as this, provides an opportunity for children to express their knowledge in a medium that is less reliant on formal linguistic capabilities, thus making it more accessible to very young pupils and those for whom English is not their first language.

This study began with a pilot phase in which two versions of the pupil questionnaire were deployed for a period of one week. The data from these pilot questionnaires was first assessed for the extensiveness and relevance of pupils’ responses. The questionnaire format and question phrasing that elicited the most extensive responses was deployed for the rest of the summer term 2009.

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The mixed methods (quantitative and qualitative) survey instruments developed for this study included a Form 1 (pre-visit) and a Form 2 (post-visit). Different variations on these forms were used (with some continuity) for primary school pupils on zoo visits versus outreach visits, as well as for secondary school pupils engaged by zoo or outreach visits.

The pre-visit form for primary school pupils visiting the zoo had the following elements:

- Demographic details: Name, age and gender.
- An item assessing whether the pupil was a first-time or repeat visitor to the zoo, with the question “Have you ever been to a zoo before today?”.
- A thought-listing item with 5 numbered lines and the instruction “What do you think of when you think of the zoo?”.
- Items assessing agreement with the following ideas: “zoos are for fun / enjoyment”, “zoos are for learning about animals”, “zoos are for seeing animals”, “zoos are for saving animals from extinction”, “zoos are for other reasons”.
- Space to complete an annotated drawing, with the instruction: “Please draw your favourite wildlife habitat and all the plants and animals that live there. (Please put names or labels on everything)”. Below the drawing space is a question, “What did you draw above?”, in order to elicit further linguistic clues to their level of understanding.

This pre-zoo visit form was altered somewhat for the secondary school pupils in line with their increased linguistic capabilities. Specifically, three new items were added for secondary school pupils only (which are carried on into the post-visit survey form).

- An item assessing ‘scientific self-efficacy’, with the question “I feel I can understand science”. This question assesses whether pupils feel they have the wherewithal to engage with scientific ideas. (response options: 5-point Likert scale from ‘Strongly agree’ to ‘Strongly disagree’)
- An item assessing the pupil’s level of concern about wildlife conservation, with the question “Do you feel personally concerned about species going extinct?”. (response options: ‘yes’, ’no’, ‘not sure’)
- An item assessing the pupil’s conservation self-efficacy, or perception that they are capable of making a difference on the domain of wildlife conservation, with the question “Do you feel there is anything you can do about animal extinction?”. (response options: ‘yes’, ’no’, ‘not sure’)

The post-visit survey instrument for primary school pupils visiting the zoo maintained the items for ‘demographic details’, thought-listing, ‘zoos are for ___’ and annotated drawing. However, it
dropped the question “Have you ever been to a zoo before today?”, replacing it with the following new (post-visit only) items.

- An item assessing whether the zoo visit was enjoyable, with the prompt “Have you had fun at the zoo today?”. (response options: ‘yes’, ‘no’, ‘not sure’)

- An item assessing satisfaction with the educational provision during the visit, with the question “How was the London Zoo lesson today? (circle the face that shows how you feel)”. For the primary school survey form used the visual Likert scale pictured below was used.

![Figure 1: Primary School Likert Scale Indicating Level of Satisfaction](image)

For the secondary school survey form used more conventional phrasing for these post-visit only items.

- Item assessing enjoyment with question “did you enjoy your time at London Zoo?” (response options: ‘yes’, ‘no’, ‘not sure’)

- Item assessing educational provision at London Zoo, “Overall, how was the London Zoo lesson?” (response option: conventional Likert scale assessing level of agreement from ‘Very Good’ to ‘Very Poor’)

Finally, the survey forms for outreach visits by zoo educators included the same items as above, but with slight modifications to be appropriate for the outreach (classroom-based) context, rather than the zoo setting.

In addition to the variables captured on the individual pupil questionnaire forms, a zoo educator noted relevant details about the school group as a whole. In the case of the self-guided zoo visits, the only details captured was the data, school name, year group and visit type (‘self-guided’). However, for school groups attending educational presentations at the zoo, the education officer also noted scores for the following variables:

- **Behaviour**: This item records whether the pupils were focussed and respectful or rowdy and unfocussed on a three-point Likert scale.

- **Lateness**: This binary variable records whether a school group arrived more than ten minutes late for their educational presentation.
Sampling

The Greater London Authority funding pupils’ attendance at the zoo offered a unique opportunity to study patterns of zoo-based educational impact without the potential selection bias of ‘ability to pay’ that would normally apply. Moreover, the fact that there was a split in the population of visiting pupils between those attending self-guided, and those whose visit was supplemented by an educational presentation tailored to the zoo context offered the opportunity to assess whether such additional zoo education made any difference and whether pupils visiting without such supplementary education still learned anything of value.

The sample for this study was mostly comprised of pupils who attended the zoo, either for a self-guided visit with their school ($n = 1097$) or for a zoo visit supplemented by an educational presentation ($n = 1742$). There were 470 boys and 607 girls in the self-guided zoo visit sample (20 respondents did not specify their gender), making a total sample size for this respondent type of 1097 pupils who completed both pre- and post-visit survey forms. The age range for the self-guided respondents was 7 – 14, with a mean age of 9.9. There were 890 boys and 834 girls in the self-guided zoo visit sample (18 respondents did not specify their gender), making a total sample size for this category of 1742 pupils for whom paired (before and after) survey data was available. The age range for the self-guided respondents was 7 – 15, with a mean age of 10. The outreach sample ($n = 179$) included 92 boys and 85 girls (two respondents did not specify their gender). The age range of the outreach respondents was 7 – 15, with a mean age of 9.5.

Unfortunately, the sample size for outreach (in school) educational presentations was much smaller ($n = 179$) than the other two visit types (self-guided and education officer-led zoo visits), due to the skewness of the outreach population towards children in Key Stage 1 (ages 5-7) and below (whereas the lower end of the sampling range for this study was Key Stage 2: ages 7-11). The minimum sample size set for each individual category for conducting comparative statistical analysis was 200; as such the outreach data were not included in comparative statistical analyses reported in this study. However, these outreach data were still analysed qualitatively with results presented in that section. The skewness in the ages of pupils receiving outreach visits from zoo educators should be taken into account in future quantitative research by lowering the minimum age range for the sample to include Key Stage 1 and possibly younger ages. The reason for not including these ages was a concern that they would not be able to participate fully in survey-based research. However, subsequent evidence from focus groups suggests that at least the annotated drawing item could be employed with children as young as five.

Procedure

Questionnaires were administered both before and after pupils’ experience with London Zoo formal learning activities—whether outreach or zoo visit. The purpose of these questionnaires was to capture any changes in pupils’ thinking about animals and their habitats as they participated in different zoo-related activities. In particular, the use of pre- and post-visit questionnaires was intended to measure the cumulative impact of the outreach or zoo visit on pupils’ developing understanding of animals, habitats and zoos.
The use of before/after surveys in this manner can result in false negatives because of inflated ‘pre-test’ responses to self-report items. However, this approach is the only way to know that any changes observed can be attributed to the cumulative impact of a zoo or outreach visit. Moreover, within the context of quantitative research, a false negative (also known as ‘beta’ error) is considered much more acceptable than the risk of false positives (also known as ‘alpha’ error). That is, the most important risk to avoid was that we might come to a conclusion that zoos deliver an educational impact when they do not. As such, the fact that the pre-/post- method employed in this study tips the balance towards the risk of false negatives (i.e. concluding that zoos offer no educational value when they actually do) was considered most appropriate, especially when considered against alternatives such as a ‘retrospective pre-test’ and post-test (i.e. both administered post-visit), which clearly increases the risk of a false positive result.

Data Analysis

Questionnaire data was entered into an Excel spreadsheet by research assistants. All data except for the annotated drawings could be straightforwardly entered without any analytic judgment required. The non-drawing data were analysed with the assistance of relevant software.

Deprivation

A measure of multiple deprivation was included using data provided by the Greater London Authority (GLA). A GLA analyst appended Index of Multiple Deprivation 2007 (the latest year for which data was available) scores to a list of schools that participated in this research project, providing school-level deprivation data that could be assessed against a range of outcome variables at the individual level. The Index of Multiple Deprivation (IMD2007) is a composite of seven dimensions of deprivation, including 37 different indicators. The general categories and weightings within the IMD2007 score are as follows: Income deprivation (operationalised as the proportion of people on means-tested government benefits; weighted at 22.5%), Employment deprivation (operationalised as the proportion of people involuntarily out of work; weighted at 22.5%), Health deprivation and disability (operationalisation includes prevalence of premature death, morbidity and disability; weighted at 13.5%), Education, skills and training deprivation (operationalisation includes achievement and participation data at various educational stages combined with an indicator of whether adults 25-54 have no or low educational qualifications; weighted at 13.5%), Barriers to housing and services (operationalisation includes geographical barriers to accessing services along with homelessness rates and a measure of housing affordability; weighted at 9.33%), Crime (this operationalisation includes area data on 33 types of recorded crime within four categories – burglary, theft, criminal damage and violence; weighted at 9.33%) Living Environment deprivation (operationalisation combines census data on the ‘indoor living environment’ with measures of the outside living environment such as air quality and road accidents; weighted at 9.33%).

The resulting Index of Multiple Deprivation (IMD2007) was used to rank schools across London and across England in their levels of multiple deprivation. The present analysis includes the placement of participating schools within these two rankings as well as the raw IMD2007 score for
each participating school. The London deprivation rank value represents a school’s ranking within Greater London based on IMD2007 scores, where 1 is most deprived and 4,765 is least deprived. The England deprivation rank value represents a school’s ranking within England based on IMD2007 scores, where 1 is most deprived and 32,482 is least deprived.

Thought-listing data

The methods of data analysis employed for the two main open-ended items in the survey are explained below. Much of the verbal data in the present sample was misspelled but decipherable. To enhance the readability of this report, the data has been standardised and spelling corrected. Most of the time the intended word was obvious, however interpretation based on the sound of the word was needed in some cases. For example, the misspelled word “egsosting” was replaced with the word “exhausting” because these words sound similar when spoken aloud. This spelling correction procedure was necessary to prepare the data for the application of the computerised quantitative analysis of word frequencies within this data. That is, the spellings of the same word needed to be made consistent for all instances of a word to be counted together. The computer software used for this analysis was Concordance 3.3.

Once word counts were established on a consistent basis, it was possible to compare the concordances for the pre- and post-visit data sets to identify aggregate patterns of change that could be attributed to the formal learning programme at ZSL London Zoo. In this vein, different overarching categories were identified which included multiple words from the thought-listing data. Such categories allowed for the assessment of the level of change on a range of higher level dimensions such as conservation values, which are defined in the Results section below. Such categories allowed for the aggregation of multiple words that fit into some kind of conceptual unity to gain a greater understanding of whether pupils’ thinking changed following a ZSL London Zoo visit. In addition, individual pupils’ thought-listing data were analysed qualitatively to contextualise the change process, often in combination with the qualitative analysis of drawing data.

Content analysis of drawings

For the drawings, a simple coding scheme was employed. On the first measure, drawings were coded as having undergone positive development, no development or negative development from Form 1 to Form 2. Training in conducting this analysis was provided to the two research assistants working on this project.

Ultimately, all of the quantitative data were cleansed, prepped and moved into SPSS (Statistical Package for the Social Sciences) for inferential statistical analysis, the results of which are reported below.
QUANTITATIVE RESULTS

The mixed methods survey yielded extensive quantitative data, which were analysed statistically using SPSS. A number of independent (causal) variables were assessed for their explanatory power, including first-time versus repeat visitor status, self-guided versus zoo educator-led visits, age, gender and multiple deprivation. The dependent (outcome) variables analysed in this report include the perceptions that ‘zoos are for seeing animals’, ‘zoos are for fun / enjoyment’, ‘zoos are for learning about animals’ and ‘zoos are for saving animals from extinction, as well as actual learning (as measured by annotated drawings), scientific self-efficacy (the feeling that one is capable of understanding science), personal concern about species extinction and conservation self-efficacy (the feeling that one is capable of making a difference in terms of saving animals from extinction). Key findings are summarized below before reporting further details of the findings from analysis of key independent and dependent variables assessed in this study.

Executive Summary

Overall Changes from Pre- to Post-Visit

- Pupils are much more likely to switch from having indicated that ‘zoos are not for seeing animals’ before to believing that ‘zoos are for seeing animals’ after (50%) rather than the other way around (7%).

- Pupils were much more likely to switch from having indicated zoos are not fun before to zoos are fun after (42%), rather than the other way around (8%).

- Pupils are much more likely to switch from having indicated that zoos are not for learning before to believing that zoos are for learning after (57%), rather than the other way around (6%).

- 44% of respondents with very low scientific self-efficacy prior to their visit shifted to a positive self-perception on this measure, agreeing with the statement “I feel capable of understanding science”.

- Pupils are twice as likely to switch from having indicated that zoos are not for saving animals from extinction before to believing that zoos are for saving animals after (29%), rather than the other way around (14%).

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10 This concept of conservation self-efficacy was operationalised in the present study through pupils’ response to the following question both pre- and post-visit (secondary school version of questionnaire only): ‘Do you feel there is anything you can do about animal extinction?’.
Participants were more likely to switch from having indicated no personal concern about species extinction pre-visit to expressing such a concern for wildlife conservation post-visit (18%), rather than the other way around (3%).

Comparing first-time and repeat visitors

- Pupils are more likely to perceive a zoo visit as a fun experience after having been at least once, when compared with the pre-visit data from first-time visitors.

- A comparison of the mean levels of learning (as evidenced by annotated drawings) for first-time and repeat visitors showed no difference between these two groups.

- Pre-visit survey results suggest that repeat visitors are more likely to indicate that ‘zoos are for saving animals from extinction’ than first-time visitors.

- Pupils are more likely to perceive the zoo as ‘saving animals from extinction’ after having visited at least once, as compared to pre-visit responses from first-time visitors.

- Those who had previously visited the zoo were much more likely to indicate personal concern about species extinction in the pre-visit survey. However, this pre-visit difference in conservation concern evened out post-visit, once all had visited. This result strongly supports the conclusion that zoo visits (whether within the context of the formal learning programme or not) are associated with significantly greater personal concern about animal species becoming extinct.

- Repeat visitors were more likely to believe that they can do something to stop wildlife extinction (41%) in comparison to first-time visitors (31%) in the post-visit survey. This pattern of repeat visitors expressing greater conservation self-efficacy suggests that impact on this dimension may be cumulative; that is, more visits to the zoo may yield greater conservation self-efficacy. Yet, this variable of conservation self-efficacy is where the most improvement is needed in terms of the formal learning programme’s educational provision in order to maximize positive outcomes.

- Pupils who have been on at least one zoo visit are more likely to perceive the zoo as fun than those who have never been before.

- Pupils are more likely to perceive the zoo as ‘saving animals’ from extinction after having visited at least once.

- Pupils are most apt to perceive the zoo as a place for seeing animals after they have been for at least one visit. This difference should be understood within the context of an overall high level of agreement that ‘zoos are for seeing animals’ among both first-time (76%) and repeat visitors (82%).
Comparing Education Officer-led and Self-guided Visit Outcomes

- Pupils’ perception that ‘zoos are for saving animals from extinction’ increased from pre- to post-visit, but education officer-led visits yielded significantly greater agreement with this idea. Thus, supplementing a zoo visit with a tailored educational presentation resulted in a significant increase in the perception that ‘zoos are for saving animals from extinction’.

- Pupils on self-guided zoo visits were more likely to associate the zoo with ‘seeing animals’ prior to their visit, but this difference evened out by the time all of the pupils had spent a day at the zoo.

- While both visit types evinced significant gains in learning, the results show that education officer-led visits yielded significantly greater learning on the drawing measure. Thus, supplementing a zoo visit with a tailored educational presentation delivered substantially improved learning outcomes, as measured by the annotated drawings.

- Pupils on self-guided visits evinced greater post-visit conservation self-efficacy than pupils on education officer-led visits. This finding stands out as one of the few measures on which self-guided visits yielded better outcomes than education-officer led visits. It is possible that the greater focus on habitats and the importance of conservation in the zoo educator-led visits distracted from the more immediate and obvious question of taking action for this sample.

- The results show that pupils on education officer-led visits were somewhat more likely to express the highest level of satisfaction with the zoo visit (57%) when compared to pupils on self-guided visits (49%). However, the overall levels of satisfaction with the zoo learning experience were very high for both education officer-led (84% satisfied; 5% dissatisfied) and self-guided visits (77% satisfied; 5% dissatisfied).

Differences in Outcomes by Age

- The results show that pupils of all ages were more likely to evince a positive change or no change in their drawings overall than a negative change. Children aged 7-10 were more likely to have a positive change in their drawings than those aged 11-15. At 51%, 10-year-old respondents were most likely to evince a positive change in their drawings after their visit to the zoo.

- At 29% (n=173), 9-year-olds were more likely to have their school groups arrive late for educational presentations than any other age group.

- There was a general increase in the level of ‘good behaviour’ during educational presentations as children got older.
• Ten- and 12-year-olds were most likely to associate the zoo with ‘fun / enjoyment’ pre-visit. Twelve-year-olds were most likely to hold this view post-visit.

• Thus, 13- and 14-year-olds are least likely to associate zoos with wildlife conservation in the pre-visit survey data. The post-visit results show 8-year-olds were most likely to associate zoos with wildlife conservation, whilst 14-year-olds were least likely to do so.

• 7- and 9-year-olds were least likely to agree with the idea that ‘zoos are for seeing animals’ in the pre-visit survey. 11-year-olds were most likely to believe that zoos are for seeing animals in the post-visit survey.

• 12-year-olds had a lower level of positive change in their drawings when compared with those aged 8, 9 and 10.

• The overall trend in these results shows that as children got older, their levels of satisfaction with the educational provision during their zoo visit increased.

Differences in Outcomes by Gender

• The perception that zoos are ‘for seeing animals’ is held slightly more by girls (86%) than boys (83%) in the post-visit survey only. Likewise, the view that zoos are for fun / enjoyment’ is held by marginally more girls (81%) and boys (78%) in the post-visit survey data only.

• Girls are slightly (but statistically significantly) more likely than boys to indicate that ‘zoos are for learning’ both pre-visit (girls 87%; boys 84%) and post-visit (girls 91%; boys 88%).

• Boys are slightly more likely to agree that zoos are for saving animals (61%) than girls (54%).

• Girls are more likely than boys to hold the view that ‘zoos are for seeing animals’ after visiting the zoo.

• While the perception of zoos as ‘for fun / enjoyment’ increases across the entire sample over the course of the zoo visit, there is a greater increase in this perception for girls.

• Girls are more likely than boys to associate the zoo with ‘learning’ in both pre- and post-visit survey, though there was an overall increase in this perception that applied to both genders.

• No gender differences are found in either the level of scientific self-efficacy (perceived capability to understand science) or learning (as measured by annotated drawings). This finding of no gender differences on both the scientific self-efficacy and the learning measure is noteworthy given that other domains of science learning have been identified as
having a potential cultural bias against female pupils. Thus, girls making gains in scientific self-efficacy and scientific learning at an equal level with boys is in itself an important positive outcome.

The Role of Deprivation

- As deprivation decreased, learning increased. However, London Deprivation Ranking was a better predictor of learning outcomes than the raw Index of Multiple Deprivation score. This suggests that relative deprivation within the context of London is a more significant factor in learning outcomes than multiple deprivation overall.

- Conversely, as deprivation increases, pupils become more likely to associate the zoo with wildlife conservation within both the pre- and post-visit survey data. Again, London Deprivation Rank was a better predictor of outcomes than other measures of deprivation.

- Deprivation does not predict any differences in personal concern about species extinction or conservation self-efficacy. That is, these outcome variables are independent of deprivation on each of the measures included in this study.

Descriptive results: Cumulative evaluation of positive change

Overall, 91% (n=2568) of respondents showed a positive change in at least one of the educational, conservation-related, satisfaction or enjoyment outcome variables.

Excluding satisfaction, enjoyment and scientific self-efficacy, the data still demonstrate the significant positive impact that education officer-led and self-guided zoo visits have on pupils' understanding of animals, habitats, environmental threats, and conservation learning. Indeed, 53% (n=1427) of post-visit survey respondents evinced a positive development in at least one area pertaining to zoos' education and conservation functions, understanding of animals and their habitats, personal concern for endangered species and empowerment to participate in conservation efforts11.

Amongst those respondents who showed positive development in the post-visit questionnaire, the largest proportional increase in knowledge was seen in ratings of the zoo's importance as a place for 'learning'. Indeed, 70% (n=277) of respondents who had not previously cited 'learning' as a zoo function selected this as an important function in their post-visit questionnaire. In a similar vein, a large number of respondents (n=358; 31%) developed a greater appreciation for the zoo's role in wildlife conservation following their zoo visit.

Moreover, amongst those who had not previously registered a concern about species extinction, 39% (n=57) switch to registering such a concern in the post-visit survey. This finding

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11 These positive development metrics are drawn from the subset of survey respondents (n=2691) who had not previously selected positive responses to questions in all of these areas in the pre-position survey.
demonstrates that zoo visits contributed to increased awareness and concern about threats to species and habitats amongst pupils.

Positive developments were also observed in pupils’ conservation self-efficacy in their post-visit responses amongst a subset of pupils who had not indicated feeling empowered to engage in wildlife conservation activities in their pre-visit responses. Specifically, 24% (n=45) of such pupils indicated that they felt empowered to participate in conservation activities following their zoo visit.

The area which most frequently benefited from positive change following the zoo visit was the learning evidenced by pupils’ annotated drawings of an animal in its habitat. Indeed, 1075 pupils (38%) showed such a positive change in their drawings in the post-visit questionnaire compared to the pre-visit drawing. Such positive changes incorporated a range of incremental developments observed across the annotated drawing data including the addition of accurate labeling (e.g., “canopy”, “understory”, “rainforest floor”), accurate positioning of animals within specific habitats, and greater elaboration of physiological characteristics of animals represented in their drawings.

Summary of the overall relationships between responses on pre- and post-visit surveys

Regardless of demographic or other individual variations in respondent identities, the results show that there were substantial positive changes in pupils’ responses from pre- to post-visit surveys for all the dependent variables investigated here. That is, there were significant changes in the perceptions of the pupils surveyed as a result of their zoo visit. It is interesting to note that the largest positive changes in answers occurred in pupils’ agreement with the idea that ‘zoos are for fun / enjoyment’, ‘zoos are for learning about animals’ and ‘zoos are for seeing animals’.

Likewise, there was a significant level of positive change in the level of agreement with the idea that ‘zoos are for saving animals from extinction’. There was also a significant increase in positive responses to the question included in the secondary school pupil questionnaire form, ‘Do you feel personally concerned about species going extinct?’ That is, pupils were significantly more likely to indicate that they felt personally concerned about species extinction following the zoo visit.

With regards to the secondary school-only question, ‘Do you feel there is anything you can do about animal extinction?’ (measuring conservation self-efficacy), there was only a marginal difference between positive and negative changes for this variable. This indicates that while some felt positive about their ability to take personal action against extinction after their visit to the zoo, an almost equal number felt negative about the action they could take against extinction. This finding suggests that empowering and equipping pupils to take personal pro-conservation actions should be a key focus for continuing development of the educational provision within ZSL London Zoo.
Identifying Zoos with Seeing Animals, Fun and Learning

Zoos for seeing animals. Unsurprisingly, a high percentage of pupils identified the zoo as a place for ‘seeing animals’. Interestingly however, this increased further from pre- to post-visit, with the results showing that participants are more likely to switch from having indicated that zoos are not for seeing animals before to zoos are for seeing animals after (50%) rather than the other way around (7%). This finding was statistically significant ($\chi^2(1, n=2656) = 598.462, p=.000$).

The changes in agreement with the statement ‘zoos are for fun/enjoyment’ in the pre- and post-visit surveys are statistically significant ($\chi^2(1, n=2656) = 738.635, p=.000$). The results show that participants were more likely to switch from having indicated zoos are not fun before to zoos are fun after (42%), rather than the other way around (8%).

Zoos for learning about animals. Even greater than this is the statistically significant change in the number of pupils indicating that ‘zoos are for learning about animals’ from pre- to post-visit surveys ($\chi^2(1, n=2656) = 446.710, p=.000$). The results show that pupils are more likely to switch from having indicated that zoos are not for learning about animals before to zoos are for learning about animals after (57%), rather than the other way around (6%).

Scientific self-efficacy. The learning-related variable of scientific self-efficacy was measured through a secondary-only item asking whether pupils felt they were capable of understanding science in the pre- and post-visit survey. The results showed significant positive change on this measure from pre- to post-visit ($\chi^2(16, n=358) = 218.274, p=.000$). Specifically, of those who strongly disagreed with the statement ‘I feel capable of understanding science’ prior to the visit (i.e., very low scientific self-efficacy), 33% changed their answer to say that they strongly agree and 11% to ‘agree’. This means that 44% of respondents with very low scientific self-efficacy prior to their visit shifted substantially to a positive self-perception on this measure. In comparison, of those that strongly agreed with the statement (high scientific self-efficacy), only 2% underwent a negative shift to strong disagreement and 3% indicated disagreement. In sum then, there was a 44% positive shift towards significantly greater scientific self-efficacy, against a 5% negative shift in this outcome variable.

Conservation-related Outcome Variables

Zoos for conservation. The results show that pupils are twice as likely to switch from having indicated that zoos are not for saving animals from extinction before to zoos are for saving them after (29%), rather than the other way around (14%). This finding is also statistically significant ($\chi^2(1, n=2656) = 890.178, p=.000$). However, it is important to note that the level of positive change is lower than in relation to ‘zoos are for fun / enjoyment’ and ‘zoos are for learning about animals’. Similarly, the level of negative change was higher than that observed in the previous tests.

Personal concern for conservation. Respondents were more likely to switch from having indicated no pre-visit personal concern with species extinction to expressing such a concern with species
extinction post-visit (18%), rather than the other way around (3%). This quantitative shift in ‘personal concern about species extinction’ from the pre- to the post-visit survey data is statistically significant ($\chi^2(4, n=293) = 200.374, p=.000$).

Conservation self-efficacy. The relationship between perceived ability to do something about extinction in the pre- and post-visit surveys is significant: ($\chi^2(4, n=291) = 194.743, p=.000$). The results show that participants were more likely to switch from having indicated an inability to do something about extinction before, to an ability to do something about extinction after (13%), rather than the other way around (9%). However, while statistically significant, this is a small margin, indicating there is room for improvement on this measure. Indeed, the present data suggest that the existing educational provision is much more successful at delivering scientific learning and promoting concern about the problem of wildlife conservation than it is at empowering with ways in which pupils themselves can take action to confront this problem.

Conservation Concern in Thought-listing Results. The thought-listing item provided open-ended responses that can be compared from pre- to post-visit to assess any aggregated changes in the associations between ‘the zoo’ and conservation-related concepts. In particular, seven conservation-related ideas were identified in pupils’ pre- and post-visit response for comparison. The total pre-visit frequency count for these conservation-related ideas was 170 (Extinct – 18; Extinction – 43; Endangered – 24; Save – 15; Saved – 0; Saving – 66; Conservation – 4); the post-visit total was 259 (Extinct – 16; Extinction – 76; Endangered – 27; Save = 10; Saved – 7; Saving = 118; Conservation – 5). Therefore, on this measure there was a 34% increase in conservation-related thinking from pre- to post-visit.

Comparing First-time and Repeat Zoo Visitors

This section begins to assess whether there are any differences in how first-time and repeat visitors respond to the zoo visits on the dependent (outcome) variables measured in this study.

Seeing Animals, Fun and Learning

Zoos for seeing animals. Prior to the zoo visit, pupils’ who had been to the zoo previously were significantly more likely to indicate that the zoo is a place for ‘seeing animals’ ($\chi^2(2, n=2665) = 13.310, p=.001$), according to a crosstabulation analysis. However, this difference is no longer significant in the post-visit survey data ($\chi^2(2, n=2621) = 1.629, p=.443$). This finding indicates that pupils are most apt to perceive the zoo as a place for seeing animals after they have been for at least one visit. This difference should be understood within the context of an overall high level of agreement that ‘zoos are for seeing animals’ among both first-time (76%) and repeat visitors (82%).

An independent 2-samples t-test was also conducted to compare sample means between first-time and repeat visitors on the measure asking whether ‘zoos are for seeing animals’ in the pre-visit survey. The pre-visit results show that repeat visitors were significantly more likely to indicate that zoos are for seeing animals (M=.816, SD=.388) when compared with first-time visitors (M
This difference is significant \((t(631) = -2.687, p=.007^{12})\), with a medium effect size \((r=.106; d=-.214)\). However, as in the crosstab analysis, in the post-visit survey the difference between first-time and repeat visitors on this measure was no longer significant \((t(2581) = -.881, p=.378^{13}; \text{effect size } r=.017; d=-.035)\). This finding suggests that visitors who have been to the zoo at least once are most likely to believe zoos are for seeing animals, when compared to first-time visitors.

**Zoos for fun.** The pre-visit survey results suggest that repeat visitors are slightly more likely to indicate that ‘zoos are for fun / enjoyment’ than first-time visitors \((\chi^2(2, n=2665) = 7.281, p=.026)\). However, this statistically significant difference should be understood within the context of an overall high level of agreement with the idea that ‘zoos are for fun / enjoyment’ among both first time (72%) and repeat (76%) visitors. Indeed, the relationship between ‘previous zoo visits’ and ‘zoos are for fun / enjoyment’ is no longer significant in the post-visit survey \((\chi^2(2, n=2621) = 1.017, p=.601)\). This set of pre-/post- results suggests that pupils are more likely to perceive a zoo visit as a fun experience after having been at least once.

An independent 2-samples t-test was conducted to compare repeat and first-time visitors mean levels of agreement with the idea that ‘zoos are for fun / enjoyment’. The results show that repeat visitors were significantly more likely to believe zoos are for fun / enjoyment \((M=.762, SD=.426)\) when compared with first-time visitors \((M=.712, SD=.451)\) in the pre-visit survey. This difference is significant \((t(648) = -1.994, p=.047^{14})\), but with a small effect size \((r=.078; d=.157)\). These results indicate that before the zoo visit, repeat visitors had a better understanding of what to expect at the zoo than first-time visitors.

However, the difference between first-time and repeat visitors in perceiving the zoo as ‘for fun / enjoyment’ in the post-visit survey is not significant \((t(2581) = -.942, p=.346^{15}; \text{effect size } r=.037; d=-.074)\). This result suggests that pupils who have been on at least one zoo visit are more likely to perceive the zoo as fun than those who have never been before.

**Zoos for learning.** There is no statistical significance difference between first-time and repeat visitors in terms of their identification of the zoo as a place ‘for learning’. The relationship between ‘previous zoo visits’ and ‘zoos for learning’ is not significant in the pre-visit \((\chi^2(2, n=2665) = 0.86, p=.958)\) or post-visit survey results \((\chi^2(2, n=2621) = 1.538, p=.463)\).

Furthermore, an independent 2-samples t-test showed no difference between repeat and first-time visitors in the mean level with which they held the view that ‘zoos are for learning about animals’. This finding of no difference on the basis of first-time versus repeat visitor status applied

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\(^{12}\) Levene statistic = 29.155, p < 0.05 (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s \(F_{\text{max}}= 1.224 (n=2627)\))

\(^{13}\) Levene statistic = 3.014, p > 0.05 (equal variances assumed)

\(^{14}\) Levene statistic = 15.225, p < 0.05 (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s \(F_{\text{max}}= 1.122 (n=2627)\))

\(^{15}\) Levene statistic = 3.401, p > 0.05 (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s \(F_{\text{max}}= 1.071 (n=2583)\))
to both the pre-visit \((t(2625) = -0.213, p=0.832^{16}; \text{effect size } r=0.004; d=0.008)\) and post-visit survey data \((t(2581) = -0.389, p=0.195^{17}; \text{effect size } r=0.008, d=0.015)\).

**Annotated drawings.** Having previously visited the zoo is not predictive of differences in learning as measured by annotated drawings in the post-visit survey \(\chi^2(4, n=2706) = 4.919, p=0.296)\). That is, both first-time and repeat visitors were equally likely to evince positive, negative or neutral development on the drawing measure used to directly assess learning. A further comparison of the mean levels of learning for first-time and repeat visitors based on an independent 2-samples \(t\)-test also showed no difference. This finding of no difference is \((t(2666) = -0.640, p=0.522^{18}; \text{effect size } r=0.012; d=0.025)\).

**Scientific self-efficacy.** There were no significant differences between first-time and repeat visitors in their self-reported capability of understanding science (scientific self-efficacy) in the pre-visit survey \(\chi^2(8, n=360) = 11.626, p=0.169)\) or post-visit survey \(\chi^2(10, n=377) = 16.004, p=0.100)\).

First-time versus repeat visitor status did not yield a significant difference in scientific self-efficacy, as evidenced by pupils' perceived ability to understand science. An independent 2-samples \(t\)-test revealed no significant difference in scientific self-efficacy as a function of first-time or repeat visitor status in the pre-visit \((t(338) = -0.325, p=0.745^{19}; \text{effect size } r=0.018; d=0.035)\) or post-visit survey results \((t(356) = -0.356, p=0.722^{20}; \text{effect size } r=0.019; d=0.038)\).

**Conservation-related Outcome Variables**

**Zoos for conservation.** The relationship between 'previous zoo visits' and the perception that 'zoos are for saving animals from extinction' is significant in the pre-visit survey \(\chi^2(2, n=2665) = 6.096, p=0.047)\). The pre-visit results suggest that repeat visitors are more likely to associate zoos with a conservation mission than first-time visitors. This finding may suggest that perceptions of the zoo as engaged in wildlife conservation develop cumulatively with further visits enhancing this positive perception. This result should be understood within the context of a majority level of agreement with the idea that 'zoos are for saving animals from extinction' among both first-time (55%) and repeat visitors (58%). The results are no longer significant in the post-visit survey \(\chi^2(2, n=2621) = 3.820, p=0.148)\), supporting the idea that pupils are more likely to perceive the zoo as 'saving animals' from extinction after having visited at least once.

However, no difference was found in the pre-visit mean levels of agreement with the idea that 'zoos are for saving animals from extinction' for repeat and first-time visitors, based on an independent 2-samples \(t\)-test \((t(2625) = -1.076, p=0.282^{21}; \text{effect size } r=0.021; d=0.042)\). No

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16 Levene statistic = 0.180, p > 0.05 (equal variances assumed)
17 Levene statistic = 0.598, p > 0.05 (equal variances assumed)
18 Levene statistic = 0.490, p > 0.05 (equal variances assumed)
19 Levene statistic = 0.222, p > 0.05 (equal variances assumed)
20 Levene statistic = 2.111, p > 0.05 (equal variances assumed)
21 Levene statistic = 3.532, p > 0.05 (equal variances assumed)
significant differences were found on the basis of previous zoo visits in the post-visit survey either ($t(655) = -1.583, p=.114^{22}$; effect size $r=.062; d=-.124$).

**Personal concern for conservation.** Prior to their zoo visit, the relationship between ‘previous zoo visits’ and ‘concern about species extinction’ is significant ($\chi^2(4, n=321) = 13.048, p=.011$). The pre-visit results suggest that repeat visitors were almost twice as likely to indicate that they are ‘personally concerned’ about species going extinct (57%) as first-time visitors (30%). Furthermore, repeat visitors were far more likely to indicate such a concern (57%) than to indicate no concern (12%). This is in contrast to first-time visitors where the difference between those that indicated a concern (30%) and those that did not (26%) is marginal in the pre-visit data. Thus, in aggregate, those who had previously visited the zoo were much more likely to indicate personal concern about species extinction in the pre-visit survey.

This significant difference between first-time and repeat visitors was no longer significant in the post-visit survey ($\chi^2(4, n=332) = 4.101, p=.393$). This means that the pre-visit difference in conservation concern evened out post-visit, once all had visited. This result strongly supports the conclusion that zoo visits are associated with significantly greater personal concern about animal species becoming extinct.

An independent 2-samples t-test was also conducted to compare sample means for first-time and repeat visitors on the dimension of personal concern about species extinction. There was no significant difference in the pre-visit survey results ($t(29) = .116, p=.908^{23}$; effect size $r=.022; d=.043$). The results remained not significant in the post-visit survey results ($t(314) = 1.359, p=.175^{24}$; effect size $r=.076; d=.153$).

**Conservation self-efficacy.** The relationship between ‘previous zoo visits’ and perceived ability to do something about animal extinctions (i.e., ‘conservation self-efficacy’) is significant in the pre-visit survey ($\chi^2(4, n=320) = 9.708, p=.046$). Repeat visitors indicated a slightly greater belief that they can act against species extinction (43%) than first-time visitors (41%). Concomitantly, first-time visitors are slightly more likely to reject the idea that they can personally act against extinction (22%) in comparison to repeat visitors (20%).

The results in the post-visit survey are also significant ($\chi^2(4, n=331) = 11.150, p=.025$). The post-visit results show a decrease in both repeat and first-time visitors’ belief that they could make a contribution to combating species extinction, in comparison to the pre-visit survey. This finding shows that despite successfully engendering a sense of personal concern about species extinction, the current educational provision is failing to provide some of these pupils with a further sense of conservation self-efficacy; that is, the perception of oneself as capable of effecting social change in the interest of wildlife conservation. Although repeat visitors were still more likely to believe that

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22 Levene statistic = 7.960, $p < 0.05$ (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s $F_{max} = 1.018 (n=2583)$)

23 Levene statistic = 8.490, $p < 0.05$ (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s $F_{max} = 1.767 (n=306)$)

24 Levene statistic = .118, $p > 0.05$ (equal variances assumed)
they can do something to stop extinction (41%) in comparison to first-time visitors (31%) in the post-visit survey data. This pattern of repeat visitors expressing greater conservation self-efficacy suggests that impact on this dimension may be cumulative; that is, more visits to the zoo may yield greater conservation self-efficacy.

An independent 2-samples t-test was also conducted to compare the mean levels of conservation self-efficacy for first-time and repeat visitors as evidenced by their perceived ‘ability to do something about extinction’. There was no significant difference in the pre-visit \( t(304) = .064, p=.949^{25} \); effect size \( r=.004; d=.007 \) or post-visit survey results \( t(314) = -.670, p=.504^{26} \); effect size \( r=.038, d=-.076 \).

**Satisfaction Variables**

**Satisfaction with education presentation.** The relationship between ‘previous zoo visits’ and satisfaction with the educational presentation (as measured by a post-visit only, five-point Likert scale with different levels of ‘smiley’ faces) is significant \( \chi^2 (10, n=2331) = 28.824, p=.001 \). The results show that most pupils were very pleased with the zoo visit. Interestingly, those indicating the highest level of happiness were more likely for first-time visitors (63.4%) than repeat visitors (52.4%). The second highest level of happiness was more likely for repeat visitors (28.3%) than first-time visitors (22.2%), as was a neutral satisfaction level (13.9% for repeat visitors and 10.1% for first-time visitors). Although levels of dissatisfaction must be understood in a context of extremely low indications, repeat visitors had the same level of dissatisfaction at the second lowest level (3%) as first-time visitors (3%). Similarly, repeat visitors and first-time visitors had selected the lowest satisfaction level with the same extremely low frequency (2%).

An independent 2-samples t-test was conducted to compare the mean levels of satisfaction with the educational presentation for first-time and repeat visitors. The results show that first-time visitors were significantly less satisfied \( M=1.744, SD=.957 \) when compared with repeat visitors \( M=1.566, SD=.889 \). This result is significant \( t(584) = -3.544, p=.000^{27} \), with a medium effect size \( r=.145, d=.293 \). Thus, the results indicate that levels of satisfaction were high overall, but that repeat visitors were more likely to be satisfied with educational presentations.

**Enjoyment.** The relationship between ‘previous zoo visits’ and the related (post-visit only) variable asking if pupils ‘enjoyed the zoo visit’ was not significant \( \chi^2(4, n=1467) = 1.143, p=.887 \).

An independent 2-samples t-test was also conducted to compare the mean levels of enjoyment of the zoo visit reported by first-time and repeat visitors. The results show no significant difference on this post-visit only measure \( t(1434) = -.871, p=.384^{28} \); effect size \( r=.023; d=-.046 \).

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25 Levene statistic = .065, \( p > 0.05 \) (equal variances assumed)
26 Levene statistic = .791, \( p > 0.05 \) (equal variances assumed)
27 Levene statistic = 4.052, \( p < 0.05 \) (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s \( F_{max} = 1.158 (n=2295) \))
28 Levene statistic = 1.152, \( p > 0.05 \) (equal variances assumed)
Other Variables: Lateness and Behaviour

Both lateness and behaviour during educational presentations varied according to ‘first-time’ versus ‘repeat’ visitor status.

**Lateness.** Indeed, the results indicate that first-time visitors are slightly more likely to be late than repeat visits ($\chi^2(2, n=2289) = 10.040, p=.007$). However, this difference should be understood within the context of an overall low level of late attendance at the zoo, with only 18.6% of first-time and 13.2% of repeat visitors showing up late.

**Behaviour.** The difference between ‘previous zoo visits’ and school group ‘behaviour’ as coded by education officers is significant ($\chi^2(6, n=1634) = 28.992, p=.000$). The results show that those on a repeat visit were slightly more likely to be identified as being better behaved (48%) than those on their first visit (45%). Furthermore, those on their first visit were more likely to be identified as having behaved poorly (50%) than to have behaved well (45%).

An independent 2-samples $t$-test was also conducted to compare the mean levels of behaviour for first-time and repeat visitors attending educational presentations, as identified by the education officers delivering those presentations. No significant difference was found ($t(1607) = -1.082, p=.280$; effect size $r=.027$; $d=-.054$).

Comparing Self-guided and Zoo Educator-guided Visits

A key question addressed by this study is, what impacts can be attributed to having an educational presentation to enhance or ‘guide’ pupils visiting the zoo? This section addresses this question by comparing the results for pupils attended the zoo without guidance from zoo educators (‘self-guided’) with those whose visit was supplemented by an educational presentation connecting the animals in the zoo to broader concepts relating to habitats and conservation. The following statistical results relate to the relationship between ‘type of visit’ and the dependent variables listed above.

**Seeing Animals, Fun and Learning**

**Zoos for seeing animals.** An independent 2-samples $t$-test was conducted to compare self-guided and education officer-led pupils’ mean level of agreement with the idea that ‘zoos are for seeing animals’. The results show that self-guided visits yielded greater agreement with the perception that ‘zoos are for seeing animals’ ($M=.842, SD=.365$), when compared with education officer-led visits ($M=.781, SD = .414$). This difference was significant ($t(2488) = 4.071, p=.000$), but with a small effect size ($r=.081$; $d=.163$). These pre-visit results indicate that self-guided pupils were more likely to agree that ‘zoos are for seeing animals’ than pupils on education officer-led visits.

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29 Levene statistic = .514, $p > 0.05$ (equal variances assumed)
30 Levene statistic = 66.505, $p > 0.05$ (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s $F_{max}$= 1.285 ($n=2755$))
However, in the post-visit survey the difference in the view that zoos are for seeing animals by visit type was no longer significant ($t(2351) = 1.582, p=.114^{31}$), and had an even smaller effect size ($r=.033; d=.066$). This result suggests that while self-guided pupils are more likely to associate the zoo with ‘seeing animals’ prior to their visit, this difference evened out by the time all of the pupils had spent a day at the zoo.

A crosstabulation analysis of the relationship between ‘type of visit’ and perception that ‘zoos are for seeing animals’ also showed it to be significant in the pre-visit survey ($\chi^2(1, n=2755) = 15.610, p=.000$). The pre-visit results suggest that those on self-guided visits are more likely to believe that ‘zoos are for seeing animals’ than those on education officer-led visits. This difference should be understood within the context of an overall high level of agreement that ‘zoos are for seeing animals’ among those on self-guided visits (84%) and education officer-led visits (78%). The relationship is no longer significant in the post-visit survey: ($\chi^2(1, n=2723) = 2.436, p=.119$).

Zoos for fun. There are no statistically significant differences in the view that zoos are fun that can be attributed to whether a visit was self-guided or education officer-led. The relationship between ‘type of visit’ and ‘zoos for fun’ is not significant in the pre-visit survey ($\chi^2(1, n=2755) = .199, p=.655$). Similarly, the results of the post-visit survey are also not significant: $\chi^2(1, n=2723) = .151, p=.698$. This finding indicates that the perception of the zoo as fun is not adversely affected by additional educational activity.

An independent 2-samples $t$-test was also conducted to compare the mean levels of agreement with the idea that ‘zoos are for fun / enjoyment’ for self-guided and education officer-led visits. There was no significant difference in either the pre-visit ($t(2753) = .446, p=.655^{32}$; effect size $r=.008; d=.02$) or post-visit survey data ($t(2721) = -.388, p=.698^{33}$; effect size $r=.007; d=-.01$).

Zoos for learning about animals. Likewise, the likelihood of associating zoos with learning was unrelated to whether the pupil’s visits were self- or education officer-guided. Indeed, ‘type of visit’ was not predictive of any significant differences in the perception that ‘zoos are for learning about animals’, either pre-visit ($\chi^2(1, n=2755) = .674, p=.412$) or post-visit ($\chi^2(1, n=2723) = 1.681, p=.195$), according to an analysis of crosstabulations.

This finding was confirmed by an independent 2-samples $t$-test conducted to compare mean agreement with the perception that ‘zoos are for learning about animals’ for self-guided and education officer-led visits. However, no significant difference was found on this measure in either

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31 Levene statistic = 9.913, $p < 0.05$ (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s $F_{max}= 1.130 (n=2723)$).

32 Levene statistic = .802, $p > 0.05$ (equal variances assumed)

33 Levene statistic = .600, $p > 0.05$ (equal variances assumed)
the pre-visit ($t(2753) = .821, p=.412^{34};$ effect size $r=.01; d=.03$) or post-visit survey ($t(2149) = -1.279, p=.201^{35};$ effect size $r=.028; d=-0.055$).

**Annotated drawings.** The relationship between ‘type of visit’ and actual learning- as measured by the drawing data- in the post-visit survey is statistically significant ($\chi^2(2, n=2808) = 20.611, p=.000$), with pupils on education officer-led visits showing consistently more positive outcomes on this measure of learning when compared to self-guided. Those on education officer-led visits were significantly more likely to have a positive change in their drawings (41%) than those on self-guided visits (34%). Those on self-guided visits were more likely to have a negative change in their drawings (16%) than those on education officer-led visits (11%). Furthermore, those on self-guided visits were slightly more likely (50%) to have no change than those on education officer-led visits (48%).

Sample means were also compared for self-guided and education officer-led visits on the drawing-based measure of learning using an independent 2-samples $t$-test. While both categories evinced significant gains in learning, the results show that education officer-led visits yielded significantly greater learning on the drawing measure ($M=2.297, SD=.659$) when compared with self-guided visits ($M=2.180, SD=.686$). This difference between the sample means for self-guided and education officer-led zoo visits is significant ($t(2806) = -4.504, p=.000$), although with a small effect size ($r=.085; d=-.170$). Thus, supplementing a zoo visit with a tailored educational presentation delivered substantially improved learning outcomes, as measured by the annotated drawings.

**Scientific self-efficacy.** The relationship between ‘type of visit’ and perceived ability to understand science (scientific self-efficacy) is not significant in the pre-visit ($\chi^2(4, n=364) = 3.601, p=.463$) or post-visit survey data ($\chi^2(5, n=383) = 7.733, p=.172$).

An independent 2-samples $t$-test was conducted to compare mean levels of scientific self-efficacy for pupils on self-guided or education officer-led zoo visits as evidenced by self-assessments of their ability to understand science. There was no significant difference in the pre-visit survey results ($t(362) = -1.226, p=.221^{37};$ effect size $r=.059, d=0.118$) or post-visit survey results ($t(381) = .774, p=.440^{38};$ effect size $r=.04; d=.079$).

**Conservation-related Outcome Variables**

**Zoos for wildlife conservation.** Turning to pupils’ conservation-related perceptions, the results show zoo-educator-guided visits were significantly more likely to yield a shift in perceptions of the zoo as a place for saving animals from extinction, as compared to self-guided visits. The

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34 Levene statistic = 2.717, $p > 0.05$ (equal variances can be assumed)

35 Levene statistic = 6.676, $p < 0.05$ (Levene result suggests non-equal variances, however variance ratio confirms assumption of homogeneity of variance: Hartley’s $F_{max} = 1.133 (n=2723)$).

36 Levene statistic = .235, $p > 0.05$ (equal variances assumed)

37 Levene statistic = 1.069, $p > 0.05$ (equal variances assumed)

38 Levene statistic = .004, $p > 0.05$ (equal variances assumed)
relationship between ‘type of visit’ and the perception that ‘zoos are for saving animals from extinction’ is significant in the pre-visit survey, according to an analysis of crosstabulations ($\chi^2(1, n=2755) = 10.165$, $p=.001$). The pre-visit results suggest that those on education officer-led visits are marginally more likely to agree that zoos serve a wildlife conservation function than those on self-guided visits. However, this must be understood in the overall context of a majority level of agreement among those on both education officer-led visits (60%) and those on self-guided visits (53%).

The statistical relationship remains significant in the analysis of post-visit survey data crosstabulations ($\chi^2(1, n=2723) = 12.890$, $p=.000$). There is an increase in agreement in the post-visit results in comparison to the pre-visit results, with those on education officer-led visits still more likely to agree that ‘zoos are for saving animals from extinction’ than those on self-guided visits. This should be understood within the context of an overall higher level of agreement with this positive perception of zoos’ conservation value among those on education officer-led visits (64%) and those on self-guided visits (57%).

An independent 2-samples t-test was also conducted to compare means for self-guided and education officer-led visits on the measure assessing the perception that ‘zoos are for saving animals from extinction’ in the pre-visit survey. Education officer-led visits ($M=.5961$, $SD=.012$) yielded greater agreement with the view that ‘zoos are for saving animals from extinction’, when compared with self-guided visits ($M=.534$, $SD=.499$). This difference was statistically significant ($t(2258) = -3.181$, $p=.001^{39}$), but with a small effect size $r=.055$; $d=-.110$.

The post-visit survey results show that pupils’ association of zoos with wildlife conservation increased, but education officer-led visits yielded significantly greater agreement with this idea ($M=.640$, $SD=.480$), when compared with self-guided visits ($M=.571$, $SD=.495$). This difference was significant ($t(2202) = -3.573$, $p=.000^{40}$), but with a very small effect size ($r=.008$; $d=.015$). Supplementing the zoo visit with a tailored educational presentation resulted in a significant increase in the perception that ‘zoos are for saving animals from extinction’.

**Personal concern for conservation.** The relationship between ‘type of visit’ and ‘personal concern about species extinction’ is not significant in either the pre-visit ($\chi^2(2, n=326) = .562$, $p=.755$) or post-visit survey ($\chi^2(2, n=338) = .362$, $p=.835$).

An independent 2-samples t-test was also conducted to compare the sample means for self-guided and education officer-led visits on the variable of ‘personal concern about species extinction’. There are no significant differences in the pre-visit survey results ($t(324) = .397$, $p=.692^{41}$; effect

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39 Levene statistic = 28.798, $p < 0.05$ (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley's $F_{max} = 1.034$ ($n=2755$))

40 Levene statistic = 42.043, $p < 0.05$ (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley's $F_{max} = 1.063$ ($n=2723$))

41 Levene statistic = .775, $p > 0.05$ (equal variances assumed)
size $r=.022; d=.044$) or the post-visit survey results ($t(336) = .570, p=.569^{42}$; effect size $r=.03; d=.062$).

Likewise, the relationship between ‘type of visit’ and perceived ability to do something about extinction (conservation self-efficacy) is not significant in the pre-visit ($\chi^2(2, n=324) = 3.761, p=.152$) or post-visit survey ($\chi^2(2, n=337) = 5.285, p=.071$).

An independent 2-samples t-test was conducted to compare the mean levels of conservation self-efficacy for pupils on self-guided and education officer-led visits as evidenced by their self-perception as being able to take effective conservation action. There was no significant difference in the pre-visit survey results ($t(322) = 1.179, p=.239^{43}$; effect size $r=.066; d=.131$).

However, the post-visit results showed that pupils on self-guided visits held a higher level of conservation self-efficacy on this measure (M=.872, SD=.755) when compared with education officer led visits (M=.694, SD=.748). This difference is significant ($t(335) = 2.167, p=.031^{44}$); though the effect size is relatively small ($r=.118; d=.237$). Thus, the pupils on self-guided visits evinced greater post-visit conservation self-efficacy than pupils on education officer-led visits. This result stands out as one of the few measures on which self-guided visits yielded better outcomes than education-officer led visits. It is possible that the greater focus on habitats and the importance of conservation in the zoo educator-led visits distracted from the more immediate and obvious question of taking action for this sample.

**Satisfaction Variables**

_Satisfaction with zoo education._ The relationship between ‘type of visit’ and satisfaction with the zoo visit is significant ($\chi^2 (5, n=2415) = 21.971, p=.001$). The results show that education officer-led visitors were somewhat more likely to express the highest level of satisfaction with the zoo visit (57%) when compared to pupils on self-guided visits (49%). Both visit types were about even on the second highest level of satisfaction, with self-guided at 28% and education officer-led at 27%. Meanwhile self-guided pupils were somewhat more likely to indicate a neutral level of satisfaction (17%) in comparison with education officer-led visits (12%). These differences must be understood in an overall context of high levels of satisfaction with the zoo learning experience. Indeed, dissatisfaction levels were extremely low, with only 2% of self-guided visitors and education officer-led visitors indicating lowest levels of satisfaction, and 3% indicating the second-lowest level of satisfaction. The overall levels of satisfaction with the zoo learning experience were very high for both education officer-led (84% satisfied; 5% dissatisfied) and self-guided visits (77% satisfied; 5% dissatisfied).

_Enjoyment._ However, the results of an independent 2-samples t-test show no significant difference in sample means between self-guided or education officer-led on self-reported enjoyment of the

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42 Levene statistic = .043, $p > 0.05$ (equal variances assumed)
43 Levene statistic = 3.692, $p > 0.05$ (equal variances assumed)
44 Levene statistic = 1.020, $p > 0.05$ (equal variances assumed)
zoo visit based on post-visit survey data (t(1513) = -0.493, p=0.622; effect size r=.013, d=0.025). The crosstabs confirmed this finding that the relationship between ‘type of visit’ and the post-visit only self-report measure of having ‘enjoyed the zoo visit’ is not significant (χ² (2, n=1515) = .971, p=.615).

**Behaviour.** Only those on education officer-led visits were assigned a ‘behaviour’ score. Thus, no statistics were computed. The results show that equal numbers of pupils in education officer-led school visits had bad behaviour (47%) and good behaviour (47%) (n=1711).

**The Role of Age**

**Seeing Animals, Fun and Learning**

*Zoos for seeing animals.* The relationship between ‘age’ and the view that ‘zoos are for seeing animals’ is significant in the pre-visit survey (χ²(8, n=2748) = 34.646, p=.000). The results show significant variation by age, with those aged 7 expressing the lowest level of agreement (66%; n=71) and those aged 15 evincing the highest level of agreement with this idea (87%; n=13). The aggregate level of agreement for this perception pre-visit is 81%.

The differences patterns of associating the zoo with ‘seeing animals’ by age in the post-visit survey: (χ²(8, n=2716) = 21.151, p=.007). Indeed, the results show an increase in agreement in all ages in the post-visit survey in comparison to the pre-visit survey. Those aged 15 still have the highest agreement (93%; n=14), while those aged 7 still have the lowest agreement (82%; n=86) but there is a clear increase in this agreement from pre- to post-visit. The aggregate level of agreement post-visit is 85%.

A one-way between subjects ANOVA was conducted to compare the effect of age on the level of agreement with the idea that ‘zoos are for seeing animals’ within the pre-visit survey data. There was a significant difference between age groups on this dimension (F(8, 2739) = 4.372, p=.000), although the magnitude of this difference was small (ω² = 0.01; ω = 0.10). The posthoc Games-Howell test revealed that 7-year-olds reported lower levels of agreement than those aged 8, 11, 12, and 13 (mean difference = -0.153; -0.204; -0.176 and -0.206 respectively; p<0.05). Moreover, 9-year-olds also reported lower levels of agreement than 11-year-olds in the view that ‘zoos are for seeing animals’ in the pre-visit survey (mean difference = -0.081; p<0.05). Thus, 7- and 9-year-olds were least likely to agree with the idea that ‘zoos are for seeing animals’ in the pre-visit survey.

The differences as a function of age are also significant in a one-way between subjects ANOVA conducted on the post-visit survey data (F(8, 2707) = 2.656, p=.007), however the magnitude of the differences in the means was still small (ω² = 0.005; ω = 0.07). The posthoc Games-Howell test

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45 Levene statistic = 2.084, p > 0.05 (equal variances assumed)
46 Levene statistic = 14.863, p < 0.05 (Outcome suggests non-equal variances, however the variance ratio confirms assumption of homogeneity of variance, with Hartley’s Fmax = 1.738 (n=2748))
47 Levene statistic = 11.684, p < 0.05 (Outcome suggests non-equal variances, however the variance ratio confirms assumption of homogeneity of variance, with Hartley’s Fmax = 1.186 (n=2716))
revealed that 11-year-olds had significantly higher levels of agreement that zoos are for seeing animals than those aged 8 and 9 (mean difference = .072 and .079 respectively; \( p < 0.05 \)). Thus, 11-year-olds were most likely to believe that zoos are for seeing animals in the post-visit survey.

*Zoos for fun.* The relationship between ‘age’ and the perception that ‘zoos are for fun/enjoyment’ is significant in the pre-visit survey \( (\chi^2(8, n=2748) = 37.591, p=.000) \). The results show that 15-year-olds are more likely to agree that zoos are for fun (87%; \( n=13 \)) than other ages, with 12-year-olds comprising the next most likely to agree (84%; \( n=274 \)). Meanwhile, 14-year-olds indicated the least agreement with this idea (58%; \( n=37 \)). These two ages had the smallest sample size however for this item and may therefore be subject to greater variance. These results should be understood in the context of a high overall level of agreement that zoos are for fun/enjoyment (75.4% across the 7 - 15 years-old age range; \( n=2072 \) out of total of 2748).

### Table 1: Perception that Zoos are for Fun / Enjoyment as a Function of Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Total</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoos Fun 0 Count</td>
<td>676</td>
<td>34</td>
<td>217</td>
<td>187</td>
<td>44</td>
<td>78</td>
<td>51</td>
<td>36</td>
<td>27</td>
<td>2</td>
</tr>
<tr>
<td>% within Age</td>
<td>31.5%</td>
<td>28.4%</td>
<td>24.6%</td>
<td>20.0%</td>
<td>23.5%</td>
<td>15.7%</td>
<td>22.4%</td>
<td>42.2%</td>
<td>13.3%</td>
<td>24.6%</td>
</tr>
<tr>
<td>1 Count</td>
<td>2072</td>
<td>74</td>
<td>546</td>
<td>573</td>
<td>176</td>
<td>254</td>
<td>274</td>
<td>125</td>
<td>37</td>
<td>13</td>
</tr>
<tr>
<td>% within Age</td>
<td>68.5%</td>
<td>71.6%</td>
<td>75.4%</td>
<td>80.0%</td>
<td>76.5%</td>
<td>84.3%</td>
<td>77.6%</td>
<td>57.8%</td>
<td>86.7%</td>
<td>75.4%</td>
</tr>
</tbody>
</table>

There are also significant differences in the perception that ‘zoos are for fun/enjoyment’ according to age in the post-visit survey \( (\chi^2(8, n=2716) = 28.320, p=.000) \). The results show that levels of agreement have increased or remained the same for all age, with an aggregate agreement that zoos are for fun of 79.5%. In particular, all those that had a low level of agreement in the pre-visit survey show an increase, for instance those aged 14 now have 61% agreement, while those aged 7 have 77% agreement. Overall, the results should be understood in the context of an overall high level of agreement that zoos are for fun / enjoyment.
A one-way between subjects ANOVA was conducted to compare the effect of age on learning at the zoo as evidenced by agreements that zoos are for fun. There was a significant relationship between age and the perception that ‘zoos are for fun / enjoyment’ ($F(8, 2739) = 4.748, p = .00048$) in the pre-visit survey. However, the magnitude of the differences in the means was very small ($\omega^2 = 0.01; \omega = 0.12$). Nevertheless, the posthoc Games-Howell test revealed significant pair-wise differences ($p<0.05$). Specifically, those aged 12 had significantly higher levels of agreement that zoos are for fun than those aged 7, 8, 9 and 14 (mean difference = .148; .127; .089; .265 respectively). Furthermore, 10-year-olds had significantly higher levels of agreement that ‘zoos are for fun / enjoyment’ than those aged 14 (mean difference = .222).

There were significant differences in agreement with the idea that ‘zoos are for fun / enjoyment’ between different ages detected through a one-way between subjects ANOVA ($F(8, 2707) = 3.565, p = .00049$) in the post-visit survey as well. Although the effect size for this result was very small ($\omega^2 = 0.001; \omega = 0.09$), the posthoc Games-Howell test revealed that those aged 12 were significantly more likely to agree that zoos are for fun in the post-visit survey than those aged 8 and 14 (mean difference = .096; .258) ($p<0.05$).

Zoos for learning about animals. The relationship between ‘age’ and the perception that ‘zoos are for learning about animals’ is significant in the pre-visit survey ($\chi^2(8, n=2748) = 17.828, p = .023$). The results show that those aged 9 are slightly more likely to agree that zoos are for learning about animals (89%) than other ages, with those aged 14 showing the least agreement (78%). Overall, however a very high proportion of pupils across the ages associated the zoo with learning about animals (86%; $n=2354$). The relationship between these two variables is no longer significant in the post-visit survey ($\chi^2(8, n=2716) = 9.449, p = .306$). This finding indicates that the differences between ages in their perception of the zoo as ‘for learning about animals’ evened out after the visit, with a small increase in the aggregate level of agreement with this idea across the full age range for the present sample (89%; $n=2418$).

A one-way between subjects ANOVA was conducted to compare agreement with the idea that ‘zoos are for learning about animals’ across different ages in the pre-visit survey. There is a significant difference between ages on this measure ($F(8, 2739) = 2.236, p = .02250$; effect size ($\omega^2 = 0.0036; \omega = 0.06$) in the pre-visit survey. However, the more conservative post-hoc test Games-Howell did not detect any significant differences between the ages ($p>0.05$) in the pre-visit survey. Moreover, there was no significant difference in pupils’ level of agreement with the idea that ‘zoos are for learning about animals’.
are for learning about animals’ in the post-visit survey ($F(8, 2707) = 1.181, p=.306^{51}; \text{ effect size } \omega^2 = 0.0005; \omega = 0.023$).

Annotated drawings. The relationship between ‘age’ and changes in learning (annotated drawings) is significant ($\chi^2 (16, n=2800) = 62.119, p=.000$). The results show that pupils of all ages were more likely to have no change or a positive change in their drawings overall than a negative change. At 51%, 10-year-old respondents were most likely to evince a positive change in their drawings after their visit to the zoo.

**Table 2: Development in Learning as a Function of Age**

<table>
<thead>
<tr>
<th>Age</th>
<th>Count</th>
<th>% within Age</th>
</tr>
</thead>
<tbody>
<tr>
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<td>13</td>
<td>11.8%</td>
</tr>
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<td>8</td>
<td>86</td>
<td>10.9%</td>
</tr>
<tr>
<td>9</td>
<td>84</td>
<td>10.9%</td>
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<td>13.3%</td>
</tr>
<tr>
<td>Total</td>
<td>367</td>
<td>13.1%</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Count</th>
<th>% within Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>55</td>
<td>50.0%</td>
</tr>
<tr>
<td>8</td>
<td>367</td>
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<td>53.2%</td>
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<tr>
<td>12</td>
<td>155</td>
<td>47.5%</td>
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<tr>
<td>13</td>
<td>91</td>
<td>55.5%</td>
</tr>
<tr>
<td>14</td>
<td>35</td>
<td>56.5%</td>
</tr>
<tr>
<td>15</td>
<td>8</td>
<td>53.3%</td>
</tr>
<tr>
<td>Total</td>
<td>1359</td>
<td>48.5%</td>
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</table>

<table>
<thead>
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<th>Age</th>
<th>Count</th>
<th>% within Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>42</td>
<td>38.2%</td>
</tr>
<tr>
<td>8</td>
<td>335</td>
<td>42.5%</td>
</tr>
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<td>9</td>
<td>295</td>
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</tr>
<tr>
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</tr>
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<td>11</td>
<td>112</td>
<td>32.9%</td>
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<tr>
<td>12</td>
<td>103</td>
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</tr>
<tr>
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<td>50</td>
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<tr>
<td>14</td>
<td>17</td>
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<td>33.3%</td>
</tr>
<tr>
<td>Total</td>
<td>1074</td>
<td>38.4%</td>
</tr>
</tbody>
</table>

Note: ‘1’ signifies negative change, ‘2’ no change and ‘3’ positive change.

Children aged 12 were more likely to have a negative change in their drawings than any other age. Children aged 10 and older were more likely to have a negative change in their drawing than those aged 7-9, although the differences were relatively marginal. As a group, children aged 7-10 were more likely to have a positive change in their drawings than those aged 11-15.

\[51\text{ Levene statistic } = 4.653, p < 0.05 (\text{Outcome suggests non-equal variances, however the variance ratio confirms assumption of homogeneity of variance, with Hartley’s } F_{\text{max}}=1.144 (n=2716))\]
A one-way between subjects ANOVA was conducted to compare the effect of age on learning at the zoo as measured by the annotated drawing data. There is a significant difference between ages as measured by these drawings ($F(8, 2791) = 4.708, p=.00052$), although the effect size is somewhat small ($\omega^2 = 0.013; \omega = 0.12$). The posthoc Games-Howell test shows that 12-year-olds had a lower level of positive change in their drawings when compared with those aged 8, 9 and 10 (mean difference = -.209; -.167; -.253 respectively).

**Scientific self-efficacy.** The relationship between ‘age’ and perceived capability to understand science is not significant in either the pre-visit ($\chi^2(12, n=364) = 4.808, p=.964$) or post-visit survey data ($\chi^2(15, n=383) = 11.637, p=.706$).

A one-way between subjects ANOVA was also conducted to compare the effect of age on scientific self-efficacy. The differences between ages are not significant ($F(3, 360) = .122, p=.94753$) in the pre-visit survey. The post-visit survey results are also not significant ($F(3, 379) =.311, p=.81854$).

**Conservation-related Outcome Variables**

**Zoos for conservation.** The relationship between ‘age’ and the perception that zoos save animals from extinction is significant in the pre-visit survey ($\chi^2(8, n=2748) = 43.158, p=.000$). The results show that there is a wide range of agreement, with 64% ($n=69$) of those aged 7 agreeing that zoos are for saving animals from extinction, but only 33% ($n=5$) of those aged 15 agreeing. Overall, while still applying to a majority of respondents, the aggregate level of agreement is lower for this item (57%; $n=1572$) than that observed in the results for the perception that zoos are for fun / enjoyment and learning.

The results still show significant differences on the basis of age in the post-visit survey for this perception of zoo as saving animals from extinction ($\chi^2(8, n=2716) = 38.902, p=.000$). The results show an increase in agreement in all ages in the post-visit survey in comparison to the pre-visit survey, yielding an aggregate level of agreement of 61% ($n=1666$). Those aged 7 still show the highest agreement (68%; $n=71$) in comparison to other ages, whilst those aged 15 ($n=6$) still show the lowest agreement (40%).

A one-way between subjects ANOVA was conducted to compare the role of age in pupils’ level of agreement with view that ‘zoos are for saving animals from extinction’ in the pre-visit survey. There was a significant difference between pupils’ perceptions of zoos as ‘saving animals from extinction’ on the basis of age ($F(8, 2739) = 5.463, p=.00055$); however the effect size was small ($\omega^2 = 0.01; \omega = 0.113$). The posthoc Games-Howell test revealed that those aged 13 and 14 differ significantly from those aged 7 and 9 in the pre-visit survey ($p<0.05$). Specifically, 13-year-olds

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52 Levene statistic = 3.331, $p < 0.05$ (Outcome suggests non-equal variances, however the variance ratio confirms assumption of homogeneity of variance, with Hartley’s $F_{max}= 1.254 (n=2800)$)
53 Levene statistic = .399, $p > 0.05$ (equal variances assumed); effect size could not be calculated.
54 Levene statistic = 2.086, $p > 0.05$ (equal variances assumed); effect size could not be calculated.
55 Levene statistic = 4.486, $p < 0.05$ (Outcome suggests non-equal variances, thus variance ratio calculated to confirm the assumption of homogeneity of variance; this assumption was confirmed by Hartley’s $F_{max}= 3.674 (n=2748)$)
evinced significantly lower levels of agreement that ‘zoos are for saving animals from extinction’ than those aged 7, 8 and 9 (mean difference = -.229; -1.94; -.206 respectively). Likewise, 14-year-olds had significantly lower levels of agreement with the idea that zoos protect wildlife from extinction than those aged 7, 8 and 9 (mean difference = -.248; -.214; -.225 respectively). Thus, 13- and 14-year-olds are least likely to associate zoos with wildlife conservation in the pre-visit survey data.

There remains a significant difference in the post-visit survey data, according to a one-way between subjects ANOVA ($F(8, 2707) = 4.917$, $p=.000$), although the effect size also remains small ($\omega^2 = 0.01; \omega = 0.11$). The posthoc Games-Howell test revealed that 8-year-olds had significantly higher levels of agreement that zoos act for wildlife conservation in the post-visit survey than those aged 11, 13 and 14 (mean difference = .106; .155; .258 respectively; $p<0.05$), and 14-year-olds had significantly lower levels of agreement than those aged 7 and 10 (mean difference = -.266; -.242 respectively; $p<0.05$). Thus, the post-visit results show 8-year-olds were most likely to associate zoos with wildlife conservation, whilst 14-year-olds were least likely to do so.

**Personal concern for conservation.** The relationship between ‘age’ and ‘personal concern about species extinction’ is significant in the pre-visit survey ($\chi^2(6, n=326) = 13.871$, $p=.031$). The results show that those aged 12 have the highest pre-visit concern for species extinction in the present sample (61%), and those aged 13 have the lowest (46%). Overall, the dominant responses to this item were either agreement from pupils that they were personally concerned about wildlife conservation or the ‘not sure’ response, with a negative response appearing in only 13.2% of responses pre-visit, and 11.8% post-visit.

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56 Levene statistic = 9.316, $p < 0.05$ (Outcome suggests non-equal variances, however the variance ratio confirms assumption of homogeneity of variance, with Hartley’s $F_{max}=2.858$ ($n=2716$))
Table 3: Post-visit Personal Concern about Wildlife Conservation as a Function of Age

<table>
<thead>
<tr>
<th>SpeciesConcern2</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td>% within Age</td>
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</tr>
<tr>
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<td></td>
</tr>
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<td>Count</td>
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</tr>
<tr>
<td>% within Age</td>
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<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>15</td>
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<tr>
<td>% within Age</td>
<td>53.6%</td>
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<table>
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<th>Age</th>
<th>Count</th>
<th>% within Age</th>
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<tr>
<td>11</td>
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<td>3.6%</td>
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<tr>
<td>12</td>
<td>17</td>
<td>9.5%</td>
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<tr>
<td>13</td>
<td>16</td>
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<tr>
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<td>6</td>
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<th>Count</th>
<th>% within Age</th>
</tr>
</thead>
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<td>42.9%</td>
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<tr>
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<tr>
<td>14</td>
<td>27</td>
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</tr>
<tr>
<td>Total</td>
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<th>Age</th>
<th>Count</th>
<th>% within Age</th>
</tr>
</thead>
<tbody>
<tr>
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<td>15</td>
<td>53.6%</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>26.8%</td>
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<tr>
<td>13</td>
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<tr>
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<td>15</td>
<td>31.3%</td>
</tr>
<tr>
<td>Total</td>
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<table>
<thead>
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<th>Age</th>
<th>Count</th>
<th>% within Age</th>
</tr>
</thead>
<tbody>
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<td>28</td>
<td>100.0%</td>
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<tr>
<td>12</td>
<td>179</td>
<td>100.0%</td>
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<tr>
<td>13</td>
<td>83</td>
<td>100.0%</td>
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<tr>
<td>14</td>
<td>48</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total</td>
<td>338</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Note: '0' indicates no personal concern about wildlife conservation; '1' signifies a personal concern about animal species going extinct and '2' means 'not sure'.

The relationship between personal concern for wildlife conservation and age is still significant in the post-visit survey ($\chi^2(6, n=338) = 15.199, p=.019$). The results show that there is generally a higher indication of species concern, with the aggregate level of personal concern moving from 54.9% pre-visit to 57.4% post-visit. Thus, a majority of respondents are indicating personal concern for wildlife conservation both pre- and post-visit, although a substantial minority have uncertain or ambivalent feelings on this as indicated by the number who indicated they were ‘not sure’ whether they felt personally concerned about this issue (in aggregate, 32% pre-visit; 31% post-visit).

A one-way between subjects ANOVA was conducted to compare the effect of age on personal concern about wildlife extinction. The results were not significant between ages ($F(3, 322) = 2.584, p=.053^{57}; \omega^2 = 0.014; \omega = 0.12$) in the pre-visit survey.

The difference between ages in relation to a concern about species extinction is significant in the post-visit survey, according one-way between subjects ANOVA ($F(3, 334) = 2.718, p=.045^{58}$), although the effect size is small ($\omega^2 = 0.015; \omega = 0.123$). The post hoc Tukey test could not be run because at least one group had fewer than two cases. The ANOVA test was run again excluding those aged 11. This time the ANOVA indicated that any differences between ages in personal concern about species extinction were not significant ($F(3, 334) = 1.667, p=.167; \omega^2 = 0.015; \omega = 0.123$).

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^{57} Levene statistic = 1.973, p > 0.05 (equal variances assumed)

^{58} Levene statistic = 1.782, p > 0.05 (equal variances assumed)
concern about species extinction in the post-visit survey were not significant \( (F(2, 307) = .252, p=.777) \).

**Conservation self-efficacy.** Turning from personal concern to conservation self-efficacy, the relationship between ‘age’ and perceived ability to do something about extinction is not significant in the pre-visit \( (\chi^2(6, n=324) = 4.223, p=.647) \) or post-visit survey data \( (\chi^2(6, n=337) = 9.084, p=.169) \). That is, the level of conservation self-efficacy was similar across the different ages. In the pre-visit survey, 22% gave a negative response to this item, 41% responded positively (indicating conservation self-efficacy) and 37% said they were ‘not sure’. Post-visit, these figures were similar, with 20% responding negatively, 39% positively and 41% unsure.

A one-way between subjects ANOVA was conducted to compare the effect of age on learning at the zoo as evidenced by an indication of personal ability to combat extinction. The differences in ages were not significant \( (F(3, 320) = .966, p=.409) \); effect size could not be calculated due to small sample size within each age category) in the pre-visit survey.

In the post-visit survey, their remain no significant differences \( (F(3, 333) = .916, p=.433) \); effect size could not be calculated due to small sample size within each age category).

**Satisfaction Variables**

**Satisfaction with zoo education.** Satisfaction with the zoo educational provision varied significantly according to age: \( (\chi^2(40, n=2408) = 523.173, p=.000) \). The results show that pupils indicated high levels of agreement that the zoo learning experience was enjoyable overall. However, the younger pupils (age 7-11) are much more likely to indicate satisfaction than the older pupils (age 12-15). The highest satisfaction scores are from 7-year-olds (91%; \( n=85 \)), 8-year-olds (90%; \( n=606 \)) and 9-year-olds (89%; \( n=563 \)).

A one-way between subjects ANOVA was conducted to compare differences in satisfaction with the educational provision during their zoo visit by age. The differences between ages on this measure are significant \( (F(8, 2399) = 62.328, p=.000) \). Moreover, the effective size is large \( (\omega^2 =0.169; \quad \omega = 0.411) \). The posthoc Games-Howell tests reveal significant pair-wise differences between pupils of different ages \( (p<0.05) \). Specifically, those aged 7 have higher levels of satisfaction than those aged 11-15 (mean difference= -.398; -.853; -.857; -1.570; -1.703 respectively). Those aged 8 had significantly higher levels of satisfaction than those aged 11-15 (mean difference= -.359; -.814; -.819; -.143; -1.665 respectively). Those aged 9 had significantly higher levels of satisfaction than those aged 11-15 (mean difference = -.366; -.821; -.826; -.154; -

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59 Levene statistic = 2.267, \( p > 0.05 \) (equal variances assumed)
60 Levene statistic = .140, \( p > 0.05 \) (equal variances assumed); effect size could not be calculated due to the small sample size within some of the age categories.
61 Levene statistic = 1.569, \( p > 0.05 \) (equal variances assumed); effect size could not be calculated due to the small sample size within some of the age categories.
62 Levene statistic = 11.077, \( p < 0.05 \) (Outcome suggests non-equal variances, however the variance ratio confirms assumption of homogeneity of variance, with Hartley’s \( F_{\text{max}} = 4.8 \ (n=2408) \))
Those aged 10 had significantly higher levels of satisfaction than those aged 11-15 (mean difference = -0.287; -0.742; -0.747; -1.459; -1.593 respectively). Those aged 11 had significantly higher levels of satisfaction than those aged 12-15 (mean difference = -0.4550; -0.460; -1.172; -1.305 respectively). Those aged 14 had significantly lower levels of satisfaction than those aged 12 and 13 (mean difference = 0.717 and 0.713 respectively). The overall trend in these results shows that as children got older, their levels of satisfaction with the educational provision during their zoo visit decreased.

**Enjoyment.** The relationship between ‘age’ and the post-visit only survey item asking if pupils enjoyed their zoo visit is significant (χ²(14, n=1511) = 94.926, p=.000). The results (pg. 71) show that children overwhelmingly enjoyed the zoo. Those aged 7 enjoyed the zoo visit most (96%; n=63), followed by 8-year-olds (93%; n=389), 9-year-olds (89%; n=266), 12-year-olds (89%; n=184), 10-year-olds (86%; n=118), 11-year-olds (82%; n=177), 13-year-olds (80%; n=86). By far the lowest level of enjoyment was indicated by 14-year-olds (66%; n=37).

A one-way between subjects ANOVA was conducted to compare differences in age and enjoyment of the zoo lesson. There is a significant difference between ages as measured by the self-reported enjoyment of the lesson (F(7, 1503) = 2.813, p=.007⁶³), though the effect size is small (ω² = 0.008; ω = 0.09). Moreover, the post hoc Tukey test revealed that 14-year-olds reported enjoying the zoo visits more than those 11-year-olds (mean difference=.218; p<0.05).

**Other Variables: Lateness and Behaviour**

The relationship between ‘age’ and ‘lateness’ is significant (χ² (8, n=2373) = 182.848, p=.000). The results show that those aged 9 were more likely to have their schools arrive late than any other age. These differences should be understood in an overall context of low rates of being late for zoo visits, with 29% (n=173) of those aged 9 arriving late at the uppermost extreme, followed by 14-year-olds (19%; n=12), 12-year-olds (14%; n=36), 10-year-olds (13%; n=24), 13-year-olds (11%; n=16), 8-year-olds (7%; n=52), 7-year-olds (7%; n=7), 11-year-olds (2%; n=6) and 15-year-olds (0%).

The relationship between ‘age’ and the school group-level variable ‘behaviour’ is significant (χ² (24, n=1705) = 306.014, p=.000). The results show that those aged 12, 13, 14 and 15 had the best behaviour (83%, 73%, 100% and 100% respectively). Those aged 7, 8, 9, 10 and 11 had the worst behaviour (59%, 53%, 56%, 46% and 41% respectively). Overall there was a general increase in the level of good behaviour as the children got older. Among those aged 7-11 however, rates of good behaviour and rates of bad behaviour tended to be similar, with bad behaviour being slightly more likely than good behaviour.

A one-way between subjects ANOVA was conducted to compare differences in pupils’ behaviour during zoo educational presentations as a function of age. The difference between ages on this

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⁶³ Levene statistic =2.813, p < 0.05 (Outcome suggests non-equal variances, however the variance ratio confirms assumption of homogeneity of variance, with Hartley’s Fmax=1.542 (n=1511))
dimension of behaviour is significant \( F(8, 1696) = 17.425, p=.000^{64} \) and there is a medium effect size \( \omega^2 = 0.072; \omega = 0.267 \).

The posthoc Games-Howell tests revealed significant differences on this measure for numerous age combinations \((p<0.05)\). Firstly, 7-year-olds had significantly worse behaviour scores than those aged 12-15 (mean difference = -1.671; -1.274; -2.354; -2.354 respectively). Eight-year-olds also had significantly worse behaviour levels than those aged 12-15 (mean difference = -1.467; -1.071; -2.150; -2.150 respectively). Nine-year-olds had significantly worse behaviour levels than those aged 12-15 (mean difference = -1.558; -1.161; -2.241; -2.241 respectively). In addition, 10-year-olds had significantly worse behaviour scores than 12-year-olds (mean difference = -1.218). Moreover, 11-year-olds had significantly worse behaviour than those aged 12, 14 and 15 (mean difference= 0.145; -1.828; -1.828 respectively). Conversely, 14-year-olds had significantly better behaviour scores than those aged 10-13 (mean difference = 1.901; 1.828; .683; 1.079 respectively), and 15-year-olds also had significantly higher behaviour levels than those aged 10-13 (mean difference = 1.901; 1.828; .683; 1.079 respectively). In sum, this pattern of results indicates that as children got older, their behaviour improved.

**The Role of Gender**

**Seeing Animals, Fun and Learning**

Zoos for seeing animals. There is no significant difference in the level of male versus female pupils' holding the perception that 'zoos are for seeing animals' in the pre-visit survey, according to the crosstabulations analysis \( \chi^2(1, n=2721) = 2.994, p=.084 \). However, the relationship between 'gender' and 'zoos are seeing' is significant in the post-visit survey data \( \chi^2(1, n=2689) = 6.519, p=.011 \). The results show that girls are slightly more likely to agree that zoos are for seeing animals than are boys. However, these differences should be considered in the overall context of high agreement that zoos are for seeing animals amongst both girls (86%) and boys (83%).

To further investigate any possible gender differences in the perception that 'zoos are for seeing animals', an independent 2-samples t-test was conducted. No significant gender differences were found in the pre-visit survey \( t(2682) = -1.728, p=.084^{65} \); effect size \( r=.033, d=.067 \). Post-visit, however, the results show that girls agreeing with the idea that zoos are for seeing animals with greater frequency (M=.863, SD=.344) than boys (M=.827, SD=.378). This difference is significant.

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64 Levene statistic = 136.126, \( p < 0.05 \) (Outcome suggests non-equal variances, however the variance ratio confirms assumption of homogeneity of variance, with Hartley's \( F_{max}=3.56 (n=1705) \))

65 Levene statistic = 11.876, \( p < 0.05 \) (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley's \( F_{max}= 1.108 (n=2721) \))
(t(2624) = -2.548, p=.011\textsuperscript{66}), but with a small effect size (r=.050; d=.100). Thus, girls were more likely to hold the view that ‘zoos are for seeing animals’ than boys after visiting the zoo.

**Zoos for fun.** As with the variable above, the pre-visit survey did not evince any significant differences between male and female pupils level of agreement with the idea that ‘zoos are for fun / enjoyment’ in the crosstabs analysis ($\chi^2(1, n=2721) = 3.076, p=.079$). Post-visit, however, the relationship between ‘gender’ and the perception that ‘zoos are for fun / enjoyment’ becomes statistically significant ($\chi^2(1, n=2689) = 4.425, p=.035$). The results show that girls were slightly more likely to agree that ‘zoos are for fun / enjoyment’ than boys. However, as with the view that zoos are for seeing animals discussed above, these differences should be considered in the overall context of a high level of agreement that ‘zoos are for fun / enjoyment’ for girls (81%) and boys (78%).

An independent 2-samples $t$-test was also conducted comparing male and female pupils’ mean levels of agreement with the idea that ‘zoos are for fun / enjoyment’. This $t$-test revealed no significant difference in the pre-visit survey results ($t(2719) = -1.754, p=.079$\textsuperscript{67}; effect size $r=.034$; $d=-.067$). However, the post-visit survey data show that girls were more likely to associate the zoo with ‘fun / enjoyment’ ($M=8.102, SD=3.92$), when compared to boys ($M=7.77, SD=4.16$). This difference was significant ($t(2687) = 2.105, p=.035$\textsuperscript{68}), though with a small effect size ($r=.041; d=-.081$). Thus, while this perception of zoos as ‘for fun / enjoyment’ increased across the entire sample, there was a greater increase in this perception for girls.

**Zoos for learning.** The relationship between the independent variable of ‘gender’ and the dependent variable indexing the perception that ‘zoos are for learning about animals’ in the pre-visit survey is significant: ($\chi^2(1, n=2721) = 3.892, p=.049$). The results show that girls were slightly more likely to agree that zoos are for learning about animals than boys. However, these differences should be considered in the overall context of a high level of agreement that ‘zoos are for learning about animals’ for girls (87%) and boys (84%).

The relationship between ‘gender’ and the perception that ‘zoos are for learning about animals’ in the post-visit survey is also significant: ($\chi^2(1, n=2689) = 6.449, p=.011$). The results show that girls were still more likely to agree that zoos are for learning about animals than boys, and we see an overall increase in the agreement in both girls (91%) and boys (88%) from the pre-visit survey.

An independent 2-samples $t$-test comparing samples means for gender differences in the view that ‘zoos are for learning about animals’ also shows that female respondents were more likely to hold

\textsuperscript{66} Levene statistic = 26.223, p < 0.05 (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley’s $F_{max}= 1.208 (n=2689)$)

\textsuperscript{67} Levene statistic = 12.279, p < 0.05 (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley’s $F_{max}= 1.082 (n=2721)$)

\textsuperscript{68} Levene statistic = 17.718, p < 0.05 (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley’s $F_{max}= 1.125 (n=2689)$)
this view in the pre-visit survey \((M=.869, SD=.337)\) than male respondents \((M=.843, SD=.364)\). This difference is significant \((t(2664) = -1.968, p=.049^{69})\), but with a small effect size \((r=.04; d=-.076)\).

As with the views that zoos are ‘fun’, an independent 2-samples \(t\)-test analyzing the post-visit survey data shows an overall increase in the perception that ‘zoos are for learning about animals’, but girls agree with this view with greater frequency \((M=.906, SD=.293)\) than boys \((M=.875, SD=.331)\). This difference is significant \((t(2599) = -2.532, p=.011^{70})\), though with a similarly small effect size \((r=.050; d=-.10)\).

**Scientific self-efficacy.** Gender is likewise not a significant factor in the level of scientific self-efficacy (perceived capability of understanding science) in evidence in the pre-visit \((\chi^2(4, n=363) = 5.760, p=.218)\) and post-visit survey data \((\chi^2(5, n=382) = 8.506, p=.130)\), based on crosstab analysis. Moreover, to assess any possible gender differences in scientific self-efficacy, an independent 2-samples \(t\)-test was conducted. This showed no difference between male and female pupils’ self-perception as capable of understanding science. Thus, there were no gender differences in scientific self-efficacy in either the pre-visit \((t(361) = -.717, p=.474^{71}; \text{effect size } r=.038; d=-.075)\) or post-visit survey results \((t(380) = -1.362, p=.174^{72}; \text{effect size } r=.070; d=-.140)\).

An independent 2-samples \(t\)-test conducted to compare the mean levels of learning for male and female pupils also showed no statistically significant differences \((t(2769) = 1.395, p=.163^{73}; \text{effect size } r=.027; d=.053)\). This finding of no gender difference on both the scientific self-efficacy and the learning measure is noteworthy given that other domains of science learning have been identified as having a potential cultural bias against female pupils\(^{74}\) Thus, girls making gains in scientific self-efficacy and scientific learning at an equal level with boys is in itself an important positive outcome.

**Annotated drawings.** The relationship between ‘gender’ and learning (annotated drawing data) is not significant \((\chi^2(2, n=2771) =2.212, p=.331)\).

**Conservation-related Variables**

**Zoos for conservation.** The relationship between ‘gender’ and the perception that ‘zoos are for saving animals from extinction’ in the pre-visit survey is significant: \((\chi^2(1, n=2721) = 15.940,\)

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\(^{69}\) Levene statistic = 15.606, \(p < 0.05\) (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm \(t\)-test assumption of homogeneity of variance; this assumption was confirmed by Hartley’s \(F_{\text{max}}= 1.166\) \((n=2721)\))

\(^{70}\) Levene statistic = 25.986, \(p < 0.05\) (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm \(t\)-test assumption of homogeneity of variance; this assumption was confirmed by Hartley’s \(F_{\text{max}}= 1.279\) \((n=2689)\))

\(^{71}\) Levene statistic = 2.459, \(p > 0.05\) (equal variances assumed)

\(^{72}\) Levene statistic = 3.241, \(p > 0.05\) (equal variances assumed)

\(^{73}\) Levene statistic = .999, \(p > 0.05\) (equal variances assumed)

\(^{74}\) http://www.open.ac.uk/invisible-witnesses/dissemination.htm
The results show that boys were slightly more likely to agree that zoos are for saving animals from extinction (61%) than girls (54%).

The relationship between 'gender' and the perception that 'zoos are for saving animals from extinction' in the post-visit survey is also significant ($\chi^2(1, n=2689) = 23.402, p=.000$). The results show that boys are still more likely to agree that zoos are for saving animals from extinction (66%) than girls (57%). Overall, the level of agreement that 'zoos are for saving animals from extinction' increased in both genders in comparison to the results in the pre-visit survey, but this aggregate agreement is still lower than that for the perception that zoos are for fun / enjoyment and for learning.

An independent 2-samples t-test was conducted to compare male and female pupils' mean levels of agreement with the idea that 'zoos are for saving animals from extinction'. The results of the pre-visit survey show that boys yielded significantly higher levels of agreement ($M=.611$, $SD=.488$) when compared with girls ($M=.535$, $SD=.499$). This difference is significant ($t(2714) = 4.006, p=.000$), but with a small effect size ($r=.077; d=.154$).

In the post-visit survey, the results of an independent 2-samples t-test shows that boys still yield significantly higher levels of agreement with the idea that 'zoos are for saving animals from extinction' ($M=.662$, $SD=.473$) when compared with girls ($M=.571$, $SD=.495$). This difference is significant ($t(2686) = 4.864, p=.000$), with a slightly larger though still small effect size ($r=.093; d=.188$). These results indicate that the zoo visit results in a significant increase in both genders' perception that zoos are for wildlife conservation, and also that boys have a significantly greater level of agreement with this idea than girls.

**Personal concern for conservation.** There is no significant difference between girls' and boys' levels of personal concern about species extinction evinced in the pre-visit ($\chi^2(2, n=325) = 4.708, p=.095$) or post-visit survey data ($\chi^2(2, n=337) = 4.296, p=.117$). An independent 2-samples t-test was also conducted to compare the mean levels of learning for gender as evidenced by a concern with species extinction. The results of the pre-visit survey show that there was no significant difference between the genders ($t(323) = .998, p=.319$; effect size $r=.055, d=.111$). The results of the post-visit survey show that there was no significant difference between the genders ($t(335) = 1.307, p=.192; r=.071; d=-.143$).

**Conservation self-efficacy.** There are similarly no gender differences in conservation self-efficacy as measured by respondents' feeling that they can do something about animal species going extinct.

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75 Levene statistic $= 52.838, p < 0.05$ (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley's $F_{max}$ = 1.046 (n=2721))

76 Levene statistic $= 86.273, p < 0.05$ (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley's $F_{max}$ = 1.097 (n=2689))

77 Levene statistic $= 1.728, p > 0.05$ (equal variances assumed)

78 Levene statistic $= 4.23, p > 0.05$ (equal variances assumed)
This finding of no significant gender differences applied to both the pre-visit ($\chi^2(2, n=323) = 3.674, p=.159$) and post-visit survey: ($\chi^2(2, n=336) = 0.113, p=.945$).

An independent 2-samples t-test comparing mean levels of conservation self-efficacy for male and female pupils also showed no gender difference in either the pre- or post-visit sample. Thus, there were no significant gender differences in either the pre-visit ($t(321) = 1.648, p=.100^{79}$; effect size $r=.100; d=.184$) or post-visit survey are also not significant ($t(334) = .284, p=.776^{80}$; effect size $r=.016; d=.031$).

### Satisfaction Variables

**Satisfaction with Zoo Education and Enjoyment.** There are no significant gender differences on either of the post-visit satisfaction measures. This finding of non-significance includes satisfaction with the zoo learning experience ($\chi^2(5, n=2386) = 7.144, p=.210$) and the general measure asking pupils whether they enjoyed their visit to the zoo ($\chi^2(2, n=1509) = 4.090, p=.129$). In comparing the mean levels of satisfaction with the zoo learning experience by gender, an independent 2-samples t-test also showed no significant differences in satisfaction amongst male and female pupils ($t(2384) = -1.841, p=.066^{81}$; $r=.038, d=-.075$). Likewise, an independent 2-samples t-test also showed no significant gender differences in the mean levels of self-reported enjoyment of the zoo visit by male and female pupils ($t(1391) = -1.400, p=.162^{82}; r=.037; d=.075$).

**Other Variables: Lateness and Behaviour**

**Lateness.** Furthermore, the relationship between ‘gender’ and the outcome of a school group being late for the zoo visit is not significant ($\chi^2 (1, n=2360) = .022, p=.881$). Likewise, gender does not predict any significant differences in behaviour, according to a crosstab analysis ($\chi^2 (3, n=1693) = 4.596, p=.204$). Indeed, an independent 2-samples t-test was conducted to compare differences in behaviour between boys and girls, with the result being no significant differences in behaviour by gender ($t(1686) = -1.661, p=.097^{83}$; effect size $r=.04; d=-.081$)

This finding of no gender differences in lateness or behaviour offers some reassurance that issues with lateness and behavioural problems are not disproportionately affecting the experience of either girls or boys.

### The Role of Multiple Deprivation

The variable of multiple deprivation was included in the analysis to assess whether this school level variable was a predictive factor in outcomes. This analysis begins with linear regressions

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79 Levene statistic = 0.35, $p > 0.05$ (equal variances assumed)
80 Levene statistic = 0.16, $p > 0.05$ (equal variances assumed)
81 Levene statistic = 1.181, $p > 0.05$ (equal variances assumed)
82 Levene statistic = 10.506, $p > 0.05$ (equal variances assumed)
83 Levene statistic = 6.574, $p < 0.05$ (Outcome suggests non-equal variances, therefore variance ratio calculated to confirm t-test assumption of homogeneity of variance; this assumption was confirmed by Hartley’s $F_{max} = 1.016 (n=1693)$)
evaluating the predictive power of different measures for multiple deprivation on key outcome variables. Overall, these linear regressions indicate that deprivation is indeed a significant factor in predicting learning and conservation-related outcomes; however the level of variance explained by this variable on its own is relatively low.

**Deprivation and Scientific Learning (annotated drawings)**

A linear regression analysis revealed that Index of Multiple Deprivation (IMD2007) scores were a significant predictor of changes in learning as measured by the annotate drawings (\(b = -0.003, p = .000\)), accounting for 0.6% of the variance (\(R^2\)) in changes in drawing (\(t(1) = -4.003, p = .000\); \(F(1, 2788) = 16.022, p = .000\)). There is a significant negative correlation between the raw Index of Multiple Deprivation scores and learning as evidenced by annotated drawings (\(r = -0.076, p = .000\)), indicating that as deprivation increased, learning decreased.

A linear regression analysis showed that Greater London area deprivation rankings were likewise a significant predictor of changes in annotated drawing results (\(b = 5.223, p = .000\)) accounting for 1.2% of the variance (\(R^2\)) in this outcome variable (\(t(1) = 5.454, p = .000\); \(F(1, 2522) = 29.745, p = .000\)). There is a significant positive correlation between London Deprivation Rank and learning as measured by the annotated drawings (\(r = 0.108, p = .000\)). As above, this result indicates that as deprivation decreased, learning increased. However, London Deprivation Ranking was a better predictor of learning outcomes than the raw Index of Multiple Deprivation score. This suggests that relative deprivation within the context of London is a more significant factor in learning outcomes than multiple deprivation overall.

A linear regression analysis indicated that England Deprivation Rank was a significant predictor of changes in drawing (\(b = 5.668, p = .000\)), accounting for 0.5% of the variance (\(R^2\)) in changes in drawing (\(t(1) = 3.810, p = .000\); \(F(1, 2788) = 14.518, p = .000\)). There is a significant positive correlation between England Deprivation Rank and learning as measured by the annotated drawing data (\(r = 0.072, p = .000\)), showing that as deprivation decreased, learning increased. However, relative deprivation within England as a whole was not as strong of a predictive factor as London-only rankings of deprivation.

**Deprivation and Conservation-related Variables**

**Zoos for conservation.** A linear regression analysis revealed that multiple deprivation scores were a significant predictor of pupils’ perception that ‘zoos are for saving animals from extinction’ in the pre-visit survey (\(b = 0.002, p = .001\)), accounting for 0.4% of the variance (\(R^2\)) in holding this perception (\(t(1) = 23.470, p = .001\); \(F(1, 2736) = 12.043, p = .001\)). There is a significant positive correlation between raw Index of Multiple Deprivation scores and the view that zoo serve a wildlife conservation function in the pre-visit survey (\(r = 0.066, p = .000\)). Thus, as deprivation increases, the likelihood of associating zoos with wildlife conservation also increases in the pre-visit survey.
A linear regression analysis revealed that overall deprivation status was a significant predictor of indicating that zoos are for wildlife conservation in the post-visit survey \((b=-.002, p=.001)\), accounting for 0.4% of the variance \((R^2)\) in indicating that zoos are for saving animals from extinction \((t(1) = 3.454, p=.001; F(1, 2703) = 11.929, p=.001)\). There is a significant positive correlation in the post-visit survey between raw IMD2007 scores and pupils’ perception of zoos as involved in wildlife conservation \((r=.066, p=.000)\). Thus, the same strength correlation between deprivation and associating zoos with wildlife conservation applied to both pre- and post-visit survey results.

A linear regression analysis revealed that London Deprivation Rank was a significant predictor of pupils perceiving that zoos are for saving animals from extinction in the pre-visit survey \((b=-2.613, p=.000)\), accounting for 0.6% of the variance \((R^2)\) in this perception \((t(1) = -3.718, p=.000; F(1, 2474) = 13.824, p=.000)\). There is a significant negative correlation in the pre-visit data between London Deprivation Rank and the view that ‘zoos are for saving animals from extinction’ \((r=-.075, p=.000)\). As above, this result indicates that as deprivation increases, pupils become more likely to associate the zoo with wildlife conservation within the pre-visit survey data.

A linear regression analysis showed that London Deprivation Rank was a significant predictor of pupils holding the view that ‘zoos are for saving animals from extinction’ in the post-visit survey \((b=-2.615, p=.000)\), accounting for 0.6% of the variance \((R^2)\) in pupils’ perception that zoos are for conservation \((t(1) = -3.736, p=.000; F(1, 2440) = 13.961, p=.000)\). There is a significant negative correlation between London Deprivation Rank and pupils associating the zoo with wildlife conservation in the post-visit survey as well \((r = -.075, p=.000)\).

A linear regression analysis indicated that England Deprivation Rank was also a significant predictor of the perception that zoos participate in wildlife conservation in the pre-visit survey data \((b=-3.589, p=.001)\), accounting for 0.4% of the variance \((R^2)\) in this outcome variable \((t(1) = -3.264, p=.001; F(1, 2736) = 10.656, p=.001)\). There is a significant negative correlation between England Deprivation Rank and the view that zoos contribute to wildlife conservation in the pre-visit survey \((r=-.062, p=.001)\). However, the predictive power of this correlation is slightly weaker than that of the London Deprivation Rank.

A linear regression analysis also showed that England Deprivation Rank was a significant predictor of pupils’ perceiving that zoos are for saving animals from extinction in the post-visit survey \((b=-3.205, p=.003)\), accounting for 0.3% of the variance \((R^2)\) in this outcome variable \((t(1) = -2.931, p=.003; F(1, 2703) = 8.593, p=.003)\). There is a significant negative correlation between England Deprivation Rank and the association of zoos with wildlife conservation in the post-visit survey \((r = -.056, p=.002)\); however, this correlation is weaker than that of the raw IMD2007 score and the London Deprivation Rank.

*Personal concern about conservation.* A linear regression analysis showed that IMD2007 scores were not a significant predictor of personal concern for species extinction in the pre-visit survey \((b=.003, p=.259)\), accounting for 0.4% of the variance \((R^2)\) in this outcome variable \((t(1) = 1.130,
A linear regression analysis indicated that IMD2007 scores were not a significant predictor of personal concern for species extinction in the post-visit survey either ($b=.002$, $p=.5$), accounting for just 0.1% of variance ($R^2$) in this outcome variable ($t(1) = .676$, $p=.5$; $F(1, 336) = .456$, $p=.5$). Moreover, the correlation between IMD2007 scores and personal concern about wildlife conservation is not significant in the post-visit survey either ($r=.037$, $p=.250$).

A linear regression analysis indicated that London Deprivation Rank was not a significant predictor of personal concern for species extinction in the pre-visit survey: ($b=-3.191$, $p=.263$), accounting for 0.4% of the variance ($R^2$) in this outcome variable: ($t(1) = -1.122$, $p=.263$; $F(1, 297) = 1.260$, $p=.263$. The correlation between London Deprivation Rank and personal concern about wildlife conservation is not significant in the pre-visit survey data ($r = -.065$, $p=.131$).

A linear regression analysis revealed that London Deprivation Rank was not a significant predictor of personal concern for species extinction in the post-visit survey either: ($b=-1.190$, $p=.664$), accounting for 0.1% of the variance ($R^2$) in this dependent variable ($t(1) = -.435$, $p=.664$; $F(1, 309) = .190$, $p=.664$). The correlation between London Deprivation Rank and personal concern for conservation is not significant in the post-visit survey ($r=-.025$, $p=.332$).

A linear regression analysis showed that England Deprivation Rank was not a significant predictor of personal concern for species extinction in the pre-visit survey: ($b=4.505$, $p=.297$), accounting for 0.3% of the variance ($R^2$) in this outcome variable ($t(1) = -1.044$, $p=.297$; $F(1, 324) = 1.090$, $p=.297$). The correlation between England Deprivation Rank and personal concern for conservation is not significant in the pre-visit survey ($r=-.058$, $p=.149$).

A linear regression analysis revealed that England Deprivation Rank was not a significant predictor of indicating personal concern for species extinction in the post-visit survey: ($b=-3.078$, $p=.462$), accounting for 0.2% of the variance ($R^2$) in indicating a personal concern with species extinction ($t(1) = -.737$, $p=.462$; $F(1, 336) = .543$, $p=.462$). The correlation between England Deprivation Rank and personal concern for conservation is not significant in the post-visit survey ($r=-.040$, $p=.231$).

Conservation self-efficacy. A linear regression analysis showed that IMD2007 scores were not a significant predictor of conservation self-efficacy (perceived ability to contribute to wildlife conservation) in the pre-visit survey: ($b=.002$, $p=.530$), accounting for only 0.1% of the variance ($R^2$) in this outcome variable ($t(1) = .628$, $p=.530$; $F(1, 322) = .395$, $p=.530$). The correlation between IMD2007 and conservation self-efficacy is not significant in the pre-visit survey ($r=.035$, $p=.265$).

A linear regression analysis indicated that multiple deprivation scores were not a significant predictor of perceived personal ability to combat extinction in the post-visit survey: ($b=.0042$, $p=.161$), accounting for 0.6% of the variance ($R^2$) in conservation self-efficacy ($t(1) = 1.405$, $p=.072$).
p=.161; \( F(1, 335) = 1.974, p=.161 \). The correlation between IMD2007 scores and conservation self-efficacy is not significant in the post-visit survey \((r=.077, p=.080)\).

A linear regression analysis revealed that London Deprivation Rank was not a significant predictor of perceived ability to combat extinction in the pre-visit survey: \((b=-3.492, p=.294)\), accounting for 0.4\% of the variance \((R^2)\) in conservation self-efficacy \((t(1) = -1.051, p=.294; F(1, 295) = 1.105, p=.294)\). The correlation between London Deprivation Rank and conservation self-efficacy is not significant pre-visit \((r=-.061, p=.147)\).

A linear regression analysis revealed that London Deprivation Rank was not a significant predictor of perceived personal ability to combat extinction in the post-visit survey: \((b=-3.802, p=.259)\), accounting for 0.4\% of the variance \((R^2)\) in conservation self-efficacy \((t(1) = -1.132, p=.259; F(1, 309) = 1.281, p=.259)\). The correlation between London Deprivation Rank and conservation self-efficacy is not significant post-visit \((r=-.064, p=.129)\).

A linear regression analysis showed that England Deprivation Rank was not a significant predictor of perceived personal ability to combat extinction in the pre-visit survey: \((b=-2.488, p=.620)\), accounting for 0.1\% of the variance \((R^2)\) in conservation self-efficacy \((t(1) = -.497, p=.620; F(1, 322) = .247, p=.620)\). The correlation between England Deprivation Rank and conservation self-efficacy is not significant in the pre-visit survey \((r=-.028, p=.310)\).

A linear regression analysis revealed that England Deprivation Rank was not a significant predictor of perceived personal ability to combat extinction in the post-visit survey: \((b=-6.964, p=.171)\), accounting for 0.6\% of the variance \((R^2)\) in conservation self-efficacy \((t(1) = -1.3731, p=.171; F(1, 335) = 1.885, p=.171)\). The correlation between England Deprivation Rank and conservation self-efficacy is not significant in the post-visit survey \((r=-.075, p=.085)\).

**Multiple Regression to Predict Learning Outcomes**

Multiple regression analysis was used to test if multiple deprivation (IMD2007 Score, London Deprivation Rank and England Deprivation Rank), 1st time-repeat visitor status, age, gender or visit type (self-guided versus education officer-led) significantly predicted changes in learning as measured by the annotated drawing results. The results of the multiple regression analysis showed that these seven predictors explained 2.1\% of the variance \((R^2)\) in changes in annotated drawing results \((F(7, 2359)=7.154, p=.000)\). It was found that age significantly predicted changes in annotated drawings \((\beta = -.031, p=.000)\): \(t(7) = -3.973, p=.000^{84}\), as did visit type \((\beta = .107, p=.000)\): \(t(7)=3.541, p=.000^{85}\)). There is a significant negative correlation between age and annotated drawing results \((r=-.102; p=.000 \text{ (SE } B=-.085))\) and a significant positive correlation between visit type and annotated drawing results \((r=.079, p=.000 \text{ (SE } B=.076))\).

\(^{84}\text{ VIF }= 1.096\)

\(^{85}\text{ VIF }= 1.110\)
There is a significant negative correlation between overall deprivation score (IMD2007) and annotated drawing results ($r=-.039$, $p=.030$); a significant positive correlation between London Deprivation Rank and annotated drawing results ($r=.06$, $p=.001$); and a significant positive correlation between England Deprivation Rank and annotated drawing results ($r=.067$, $p=.001$).

The overall deprivation score did not significantly predict changes in the annotated drawing results ($\beta=-.066$, $p=.154$), nor did the London rank deprivation score ($\beta=-.057$, $p=.543$). First-time versus repeat visitor status also did not significantly predict changes in the annotated drawing results ($\beta=.045$, $p=.216$). Similarly, gender did not significantly predict changes in drawing results ($\beta=.008$, $p=.779$).

**QUALITATIVE RESULTS**

**Positive Development in Drawings**

A key aim of the London Zoo Formal Learning programme is to promote enhanced scientific knowledge about animals and habitats. This section presents an analysis of pupils’ annotated drawings which were collected to identify any evidence of such learning.

As key sites for biodiversity and conservation, rainforest habitats are a particular emphasis in some of the educational presentations in the Formal Learning Programme at ZSL London Zoo, as well as in one key building within the zoo (The ‘Rainforest Life’ exhibition), which simulates the humidity of the rainforest with a biome containing a number of rainforest animals including sloths, monkeys and snakes. Educational presentations about rainforests are sometimes held in a room in this building just past the biome.

*Learning New Scientific Concepts.* An important form of positive change identified in pupils’ drawings was the acquisition of new scientific concepts for use in understanding rainforest animals and their habitats. The following example shows positive change following a zoo visit with an educational presentation. In the pre-visit drawing, a desert habitat is represented with snakes and cacti. In the post-visit drawing, a rainforest is depicted with important new scientific detail. Firstly, specific animal species are identified (viz., spider monkey and anaconda snake). Secondly, the respondent evinces a more differentiated scientific knowledge of the habitat by identifying the different layers of the rainforest in the post-visit drawing. The fact that rainforests are differentiated into layers (viz., “emergent layer”, “canopy”, “understory”, “forest floor”), which house different animal species was a key message communicated in the ‘South American Rainforest’ educational presentation this pupil attended during her zoo visit.
Figure 2: Increased differentiation and scientific understanding of animals and habitat (female, age 8)\(^{86}\)

This evidence shows that the pupil understood a central message from the zoo-based educational presentation regarding the diverse adaptations necessary for wildlife at different levels of the rainforest. Moreover, the combined impact of the presentation and her visit to the ‘Rainforest Life’ exhibit in the zoo were sufficient to shift the pupil’s selected ‘favourite wildlife habitat’ to the rainforest, while giving her new knowledge she could use to represent this habitat scientifically.

In the following example, there is a similar shift to words representing a rainforest habitat. However, this pupil’s starting point in terms of displayed knowledge of animals and habitats is relatively low. For example, the pre-visit drawing inaccurately represents a three-humped camel, with no explicit labeling of the animal or its desert habitat. There is a significant increase in labeling and coherent placement of animals within a habitat labeled ‘rainforest’ in the post-visit drawing indicating concomitant cognitive gains.

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\(^{86}\) EO250
Figure 3: Post-visit drawing shows improvement after South American Rainforest outreach presentation (female, age 9)\textsuperscript{87}

The post-visit drawing above represents rainforest animals with key physical characteristics such as the spots on the jaguar and snake and the placement of a monkey and a sloth ("sloph" in the drawing) in trees, as well as general aspects of the rainforest habitat (e.g. "big trees").

Enhancing Existing Knowledge

Some of the pupils’ drawings show that they already had an understanding of scientific concepts relating to animals and/or habitats prior to the zoo visit. In such cases, there was less scope for the zoo education to foster substantial further learning. Nevertheless, as can be seen in the following examples, new ideas introduced during the educational presentations were incorporated into pupils’ already good understanding of certain rainforest animals. Indeed, the following example displays scientific learning about the different levels of the rainforest habitat (as above). In this case, the pupil’s pre-visit drawing of a rainforest is maintained almost exactly in terms of the animals represented, but with the significant addition of the identification of the different layers of the rainforest.

\textsuperscript{87} OR99
Figure 4: Evidence of enhanced scientific knowledge about the rainforest habitat (female, age 8)\textsuperscript{88}

The pupil’s increased scientific knowledge of rainforest habitats is also evidenced by the statement in the post-visit drawing, “I drew rainforest levels”. Given that the pupil in the example above had attended an educational presentation on the topic of South American rainforests which communicated scientific information about the different rainforest layers, this is a particularly clear case showing learning that can be directly attributed to an education officer enhanced zoo visit (i.e., the pupil did not hold this knowledge before her visit to the zoo).

Increasing Accuracy of Habitat Representations

The following example of positive development in thinking about rainforests shows a shift from an inaccurate representation of a zebra and other animals in a “forest” habitat to an accurate representation of a bird and snake within a “rainforest” habitat. It is notable that this pupil attended the educational presentation ‘Deserts and Rainforests’ as part of her zoo visit.

\textsuperscript{88} EO251, Education officer-led zoo visit, State School, Y5, 25.7.09
Figure 5: Positive development in accuracy of pupil’s placement of animals in habitats (female, age 8)

Other Habitats

Although the rainforest habitat appeared frequently in pupils’ post-visit drawings, there was evidence of positive development in pupils’ understanding of other habitats such as deserts and forests. In the following example of positive change, there is a clear increase in detail and labeling in the post-visit drawing of a desert.

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89 Education Officer-led, 2.7.09_Y3-4_Desert and Rainforests_B1_Hot, sunny_EAL
Figure 6: Positive development in conceptual understanding following educational presentation on 'Desert and Rainforests' with a zoo visit (male, age 9) 

In addition to showing scientific and environmental learning, the post-visit drawing above also gives some clues about remaining lacunae in his understanding of the desert and the role existing cultural (as opposed to scientific) knowledge that he held upon entering the zoo. As sand dunes are not addressed by the educational presentation, this pupil attended, nor by the interpretation within the zoo, it is reasonable to infer that the representation of 'lumps' in the drawing indicates the pupils' memory of this environmental detail from popular culture. However, this feature remained unrefined by the education at the zoo, leaving his knowledge of this particular feature of desert habitats at the cultural and visual level (i.e. this detail was not developed or integrated into scientific or environmental knowledge). This example highlights that zoo-based education must always negotiate existing cultural representations of the natural world. Sometimes knowledge of these cultural representations supports the zoo's intended learning outcomes (as in this case); while other times it is a source of inaccuracies and therefore a barrier to learning to be overcome or transcended (e.g. see Wagoner & Jensen, 2010). Nevertheless, the main point of the zoo education message regarding the coherent placement of animals in habitats has clearly been understood.

In the following example, there is a substantial increase over the course of the pupil's zoo visit and accompanying educational presentation in the labelling of the 'woodland' habitat represented.

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Figure 7: Greater elaboration, labelling post-visit evincing positive change (female, age 9)

The pre-visit drawing above only presents two animals (a rabbit and bird); whereas the post-visit drawing includes a dragonfly, butterflies and a generic “insect”, as well as a pond with a frog, fish and duck and bird’s nest in the tree. In addition, there is evidence of a more sophisticated understanding of the environment in which these animals live, with the addition of “grass” in the post-visit drawing, the more detailed selection of an apple tree and the representation of a hole in the tree “for squirrels”. Thus, there is evidence of a substantial expansion of this nine-year-old pupil’s knowledge over the course of her visit to the ZSL London Zoo, which included an educational presentation on ‘Teeth and Diets’.

Another example of subtle positive development in pupils’ understanding of placement of animals within their indigenous habitats can be seen in the following drawings of kangaroos. While this pupil accurately places a kangaroo within a desert habitat in both pre- and post-visit drawings, the pre-visit drawing is unlabelled. In addition to this pupil’s adjustments to the relative size of the kangaroos’ ears and nose, the post-visit drawing includes the label in the bottom left hand corner “kangaroos in the desert”. This makes it clear that the pupil has anchored her understanding of the kangaroo to the more general concept of a desert habitat.

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92 E0736

93 This educational presentation is described on the ZSL website as follows: "Animal skulls and images are used to teach children about the function of teeth and the different foods animals eat" (http://www.zsl.org/education/schools/zsl-london-zoo-schools/primary-programme-at-zsl-london-zoo,189,AR.html).
Figure 8: Positive development in accuracy of pupil’s placement of animals in habitats
(female, age 9)94

Because the positive development in the drawings above is subtle, it is useful to seek further evidence from the thought-listing data. As can be seen in the table below, while the ‘before’ thoughts about the zoo are positive, the post-visit (‘after’) thoughts show an important shift.

Data Table 4: Positive development in thought-listing for ‘the zoo’ (female, age 9)

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Animals</td>
<td>1. Animals</td>
</tr>
<tr>
<td>2. Happy things</td>
<td>2. Habitats</td>
</tr>
<tr>
<td>3. Nice thoughts</td>
<td>3. Wildlife</td>
</tr>
<tr>
<td>4. Mothers and babies</td>
<td>4. Happy feelings</td>
</tr>
<tr>
<td>5. Nice things</td>
<td>5. Nice faces</td>
</tr>
</tbody>
</table>

Note: Emphasis added.

The set of post-visit thoughts maintained the use of phrases indicative of general positive affect (e.g., “happy things” before, “happy feelings” after), but the terms “habitats” and “wildlife” were

94 Education officer-led zoo visit, Church of England school_17.6.09_Y4_South American Rainforest_B2
added. This is indicative of a positive shift towards a ‘scientific learning’ frame in the pupil’s thinking about the zoo.

An important positive impact of zoo visits was the acquisition of new conceptual tools for understanding animals through scientific observation of the details of their natural surroundings. The following example of positive conceptual development begins in the pre-visit drawing with an accurate rendering of the animal itself (cheetah), but no evidence of understanding of the animal’s habitat. For example, the pupil’s label on the pre-visit drawing simply says “cheetah in its habitat” with the only habitat-related detail being the grass; also represented is what appears to be a doorway, suggesting a potentially problematic conception of the cheetah’s natural habitat prior to the zoo visit.

**Figure 9: Positive development in pupil’s understanding of habitat (male, age 9)**

The penguin habitat represented in the post-visit drawing has much more detail, including an appropriate food source (“fish to eat”) and the accurate identification of the penguin’s icy surroundings (“iceberg”) and adjoining environment (“sea”).

The pupil’s positive change is also visible in the thought-listing data, which showed the typical pattern of development from expressions of general positive affect (pre-visit) to the addition of (post-visit) thoughts associating ‘learning’ with the zoo.

**Table 5: Positive development towards associating ‘learning’ with ‘the zoo’ (male, age 9)**

<table>
<thead>
<tr>
<th>Before</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Good</td>
<td>2. Exciting</td>
</tr>
<tr>
<td>3. Funny</td>
<td></td>
</tr>
</tbody>
</table>
4. Happy
5. Smelly

| After | 1. Learning about animals
2. Visiting
3. Watching
4. Talking
5. Meeting |
|-------|----------------------------------|

Notably, this positive development towards ‘learning’ and ‘observation’-related associations with the zoo did not come at the expense of enjoyment. In the post-visit questionnaire, this pupil ticked ‘yes’ in answer to the question, “Have you had fun at the zoo today?”. He also circled the happiest face on the Likert scale item: “How was the London Zoo lesson today?”.

Another example of the pattern that increased learning was correlated with an increased perception of the zoo as ‘fun’ can be seen in the case of female pupil ‘Shaheen’ (age 10), who was visiting the zoo for the first time. Prior to the zoo visit, the words she associated with ‘the zoo’ were negative, believing the zoo would make her feel like she was not knowledgeable that the visit would be “no fun”.

Data Table 6: Positive development in pre- and post-visit thought listing for ‘the zoo’ (10-year-old female pupil)\(^95\)

| Before       | 1. That is *no fun*
2. That you *don’t know very much*
3. You can see all different animals |
|--------------|--------------------------------------------------|
| After        | 1. *Extra fun*
2. *Learning*
3. Good
4. *Saving Animals* |

NOTE: Emphasis added.

\(^95\) Education officer-led zoo visit, 8-6-09, Year 6, Session: Desert and Rain, Time: 12.00, Behaviour: ’2.5’
Sig. Weather: Overcast (lecture theatre cold), Late: NO, SEN: NO, EAL: NO
In the post-visit questionnaire, Shaheen had added a conservation dimension to her perception of the zoo (“saving animals”) as well as developing a substantially more positive view of the zoo, including viewing it as “extra fun” and a place for “learning”. It is noteworthy in the above example and indeed across this study that for these children the widespread stereotypic contrast between ‘learning’ and ‘fun/enjoyment’ did not apply within the zoo context. That is, post-visit questionnaires in particular frequently mentioned both education and enjoyment, suggesting that within the context of visiting the zoo these two functions of the zoo are coterminous.

These results suggest that associating the zoo with learning does not detract from pupils’ satisfaction and perception of the zoo as ‘fun’.

Enhancing Appreciation for Wildlife Biodiversity

Some of the positive developments evident in the drawing data did not correspond to an explicit educational aim of ZSL London Zoo, but are nevertheless important. One such example identified in the present study is appreciation for non-charismatic animals. There was clear evidence of pupils developing an appreciation for non-charismatic animals as an impact of the Formal Learning programme. That is, this study suggests that the longstanding view that certain animals, namely large mammals (‘mega fauna’) are immutably favoured by zoo visitors requires significant revision in order to account for the significant changes from pre-visit to post-visit data in the present study. Indeed, post-visit drawing data shows a marked shift towards the selection of non-charismatic animals as pupils’ ‘favourite’. The aggregated thought-listing data further develops this finding, with shifts in the animals listed from pre- to post-visit.

Thought-listing Results

This pattern can be seen first of all with invertebrates. In particular “bugs” of various kinds are not part of the set of ‘charismatic’ mega-fauna that zoo visitors are thought to favour. However, the present data suggests that appreciation for these animals can develop through zoo education and the experience of viewing such live animals in person. Combining both the plural and singular forms of the words Insect (n= 40), Butterfly (n= 30), Spider (n= 18), Bug (n= 16) and Ant (n= 2) the frequency count in the pre-visit thought-listing data is 106. Post-visit the combined total for Insect (n= 64), Butterfly (n= 57), Spider (n= 29), Bug (n= 54) and Ant (n= 0) comes to 204. Thus, the aggregate salience of these invertebrate species and categories nearly double from pre- to post-visit in the thought-listing survey results.

Given the large increase in the salience of butterflies evident in these data, the butterfly house at ZSL London Zoo seems to be having a positive impact on appreciation for these animals. However, the increase in the concept of ‘insects’ suggests a broader development in appreciation of invertebrates, going well beyond butterflies. Indeed, the fact that ‘spider’ also showed an increase in mentions shows that even those animal species that are demonised within much popular culture became more prevalent in pupils’ thoughts post-visit. Interestingly however, the one of these animals that does not appear in the zoo- the ant- suffered a reduction in salience from 2 to 0.
This finding suggests that the combination of viewing live animals and active zoo education yields the best results in terms of fostering greater appreciation for biodiversity.

Annotated Drawing Results

In addition to evidence from the thought-listing data, a shift was visible in the selected ‘favourite’ animals in the annotated drawing data towards non-charismatic animals.

Outreach results. The outreach zoo education presentations in schools were particularly effective at fostering interest in and positive affect towards cockroaches. Such outreach presentations include two or three live animals, one of whom is usually a Madagascan hissing cockroach (pictured below).

Figure 10: Madagascan hissing cockroach used in 'outreach' educational presentations

![Madagascan hissing cockroach](image)

Note: Photo courtesy of ZSL: [http://www.zsl.org/zsl-london-zoo/animals/inverts/hissing-cockroach,57,AN.html](http://www.zsl.org/zsl-london-zoo/animals/inverts/hissing-cockroach,57,AN.html)

Given the widespread negative perceptions of cockroaches within British and more generally Western cultural representations, fostering appreciation for these animals is a remarkable achievement, which the outreach presentations on a regular basis.

In the following example, a pupil’s pre-visit selection of a polar bear (a charismatic mammal) as favourite is changed to a cockroach in the post-visit drawing⁹⁶.

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⁹⁶ Or5
Figure 11: Favourite animal shifts from charismatic animal (polar bear) to cockroach (male, age 15)\textsuperscript{1}

The post-visit drawing is labeled ‘Charlie the cockroach’ (above - Male, age 15). This reflects the name given to the cockroaches presented to pupils during both outreach and in-zoo educational presentations by the Formal Learning team at ZSL London Zoo. In presentations featuring the cockroaches, the pupils are usually able to gently stroke the cockroach, which may contribute to the memorability of this animal for pupils.

Indeed, the strong pattern of increased appreciation for a wider range of animal taxa may be the strongest evidence to date of the value of including touch within educational presentations. Unfortunately in the case above the pupil’s shift to favour the cockroach over the polar bear also came with a decrease in detail about the animal’s natural surroundings. As such, despite the positive change of developing interest in a non-charismatic animal species, this case was coded as ‘negative change’ with the content analysis of the annotated drawing data. This pattern of declining attention to the surrounding environment after outreach visits is further explored in the ‘Negative Change’ section.

In contrast to the example above, the following drawings indicating a pupil favouring a cockroach in the post-visit data comes with an increase in detail in the form of the label ‘cockroach’ in the post-visit drawing; whereas the pre-visit drawing was unlabeled. Thus, this pair of drawings was coded as positive change in the content analysis.

\textsuperscript{1} Or5
Nevertheless, there is still a lack of evidence of the development of knowledge about the cockroach’s natural environment in the post-visit drawing (female, age 13).99

The following example is very similar with a shift from an unlabeled mammal in the pre-visit drawing (clearly a lion though) shifting to a labeled drawing of a cockroach in the post-visit drawing (female, age 13), which likewise lacks environmental detail.

Thus, this pupil was influenced by the outreach educational presentation to favour a cockroach over a quintessentially charismatic mammal (lion).

This shift from representing a large cat to a cockroach following an outreach presentation at the pupil’s school can also be seen in the following example (female, age 13).

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98 Or24
99 Or24
100 Or16
Figure 14: Pupil's favourite animal shifts from large cat to cockroach as favourite animal (female, age 13)\textsuperscript{1}

The post-visit drawing above shows a detailed recall of the physical characteristics of the Madagascan hissing cockroach that the pupil saw live in her school the day before. Again however, there is no detail about the cockroach’s habitat.

While the zoo outreach presentations were effective at promoting interest in specific non-charismatic animal species, as can be seen in the examples above this gain came at the expense of pupils providing detail about the habitat of these animals. It would be reasonable to hypothesize that the lack of cues about an animal’s habitat in schools-based zoo education accounts for the decrement in focus and detail on habitats in the outreach drawing data. Although not all of ZSL London Zoo’s exhibits have been fully transitioned into contemporary naturalistic enclosures, there are significantly more clues to an animal’s habitat available to visitors at the zoo when compared to a classroom setting. Indeed the appearance of animals in such a clearly ‘out of context’ setting may be a steep pedagogical barrier for zoo outreach programmes to overcome.

Zoo visit results. This impact of greater appreciation for non-charismatic animals was far more prevalent amongst those pupils who had had an educational presentation, whether at the zoo or in their school from an outreach officer. The following example is from a pupil who attended the educational presentation on ‘South American Rainforests’ during a zoo visit. In this case the pupil began by representing one of the typical charismatic favourites, a lion.
Figure 15: Pupil develops greater appreciation for non-charismatic animal (male, age 8)\textsuperscript{101}

![Before and After drawings](image)

Post-visit, the pupil’s favourite animal is a fish. While the lion is a large mammal typically identified as popular with visitors\textsuperscript{102}, the fish is not. Thus, this shift in the pupil’s selected favourite is noteworthy in that it diverges from the findings of previous zoo studies.

This pattern can also be seen in the following example in which the pupil’s pre-visit selection of a quintessentially charismatic mammal (polar bear) shifts to two insects in the post-visit drawing: a spider represented on a web and a worm.

Figure 16: Development of appreciation for non-charismatic animal (female, age 8)

![Before and After drawings](image)

\textsuperscript{101} Church of England school_17.6.09_Y4_SA Rainforest_B2

Such expansion in pupils’ animal preferences may be one of the most important benefits of a zoo visit, given that interest in non-charismatic, non-mammalian species is necessary for the development of an accurate understanding of the rich diversity of interconnected living species. Indeed, widening the range of ‘interesting’ species in this manner through zoo education could also support the development of appreciation for the keystone concept of biodiversity.

**Prior Research on Species Preferences**

Prior research has indicated that taxonomic group is a significant determinant of visitor interest, as measured by ‘stopping time’ (Moss & Esson, 2010 & Bitgood 1988). Based on a large-scale visitor tracking study at Chester Zoo ($n = 1863$), Moss and Esson (2010) found:

Mammals in particular appear to be of most interest to visitors, relative to the other taxonomic groups. [...] Only mammals achieve both positive attracting power and holding time scores. Amphibians and, to a lesser extent, fish have above average attracting powers, but holding time is below average for all the other groups.

In addition to taxonomic group, the size of an animal has been identified as an important factor in visitor interest (Hosey, Melfi & Pankhurst 2009, p. 477). The present study finds support for Moss and Esson’s conclusions in the pre-visit data. However, there is an important shift in animal preferences over the course of the zoo visit in the present data that has not been identified in prior research, which has assumed that such preferences are static. This process of development in animal preferences suggests that Moss and Esson’s (2010, p. 15) concern that zoos are promoting mammal-centric visitor expectations may be unfounded as long as access to non-mammalian species is provided within zoos. Indeed, the present study suggests that as visitors’ openness to becoming interested in species from non-mammalian taxonomic groups may be robust to zoos’ mammal-centric marketing. In terms of zoo education, a key implication of this finding is that the combination of zoo-based education and the opportunity to view animals ‘live and in person’ can change pupils’ perceptions and foster affinity for non-charismatic animal species.

**Unintended Ancillary Impacts**

One interesting example of an unintended positive impact of a zoo outreach visit for a female respondent was a shift in gender coding of the ‘zoo keeper’ role. This example was coded as ‘negative’ because it showed a reduction in scientific labelling and connections to habitats. However, there was a positive dimension. In addition to fostering appreciation for the cockroach

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(indicated by its appearance in the post-visit drawing), the fact that the current ZSL outreach officers are female appears to have had an impact on this male adolescent pupil who has changed the gender of the zoo keeper in his drawing from male to female (indicated symbolically by changing the keeper's cap to a bow).

**Figure 17: Adolescent pupil shows increased appreciation for cockroach and shifts gender coding of zoo keeper (male, age 15)**

![Before and After drawings](image)

This shift in the gender coding of the zoo keeper profession is indicative of the potential of the ZSL London Zoo educational presentations to deliver positive impacts that were not intended or anticipated.

Yet at the same time, the lack of integration of new knowledge about a specific animal (cockroach) with the wider concepts of habitats and adaptations raises the concern that outreach sessions are not successfully making the link between viewing live animals in their classroom and the more abstract notion of its natural habitat far away in the wild.
No Change in Drawings

For 48% of pupils, the drawing data showed no evidence of significant change in their understanding of animals and habitats. Examples of drawings coded as ‘no change’ include the following paired drawings.

Figure 18: Drawings show no evidence of significant change in representations of animals or habitats (female, age 11)

Although there were some small changes such as the addition of a flower and some increased definition to the bird, these drawings do not merit the conclusion that learning had occurred\textsuperscript{106}.

The following example was also coded as ‘no change’. In this example, the ‘before’ drawing inaccurately has penguins and husky dogs and polar bears living alongside each other in the arctic; however, drawing correctly associates these animals with a cold, snowy climate.

\textsuperscript{106}Sg350
Figure 19: No significant development in boy’s pre- to post-visit drawings (age 11)\textsuperscript{107}

The same features are evident in the post-visit drawings, indicating no new learning on this evaluation measure. In particular, the same mistaken linkage of penguins and polar bears can be seen and there is no evidence of further knowledge gains related to habitat.

A similar pattern of ‘no change’ can be seen in the following pair of drawings from a female pupil, age 11\textsuperscript{108}.

\textsuperscript{107}Education Officer-led Zoo Visit, 8-6-09, Year 6, Session: Desert and Rain, Time: 12.00, Behaviour: ’2.5’, Sig. Weather:, Overcast (lecture theatre cold), Late: NO, SEN: NO, EAL: NO.
\textsuperscript{108}Education Officer-led Zoo Visit, 8-6-09, Year 6, Session: Desert and Rain, Time: 12.00, Behaviour: ’2.5’, Sig. Weather:, Overcast (lecture theatre cold), Late: NO, SEN: NO, EAL: NO.
Figure 20: Equivalent accuracy in pre- and post-visit drawings of forest and desert (female, age 11)

The drawing above accurately depicts animals that reside in or transit through forest habitats. Post-visit, this respondent maintained a similarly accurate representation of the animals.

The following drawings are even more obviously similar, with the pupil drawing almost an identical scene of a giraffe grazing in the pre- and post-visit questionnaires.

Figure 21: Pupil’s drawings show ‘no change’ in representation of ‘favourite animal where it lives in the wild’ (female, age 14)
There is slightly more detail in the description in the post-visit questionnaire, with the giraffe described as “eating a tree” and large ears in the pre-visit annotated drawing become more accurate antlers in the post-visit drawings. However, these small changes were not deemed to be sufficiently substantial to warrant a coding of ‘positive change’ on this measure of learning from the education officer-led zoo visit this pupil attended.

Arguably the most problematic form of annotated drawing data coded as ‘no change’ is when pupils did not develop a coherent understanding of habitats. The following example presents a range of individual animal species accurately, but fails to integrate this knowledge with an understanding of where they live in the wild.

**Figure 22: No significant changes from pre- to post-visit drawing (female, age 13)**

Thus, although this pupil (above) added a new animal to her post-visit drawing, there is still no coherence in terms of the placement of these animals within their correct wildlife habitats. As there were also no significant improvements in the accuracy or elaboration of the animals drawn, this pair of surveys was coded as 'no change'. Despite the lack of visible change in this pupil’s drawings however, there was some small evidence of impact in her thought-listing data. Prior to the visit (which was her first ever visit to a zoo), the pupil used the general terms ‘animals’ and ‘plants’ amongst others. After the visit, specific kinds of animal were mentioned.

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109 Self-guided_24.6.09_(Year 8)
Table 7: Increased elaboration in pupil’s thought-listing data (female, age 13)

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Animals</td>
<td>1. The monkeys</td>
</tr>
<tr>
<td>2. Trees</td>
<td>2. The birds</td>
</tr>
<tr>
<td>3. Plants</td>
<td>3. The fishes</td>
</tr>
<tr>
<td>4. Fun</td>
<td>4. The gorillas</td>
</tr>
<tr>
<td>5. Activities</td>
<td>5. The llamas</td>
</tr>
</tbody>
</table>

This shift from general to specific may be an indicator of increased elaboration in this pupil’s thinking about animals, despite the lack of change in the drawings. In addition, the pupil switched from ticking ‘not sure’ on the two secondary-only conservation-related questions (‘do you feel personally concerned about species going extinct?’ and ‘do you feel there is anything you can do about animal extinction?’) in the pre-visit survey to ticking ‘yes’ for both of these questions in the post-visit survey. This shift in conservation attitudes offers another indication of positive impact despite the lack of improvement on the drawing measure, thereby reinforcing the importance of employing a triangulated methodological approach of this kind in order to gain a full picture of educational impact.

**Negative Change in Drawings**

In a minority of case (just under 13%), pupils’ annotated drawings evinced a negative change from the pre- to the post-visit data collection points. These negative changes took three forms: Knowledge decrement, knowledge conflation and representations of animals in captivity. These negative developments in pupils’ thinking are important for zoo educators to understand in order to develop pedagogical mechanisms for counteracting their emergence.

*Knowledge Decrement*

Straightforward reductions in pupils' knowledge about animals and habitats were exceedingly rare in the present sample. However, there were a few examples of pupils drawing more elaborate
representations before their zoo visit. The following drawings\(^{110}\) by a pupil attending the zoo for a self-guided visit are an example of knowledge decrement from pre- to post-visit.

**Figure 23: Negative change in level of detail and scientific knowledge displayed**

(male, age 13)

In the pre-visit drawing above, there is a lot of detail including labeling whereas in the second image there is no labeling at all. As with the drawings above, the following example was also coded as ‘negative change’ in the content analysis of the drawing data. In this case, the pre-visit drawing identifies the habitat and accurately places animals within that habitat.

\(^{110}\) SG 140
While the post-visit drawing accurately depicts forest animals (the respondent’s selected habitat for Form 2), there is less detailed labelling of the animals, which indicates a less detailed and scientific understanding of them. There is also a less detailed elaboration of the relevant habitat, when compared with the pre-visit drawing, which includes “sun”, “tree”, “sand” and “bush” in the drawing of “savannah land”.

Before seeking to identify possible reasons for this decrement in the quality of knowledge displayed in the drawings, it is first worth noting that there is some counter-evidence suggesting positive educational impact for this pupil. Namely, there is an increase in scientific self-efficacy, from the pre-visit questionnaire in which the pupil selected ‘2’ (agree) for the statement “I feel I can understand science” to a ‘1’ (strongly agree). Also, on the pre-visit questionnaire, she did not select any of the zoo functions for the ‘Zoos are for...’ item; whereas, post-visit she selected ‘Zoos are for learning about animals’.

Nevertheless, this pupil’s learning was clearly not fully developed during this visit. One possible explanation can be seen in the thought-listing data. These data indicate that the pupil's pre-visit orientation towards the zoo visit was primarily entertainment-oriented (3. “day out”, 4. “shoes” and 5. “gift shop”) and attuned to the means by which animals are held in captivity at the zoo (2. “cages”). The post-visit thought-listing data evinced dissatisfaction with the entertainment or touristic dimension of the visit (1. “the shop was so expensive”) and a focus on practical concerns (2. “busy”, 4. “toilets”), although “learning” was listed as the 5th thought associated with the zoo

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111 Year 2, 10.7.09 (KM1)
post-visit. Lines 2. and 4. in the post-visit thought-listing data are indicative of the principle that both expectations and practical difficulties can impinge on learning outcomes.

**De-Contextualizing of Animals**

A form of knowledge decrement that emerged initially in the context of the qualitative results showing the zoo outreach presentation’s effectiveness in fostering interest in non-charismatic animals is the decline in pupils’ attention to animals’ environmental context. One example of this negative pattern of de-contextualization can be seen in the drawings below. Here an initially context-sensitive representation of animals in a rainforest shifts to a de-contextualized scene remembered directly from an outreach presentation. Specifically, the post-visit drawing shows a ferret that features in outreach presentations, with the trail of food the ferret is provided at a couple of points in the presentation.

**Figure 25: De-contextualisation in pupil’s perception of animals and habitats**

![BEFORE](image1.png) ![AFTER](image2.png)

The kind of de-contextualization seen in the example above must be considered a wholly negative outcome given that the ferret is not a ‘non-charismatic’ animal and the way in which it is fed within the zoo outreach presentation is not representative of its behaviour in the wild. It is possible that such negative outcomes may be inescapable given that live animals are appearing in such an obviously de-contextualized setting when they arrive at a school classroom or assembly hall. This may simply be too large of a barrier to overcome for even the most effectively designed outreach presentations. However, when outreach presentations feature predominately non-charismatic animals, as in the case of the Madagascan cockroach, there is a clear positive change that may offset the negative impact of de-contextualisation. The other response available to zoo outreach officers is to find ways to enhance environmental cues within the strictures of the school setting. This could involve video footage of the live animals’ natural environment, ideally accompanied by animal sounds. A video clip of the animal in its natural habitat could be particularly useful as a countervailing force to the inherent de-contextualization of presenting animals out of context and without the benefit of naturalistic zoo enclosure design. If such additional cues are vivid enough, outreach officers may stand a better chance of successfully
facilitating children’s understanding of the link between the particular animal in front of them, the species as a whole and the natural habitats for that species.

**Knowledge Conflation**

Another form of negative development in pupils’ understanding was the inaccurate placement of newly encountered (and already known) animals within the same wildlife habitat in their post-visit annotated drawing.

One aspect of this pattern was for children to have an existing ‘favourite’ wildlife scene or animal—which they represented in the pre-visit survey—and then in the post-visit survey to add an animal they had encountered at the zoo to that same scene. In the following example, the pupil’s accurate pre-visit drawing of a rainforest populated with a monkey and a snake is supplemented with the image of lion (an animal not indigenous to the rainforest) in the post-visit drawing.

**Figure 26: Knowledge conflation in pupil's understanding of rainforest animals during self-guided zoo visit (female, age 13)**

Despite the fact that the addition of the lion makes the drawing inaccurate, other measures on this self-guided pupil’s surveys suggested positive developments. For example, on the Likert scale question ‘I feel I can understand science’, ‘Helen’ initially (pre-visit) indicated that she ‘strongly disagreed’ with this statement; whereas, in the post-visit survey she ‘strongly agreed with the statement’. Thus, despite the negative pattern of knowledge conflation in Helen's drawings, there is also evidence of positive educational impact from the zoo visit overall.

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112 Rook and Heath College_24.6.09_SG(Y8)
This pattern of knowledge conflation illustrates the principle that the development of human knowledge is always cumulative. As such, new ideas sparked by observations at the zoo must be integrated with existing ideas in pupils’ minds. It is possible for this process to completely displace certain misconceptions about animals and their habitats, as seen in the ‘positive change’ examples given previously. However, if the scaffolding for guiding children’s interpretation of new stimuli encountered at the zoo is insufficient, then it is not surprising that knowledge conflation would occur. That is, pupils that have not been equipped with the relevant conceptual tools for making sense of stimuli within the zoo will be more likely to evince sub-optimal or negative learning outcomes such as knowledge conflation.

**General Negative Experiences (Deviant Case Analysis)**

Given the large sample for this study, there are a number of examples of respondents’ whose perceptions of the zoo experience deviated strongly from the overall patterns identified above. Rather than dismiss these examples as statistically insignificant, it is important to consider them and what lessons can be gleaned from them.

In the following example, the respondent clearly had a negative experience at the zoo. She was disappointed at not seeing some specific species and she shifted from having identified the zoo with both enjoyment and learning to only identifying it with learning. Development of negative perceptions of the zoo as lacking certain species was the focus of this pupil’s negative framing of her visit in the post-visit thought-listing data.

**Data Table 8: Negative zoo experience – thought-listing data (male, age 9)**[^113]

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is big</td>
<td>1. Little bitty animals</td>
</tr>
<tr>
<td>2. Is noisy</td>
<td>2. Stinky places</td>
</tr>
<tr>
<td>3. Amazing</td>
<td>3. No tigers</td>
</tr>
<tr>
<td>4. Fun</td>
<td>4. No cows</td>
</tr>
<tr>
<td>5. Great</td>
<td>5. No sheeps</td>
</tr>
</tbody>
</table>

[^113]: 8.7.09_Des and Rain_Y4_Behavior1
In addition to the negative change visible in the thought-listing data, this pupil also shifted from indicating her agreement that zoos are for "fun", "learning about animals" and "seeing animals" pre-visit to only ticking "learning about animals" post-visit. Moreover on the post-visit questionnaire, he ticked "No" for the question “Have you had fun at the zoo today?” and circled the least happy face on the Likert scale for the question “How was the London Zoo lesson today?”. All of these indicators show that this pupil had a negative experience, which may stem from the pupil’s expectations which were not met because of the lack of very large mammals at ZSL London Zoo ('little bitty animals') and specific farm animals.

**Representing Animal Captivity**

For the small minority of drawings evincing a negative change from pre- to post-visit, a recurring problem was a shift from representing animals in a natural environment to representing them within a captive (viz., zoo or aquarium) environment. Such problematic shifts may indicate that bioethical concern about holding animals in captivity has displaced learning for these pupils. Indeed, this form of negative development implicates at the crucial juncture between the direct experience of viewing animals within the zoo and the much more abstract concepts of nature, habitats and animal behaviour in the wild. As such, this phenomenon of post-visit representations of captivity deserves idiographic exploration despite the relative scarcity with which it appeared in the present data.

Within this pattern, the zoo environment represented was disproportionately from the small aquarium within ZSL London Zoo. The following extract\(^\text{114}\) exemplifies this pedagogically negative shift, starting with a relatively accurate representation of animals in the wild (although this representation is not fully accurate given that a male lion is shown rather than the hunting lioness, probably because a maned lion is iconic of lions in general).

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\(^{114}\) Education Officer-led Zoo Visit, 8-6-09, Year 6, Session: Desert and Rainforests, Time: 12.00, Behaviour: '2.5', Sig, Weather: Overcast (lecture theatre cold), Late: NO, SEN: NO, EAL: NO.
Figure 27: Female pupil’s problematic development from wild to captive representation in pre- and post-visit drawing of animals (age 11)\textsuperscript{115}

![Before and After drawings of a female pupil's representation of animals](image)

The new representation in the post-visit annotated drawing above was of sea life, but problematically the marine animals were represented in an aquarium (“fish tank”). Yet, there is still evidence of learning in the post-visit drawing, with a relatively elaborated drawing of stingrays and seaweed represented as part of the marine animals' habitat. This learning despite a problematic development can reasonably be attributed to the cues offered by the inclusion of seaweed and coral in the zoo’s aquarium displays.

While this is an important form of ‘negative change’ in pupils’ drawings, it is important to acknowledge that a representation of captive animals is not always negative in terms of pupils' learning. In the following example, the pupil's animal representation is elaborated in the post-visit drawing, thereby evincing a gain in knowledge, even though it is based on ego-centric framing of the scene depicted as “me taking a photo of a lion eating meat”\textsuperscript{116}.

\textsuperscript{115} Education Officer-led Zoo Visit, 8-6-09, Year 6, Session: Desert and Rainforests, Time: 12.00, Behaviour: '2.5', Sig. Weather: Overcast (lecture theatre cold), Late: NO, SEN: NO, EAL: NO.

\textsuperscript{116} Year 7, 10.7.09 (KM25)
This post-visit annotated drawing (above) is based on what the pupil saw in the zoo ("lion eating meat") during her school group’s self-guided visit. The drawing includes important physiological details about the lion such as its teeth and mane. This example is indicative of the general principle that children can still positively develop their learning about aspects of animal species and their habitats while at the zoo even when they do not fully connect zoo animals with their wild counterparts. However, such problematic examples also demonstrate the importance of zoo interpretation and education designed to assist visitors in making the connection between the concrete experience of viewing particular animals in the zoo and the more abstract concept of the species’ larger existence in the wild. This connection is necessary for a more coherent of animals in context.

**Ethical Concern**

The open-ended items in the present survey yielded some unprompted data about children’s perceptions of keeping animals in captivity in zoos, indicating possible ethical concern on their part about this practice. One strong indicator of this concern was the high frequency of “cages” \((n = 299)\) as a response in the pre-visit thought listing data. Interestingly, pupils’ ethical concerns tended to undergo change from the pre- to the post-visit data collection. For example, in the post-visit thought-listing data, the frequency of “cages” declined all the way to 0. A better measure of the development of pupils’ thinking about animal cages and captivity is to aggregate a number of related words. In this case aggregating “cage” \((n=47)\), “cages” \((n=299)\), “caged” \((n=3)\), “captivity” \((n=13)\) and “enclosed” \((n=3)\) showed that a total of 365 instances of such words pre-visit reduced to a total frequency count of just 32 for these same words in the post-visit thought-listing data (“cage” \((n=22)\), “cages” \((n=0)\), caged \((n=3)\), “captivity” \((n=7)\) and “enclosed” \((n=0)\)).
This clear general pattern of declining ethical concern over the course of the zoo visit can also be seen in the annotated drawing data.

In the following drawings, the female pupil\textsuperscript{117} (age 11) initially drew an animal inside a cage in a manner evoking a prison scene (e.g. with the “monkey” holding the bars of the cage), while indicating that the words she associated with the zoo were “animals”, “cages”, “food”, “snack bar” and “pool with dolphins”.

**Figure 29: Pre-visit drawing of caged monkey (female, ‘Fatima’ age 11)**

The post-visit drawing and ‘words’ section (below) evince the abandonment of this prior negative perception of zoos, which had constricted the pupil’s pre-visit representation of animals in the wild.

\textsuperscript{117} Education Officer-led Zoo Visit, 8-6-09, Year 6, Session: Desert and Rainforests, Time: 12.00, Behaviour: ‘2.5’, Sig, Weather: Overcast (lecture theatre cold), Late: NO, SEN: NO, EAL: NO.
Figure 30: Post-visit survey showing decline in ethical concern after zoo visit and ‘Deserts and Rainforests’ educational presentation (female, 'Fatima' age 11)

In the above extract, it is clear that the pupil’s observations within the zoo (e.g. “peaceful animals”, “nature”) caused her to change her prior association of zoos with ‘cages’. Moreover, this positive experience has had a mood enhancement impact for this pupil, which is evident in her post-visit listed thoughts, “peace” and “happy”.

Below is another example of this pattern of transformation from problematic drawings of animals in cages towards more positive representations of animals in the wild.
Figure 31: Positive development from pupil’s initial (pre-visit) problematic representation of a tiger in a cage.

The pre-visit drawing above is labelled “a tiger lives in a cage” (corrected version). However, this pupil\(^\text{118}\) clearly had a positive experience in the zoo, which helped to change his problematic animal representation. This can be seen further in the shift from his limited pre-visit response to the question ‘what do you think of when you think of the zoo?’, in which he merely writes in passive voice “there will be lots of animals”.

Data Table 9: Positive development in pre- and post-visit thought listing about ‘the zoo’ (male, age 8)\(^\text{119}\)

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. There will be lots of animals.</td>
<td>1. I want to go back and stay there for long.</td>
</tr>
<tr>
<td></td>
<td>2. It’s so much fun.</td>
</tr>
<tr>
<td></td>
<td>3. I saw so many animals.</td>
</tr>
</tbody>
</table>

\(^{118}\) Education officer-led_2.7.09_Y3-4_Desert and Rainforests_B1_Hot, sunny_EAL

\(^{119}\) Education officer-led_2.7.09_Y3-4_Desert and Rainforests_B1_Hot, sunny_EAL
The post-visit thought list, written in first person (active) voice, communicates the pupils' enthusiasm ("It's so much fun") at having viewed "so many animals".

Such evidence of positive change in perceptions of animals in captivity can also be seen in the following drawing data from a first time visitor to the zoo. In the drawings below, a pre-visit representation of a lion in a cage shifts to a post-visit representation of a gorilla or monkey in the wild.

**Figure 32: Shift from representing animal in captivity to showing animal in wild (male, age 9)**

The thought-listing data offers evidence that the development in the Figure above can be attributed to learning during the zoo visit. Namely, in the post-visit thought-listing data "learning more" and "seeing animals in person" indicate that the zoo experience was perceived as a positive learning experience by this pupil (see Data Table below).

**Data Table 10: Addition of 'learning' in pupil's thought-listing data (male, age 9)**

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Lions</td>
<td></td>
</tr>
<tr>
<td>3. Tigers</td>
<td></td>
</tr>
<tr>
<td>4. Elephants</td>
<td></td>
</tr>
</tbody>
</table>

\[120\] Church of England_Education officer-led_17.6.09_Y4_South American Rainforest_B2
\[121\] Church of England_Education officer-led_17.6.09_Y4_South American Rainforest_B2
In the following example, the prominence of the cage bars placed in front of the elephant suggest that the holding of animals in captivity is a prominent concern prior to the pupil's visit to the zoo. Post-visit, cages are no longer present in the young pupil's drawing, thereby indicating a reduction in concern.\(^{122}\)

Figure 33: Drawing indexes reduction of concern, from pre-visit representation of a caged animal to post-visit drawing of a singing animal (female, age 9)

However, the ambiguous nature of the post-visit drawing (above) makes this a less straightforwardly positive case.

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\(^{122}\) Kh 14
Ethical concern as barrier to learning

Although it was rare for ethical concern to persist from pre- to post-visit data collection, there was evidence in a couple of isolated cases that pre-visit ethical concern can reduce the enjoyment and educational impact of zoo visits.

Table 11: Pre-visit ethical concern limits enjoyment and impact of visit (male, age 11)

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Seduced</td>
<td>1. Tiring</td>
</tr>
<tr>
<td>2. Unentertaining</td>
<td>2. Dehydrating</td>
</tr>
<tr>
<td>3. <em>Animals should be living in a jungle</em></td>
<td>3. <em>Boring</em></td>
</tr>
<tr>
<td>4. Adventurous</td>
<td>4. <em>Nothing to see</em></td>
</tr>
<tr>
<td>5. Fun but <em>not fun for the animals</em></td>
<td>5. <em>Unenjoyable</em></td>
</tr>
</tbody>
</table>

Note: Emphasis added

In the pre-visit thought-listing data, this pupil expressed ethical concern about the animals in the zoo not being happy ("not fun for the animals"), suggesting that they should live in the wild rather than in a captive setting ("animals should be living in a jungle"). In the post-visit questionnaire it becomes clear that these pre-existing views inhibited his enjoyment of the zoo visit and limited the zoo’s impact on him during this self-guided visit. Indeed, it is noteworthy that this example of persistent negative framing of the zoo visit is on a self-guided visit as the evidence suggests that pupils entering the zoo with negative representations of the zoo are much more likely to change those representations when there is an educational intervention. Without the introduction of new information or concepts to contextualise or explain the zoo’s efforts to maintain animal welfare and enrichment, such pupils may be left with the negative impressions with which they entered the zoo.

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123 7, 22/06/2009, 2, 1, 11, 1, 3
Analytical Note

A methodological comment is necessary at this point to highlight that appearances of the term ‘cage’ in children’s thoughts and the visual representations of cage bars in pupils’ drawings do not necessarily signify negative emotions relating to the idea of animals in captivity. It is possible for the cage to be a prominent symbol associated with the zoo, but for children not to perceive this as problematic. The following drawing is one example of this interpretational pattern, as it shows a captive animal with a large smile on its anthropomorphised face124.

Figure 34: Post-visit questionnaire shows owl in a cage with large anthropomorphic smile (female, age 9)

This kind of example suggests the possibility that some pupils’ representing cages in their responses are not actually experiencing negative emotions or thoughts relating to these representations. Indeed, further in-depth qualitative research would be necessary to fully understand children’s perceptions of holding animals in captivity, and the impact of those perceptions on their learning. From a purely educational perspective however, it is clear that the focus on cages and other aspects of the captive settings must be considered counter-pedagogical given that the learning aims of the zoo centre on wildlife in their natural habitats. As such, this pattern of pre-visit perceptions should be addressed by zoo educators directly to maximise the educational value of visits.

Iconic representations of wildlife habitats

Pupils’ drawings showed clear patterns of iconic representation of certain habitats. These representations are based on cultural stereotypes and shared iconography. In this section, the symbolic representations of hot, desert habitats and cold arctic or Antarctic habitats are examined to identify patterns in children’s understanding of these wildlife habitats.

124 Kh 12
Representing Desert Habitats

The patterned ways in which children represented desert habitats in their drawings suggests that certain features are inherent in shared cultural representation of deserts. In particular, pyramids and cacti are regular features in representations of the desert.

The first example of cultural representations entering into children’s drawings of desert habitats is the pyramid.

Figure 35: Post-visit survey showing pyramids as iconic of desert habitat (Girl, age 11)

The post-visit drawing above indicates the pupil understands that camels’ natural habitat is desert. However, pyramids feature prominently in her representation of the desert. This iconic status of the pyramid as a symbol of the desert was widespread across the drawing data.

The following pre-visit drawing offers another example of the pyramid’s symbolic function. The pupil’s label for the drawing below is “I draw a hot desert. It has a snake, a camel and a scorpion”.

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125 Education Officer-led Zoo Visit, 8-6-09, Year 6, Session: Desert and Rainforests, Time: 12.00, Behaviour: ‘2.5’, Sig. Weather: Overcast (lecture theatre cold), Late: NO, SEN: NO, EAL: NO
Central to the pupil’s representation of this ‘hot desert’ (above) are images of pyramids which are labeled as such. Interestingly, the camel in this pre-visit drawing appears with a saddle on its back, connecting further to cultural representations (e.g., films) of camels as pack and riding animals. This can be considered a pedagogically problematic representation because it has persisted in this pupil’s thinking despite the question prompt asking about where animals live in the wild.

Another recurring visual signifier of the desert habitat is the cactus (also featured in the annotated drawing above). In the following extract, the cactus is the only recognizable feature of the camel’s habitat, which is labeled ‘desert’.
These results could be useful to zoo educators in two ways. First, these cultural representations of deserts suggest a way in which educators can anchor pupils’ understanding of other desert animals besides camels. For example, placing a meerkat in an image next to a cactus may facilitate a basic appreciation of meerkats as desert animals for a young pupil. Secondly, the limited range of icons representing deserts for these pupils suggests a possible direction for further educational development. Namely, pupils could be taught about the broader range of vegetation and landscape features with which desert animals interact.

Representing Arctic and Antarctic Habitats

In pupils’ representations of animals that reside in cold, icy and snowy habitats, there were consistent iconic symbols employed, with the most consistent being the igloo. The use of the iconic image of an igloo can be seen across a range of age groups and schools, and from pupils demonstrating both high and low levels of knowledge in their drawings.

\footnote{2.7.09_Y3-4_Des, Rain_B1_Hot, sunny_EAL}
Significantly, the same symbols were used to represent habitats for animals in both arctic and Antarctic habitats. In the following example, a student’s post-visit drawing correctly places the penguin within a cold habitat, but incorrectly identifies this habitat as the ‘arctic’. Nevertheless, the symbolic marker of this cold habitat is an igloo.

**Figure 38: Post-visit drawing of penguin in habitat featuring igloo (male, age 13)**

![Post-visit drawing of penguin in habitat featuring igloo](image)

*What did you draw above?*  
*Arctic*

While the labelling of the penguin’s habitat (above) is technically inaccurate, the pupil has clearly understood the fundamental idea that penguins are cold weather animals. Moreover, this pupil has used an igloo as a symbol for such cold weather.

This pattern of the igloo symbolizing a cold climate was visible across a wide range of drawings. In the following example, the two drawings were coded as ‘no change’ with the igloo remaining a consistent symbol. The consistent representation of this technically inaccurate object within children’s drawings of cold habitats indicates that this is a cultural representation cultivated well before the zoo educational visit by mass media and other influences.

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127 Self-guided Zoo Visit_24.6.09_(Y8)
Figure 39: Igloo consistently symbolizes cold habitat in pupil’s drawings (female, age 13).1

The following example offers particularly clear evidence that the focus of this igloo symbol is the cold habitat (rather than any particular animal). In it, the igloo remains constant, even as the polar bear is removed from the image, thereby enhancing its scientific accuracy.

Figure 40: Pupil employs iconic symbol of igloo and improves accuracy (female, age 13)1
The following drawings further illustrate the durability of the igloo symbol in pupil’s understanding of cold habitats. Despite the clear limitations in terms of the accuracy of the drawing of the penguin, this pupil maintained the same iconography both before and after her zoo outreach visit (female, age 13).²²⁹

**Figure 41: Pupil consistently links penguin and igloo in drawings** (female, age 13)

The pupil’s set of drawings (above) show the explicit labeling of the penguin and igloo in the post-visit drawing, thus demonstrating that ‘igloo’ is indeed the intended denotative meaning of the symbol. However, the connotative or cultural meaning of the igloo is the broader concept of a very cold, snowy climate.

This pattern of stereotypic representations of habitats with cold climates suggests that pupils’ have and maintain a relatively indiscriminate understanding of such habitats. Once an animal is accurately identified as living in a cold climate, a powerful set of root symbols connect that animal with others that the pupil understands to live in cold climates. Thus, we regularly see animals who live on opposite poles represented as cohabitating in the pupils’ drawings.

Overcoming such misunderstandings is likely to be a very difficult task for zoo educators, should they choose to undertake it, given that such cultural symbols run deep and wide. Nevertheless, an understanding of the key cultural representations that impinge on learning about animals and their natural habitat should offer valuable guidance in the preparation and calibration of new educational content.

²²⁹ Or26
DISCUSSION

Non-human animals have been at the centre of the human imagination and experience from the very beginning. However, in recent years it has been argued that urban living has led to increased distanciation between animals and humans. Such distanciation is addressed by parks and zoos that provide access to animals and the natural world, which would otherwise exist for some children and young people only as cultural imagery, mediated through television, films and books. As this study demonstrates, the experience of viewing animals ‘live and in person’ can have a powerful impact on children and adolescents, interacting with pre-existing cultural representations to construct new understanding of wildlife, the natural world and the role of humans intervening in this natural world. Evidencing the potential impact of zoos, the present study reveals that zoo visits alone yielded a statistically significant mean increase in scientific learning.

The present research indicates that such impact can be enhanced by the zoo’s educational interventions. By providing educational (or ‘interpretational’) materials and presentations, pupils' understanding of how the animals they see in front of them connect to habitats and environmental concerns in distant lands and seas can be developed. Indeed the link between the concrete experience of viewing animals in the zoo and the development of a more elaborated understanding of abstract scientific concepts and environmental values is crucial. This link cannot be taken for granted and the present research shows that scientific and conservation learning can be enhanced by more extensive conceptual scaffolding and didactic communication from the zoo. In this case, the addition of an educational presentation to pupils’ day at the zoo yielded a statistically significant increase in scientific learning, almost doubling the mean increase in scientific learning for self-guided zoo visits. However, the educational value of a zoo visit is certainly affected by a range of variables that precede the visit. Factors such as prior knowledge (both positive and negative) from school, mass media and other sources, the age and gender of the pupil, whether they have visited a zoo before and whether their school selected to have a zoo educator-led presentation all had significant predictive power in defining outcomes from zoo visits.

Methodological Implications

Methodologically, this study runs counter to recent trends in zoo visitor research, which have focused on audience or visitor segmentation approaches and visitor tracking studies. The audience segmentation approach has been most notably propounded by John Falk and colleagues. One of several studies within the zoo visitor research literature to develop a segmentation approach was the American Zoo Association-sponsored multi-institutional research program or MIRP. In this large-scale and well-funded visitor research project, Falk et al. (2007) aimed to assess zoo and aquarium visitors’ reasons for attending and self-reported attitudinal and cognitive change caused by the zoo visit. Using statistical methods for testing internal reliability within a psychometric scale, 100+ postulated reasons for zoo attendance were reduced to 20. Falk et al. (2007, p. 15) claimed this 20-item scale constituted a “single measure for validly and reliably capturing zoo and
aquarium visitors’ identity-related motivations”. The second phase of the project used this scale along with others that were said to measure ‘cognitive development’ and ‘affective response’ through the selection and ranking of five items that the sampled visitors thought aligned best with their motivations for attending the zoo that day.

The problem of reductionism which is inherent in all segmentation approaches can be seen clearly in the Falk et al. (2007, p. 15) project described above, both in terms of its model of five visitor types and the use of psychometric methods developed on purely internal statistical grounds. First, the project’s initial goal of creating “a meaningful categorization of visitors based on their knowledge, interests, beliefs, attitudes, behaviours, and motivations” became a much reduced “instrument development” task as the report continued. Secondly the project uncritically employed methods designed to confirm Falk’s longstanding ‘five identity-related motivations’ segmentation model without maintaining falsifiability (that is, setting up a study in such a way that the hypothesis can be proved wrong if the data go that way). Rather, it was presumed a priori that “many of these multiple ‘entry’ variables could be successfully subsumed into a single, multidimensional variable related to visitor’s identity-related motivations” (sic) (Falk et al., 2007, p. 15). Moreover, by reducing the dynamic knowledge, interests, etcetera of visitors to ‘entry’ variables, the MIRP report maintains a very narrow and instrumentalized vision of the zoo visitor.

In addition, the validity of the scale developed within the MIRP was not established. The project lacks qualitative research that could shed light on the validity of the postulated statements used in the MIRP as proxies for different visitor ‘segments’ or ‘types’. The use of instruments that have been developed based on purely statistical grounds without validating the items through qualitative research is an endemic problem in the zoo visitor research literature, which features several different segmentation approaches, some of which are contradictory. In this vein, Sickler and Fraser (2009)130, Packer (2002)131 and others have also relied heavily upon psychometric methods (scales) to segment audiences into ‘types’. Clearly, the present approach represents a rejection of the psychometric scale development approach that has gained ascendency in the zoo visitor research literature in recent years due to the influence of Falk, Fraser and colleagues.

The present approach can also be contrasted with tracking studies, which only reveal the outwardly visible patterns of transit and stop time. What such tracking studies leave completely unexamined is whether such transit and stopping behaviour translates into any form of educational impact whatsoever. From the fact that an individual spends 30 seconds in front of a sign or exhibit, we can draw no firm conclusions (either positive or negative) about their learning. This amount of time may suffice to spark a new enthusiasm for an animal or a visitor may be preoccupied by other concerns and gain nothing from this ‘stop time’. Any analyst considering the learning that has occurred during such ‘stop time’ cannot validly distinguish between these and


myriad other possible outcomes that could result from an individual standing in front of an enclosure in the zoo. Therefore, it is crucial that research evaluating educational impact employ measures that allow valid access, however imperfect, to cognitive and affective development that occurs within the individual visitor and developed through social interaction.

The present study adds a qualitative dimension to measurements of visitor impact, which has allowed for an understanding of a wider range of benefits and limitations of zoo visits as educational interventions than prior research. Moreover, measures such as the thought-listing and annotated drawing items in the present study allowed direct access to learning that occurred, which was not dependent on methodologically flawed approaches such as self-reports (e.g. ‘Have you learned about conservation during your visit today?’). Moreover, the using of drawings for younger children is particularly indicated in that it flips the conventional prioritisation of the linguistic within social research methods, instead comprising a data collection method that is primarily visual and supplemented by linguistic data. Because it avoids some of the pitfalls of dominant research approaches in visitor studies (highlighted above), the present study holds methodological implications for other visitor studies researchers by offering a different way forward for this kind of research. This different way is defined by a focus on the mixed methods assessments of the complex and multi-dimensional process of learning, in a manner that is methodologically robust and falsifiable.

**Theoretical Implications**

Results indicate that pupils visiting the zoo are significantly more likely to evince clear positive transformations in their understanding of animals and their habitats when they attend an educational officer-led presentation, when compared to zoo visits that are exclusively ‘self-guided’ by the schools themselves. This finding is consistent with a Vygotskian theoretical explanation of the Formal Learning team’s impact. That is, zoo educators assisted pupils’ learning within a ‘zone of proximal development’, as theorised by influential developmental psychologist Lev Vygotsky. On the basis of his research, Vygotsky argued that there is a zone of potential ‘assisted’ learning that can occur above and beyond the autonomous learning potential of a pupil.

This study suggests that the zoo is a setting in which this distinction between a zone of ‘autonomous learning’ (i.e., self-guided) and a proximal zone of potential assisted learning is very applicable. Vygotsky’s social development theory proposes that learning is inherently connected to social relationships and communication. Most relevant in the present context is his argument

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132 On the other hand, one limitation of the annotated drawing method of evaluation data collection is that some pupils’ drawing ability will constrain the level of detail they can add to their drawings, especially at the very highest levels of knowledge. Thus this manual skill barrier introduces a risk of Type 2 (false negative) or ‘beta’ error. That is, there is a genuine risk of false negatives from the drawings (concluding there is no impact when there in fact is educational impact that the pupil is unable to represent). On the other hand, the risk of Type 1 error (false positive) is negligible as this would require a pupil adding detail and labelling randomly in a manner that aligned with desired learning outcomes by pure chance. To address the Type 2 error risk, other forms of data collection have been included in the present analysis which should capture positive impact that might not be visible in the annotated drawing data.
that learning can be assisted by a ‘More Knowledgeable Other’ who can provide support or guidance through the learning process. In this case, the More Knowledgeable Others are the education officers who helped pupils to develop their scientific and conservation learning. The provision of conceptual tools relevant to the zoo context was effective at enhancing learning beyond the level that could be achieved autonomously.

A further direction for theorizing the present research results connects to the work of another influential developmental psychologist and learning theorist, Jean Piaget. Piaget’s theory proposes that learning takes place when children face new situations that existing mental schema are not set up to process – thereby leading to cognitive ‘disequilibrium’. To re-equalise, the pupil must extend their existing schema. Thus, in the present context, pupils are confronted with new stimuli at the zoo - animals they have never seen before. These stimuli may cause disequilibrium in pupils’ existing mental schema relating to animals. If facilitated effective by zoo interpretation and education, the re-equalising process has the potential to extend pupils’ thinking about animals. However, from this point in the zoo learning process on the present data support the Vygotskian explanation regarding a zone of proximal development. That is, on the basis of the present data I would argue that viewing new animals in a zoo has the potential to result in a form of cognitive disequilibrium as theorised by Piaget. However, the assimilation of new ideas into a pupil’s existing mental schema for understanding animals and habitats can be significantly enhanced through assistance from a More Knowledgeable Other (in this case an educational officer).

Thus the present research indicates a dialogical way out of the classic divide between the contradictory arguments of these two prominent learning theorists. I propose a theoretical model in which new stimuli (viewing live animals) create the potential for the assimilation of new information into existing mental schema as predicted by Piaget; however, this assimilation process is more likely to occur and likely to be better elaborated with guidance from a More Knowledgeable Other (education officer or tailored educational materials). In sum, regardless of the precise nature of the facilitator, this study supports Vygotsky’s (1987; 1994) argument that the facilitator plays a vital role in drawing a child’s attention in useful directions and providing conceptual tools that allow the child to develop their knowledge beyond what could be achieved autonomously. In other words, this theoretical model of zoo learning places zoo educators in the role of toolmakers, fashioning the most effective concepts and explanations possible and provisioning pupils with these concepts for them to use to leverage themselves into a higher level of learning.


Practical Implications

This research project represents the largest and most robust study to date evaluating the cumulative educational impact of zoo visits on children and adolescents. The study has yielded clear findings regarding the kinds of knowledge development fostered by the ZSL London Zoo Formal Learning programme. Indeed the survey data show that pupils developed new knowledge and enhanced existing knowledge about animals and habitats, as a result of zoo education.

There is clear statistical evidence that educational presentations resulted in significantly improved rates of positive development in pupils’ science learning. Surprisingly, this impact from the educational presentations generalised beyond the specific habitats that were the focus of the presentations. For example, an educational presentation on rainforests could yield a positive development in understanding of deserts as of rainforests. Thus, this study suggests that educational interventions focused on concepts relevant to the zoo context can yield positive results across a broad spectrum of knowledge and attitudinal indicators. That is, concepts learned to help understand the relationship between particular animals and their natural habitats can be generalised by pupils for use in understanding new wildlife species encountered at the zoo.

However a key element of this research is self-guided zoo visits. This research indicates that a sufficient level of scaffolding, priming and anchorage can direct the inherent curiosity-generating impact of viewing live animals towards the desired educational outcomes of increased science and conservation learning. Given the present findings, it is clear that visitors that do not experience an additional educational intervention from the zoo are not learning as much as they could be if they were better equipped by zoo educators. As such, a fundamental practical recommendation from this study is that the zoo needs to dramatically expand and improve its interpretation and educational provision within the zoo itself in order to maximise educational impact. The current methods of interpretation are yielding significant learning, but with the right interpretation or educational interventions this level of learning could be dramatically enhanced.

A number of other findings from this study also have practical implications for zoo-based science and conservation education. For example, knowledge of the kinds of ideas that tend to be salient for visiting children could be used to guide the framing of interpretation within the zoo. One example is the finding that olfactory aspects of the zoo visit were memorable for especially primary school pupils. Indeed, variations on the concept of ‘smelly’ were a consistent and durably salient feature of children’s experience of the zoo. Zoo educators could use the knowledge that this idea is salient to children in order to design learning messages that focus on animals’ smells and then scaffold broader learning onto this base.

Another example is the widespread awareness of ‘cages’ as a possible index of ethical concern amongst pupils in pre-visit thought-listing and to a lesser extent drawing data. Although this concern declined significantly over the course of the visit, there was evidence in individual cases that ethical concerns were acting as a barrier to both learning and enjoyment during the zoo visit. Given that this pattern was visible even in the youngest pupils sampled for this study (age 7), the current pedagogical approach at ZSL of only directly addressing ethical concern at the secondary
and post-secondary levels in formal learning presentations and not at all in general zoo visitor interpretation (which is the main message delivery mechanism for self-guided visits) should be reconsidered. Moreover, findings such as the gap between the ZSL formal learning team’s success in fostering personal concern for wildlife conservation on the one hand and a feeling of conservation self-efficacy on the other hand point to clear directions for pedagogical development for zoo education.

Basing zoo education on this kind of empirical research has the potential to maximise the attracting power of education messages as well as their ability to effectively engage visitors’ memory. That is, it should be possible to connect scientific and conservation messages with the salient phenomena at the zoo to maximise positive learning impact.

In addition, the positive results achieved by ZSL educational presentations featuring live animals in terms of enhancing appreciation for biodiversity offers some of the first empirical evidence supporting the use of touch within live animal presentations as an educational tool. In particular, allowing children to touch a Madagascan cockroach made a substantial impact on children attending educational presentations, fostering greater appreciation for these conventionally uncharismatic but ecologically important animals. However, the results also suggest caution in the case of charismatic animal species used in zoo education, particularly if they are behaving in any way that is unnatural. Moreover, taking animals out of a naturalistic enclosure to present to children within an educational presentation in school was shown to have an inherently de-contextualising negative impact. Thus, there must be a stronger countervailing reason (e.g. fostering appreciation for conventionally under-appreciated animal species) to justify the risk of incurring this educational debit of de-contextualisation.

Finally, the ways in which publics understand the relationship between animals (both human and non-human) and natural habitats bears directly on zoos’ efforts to promote wildlife conservation. This is because the critical connection between endangered animals and their increasingly degraded wild habitats comprises the basis for understanding the need for conservation and the kinds of conservation action necessary. That is, knowledge of the animal – habitat relationship is the fundamental building block for learning about wildlife conservation. While it may be possible to develop short-term pro-conservation visitor actions such as one-off donations in the absence of such understanding, I would argue that engendering a long-term and holistic commitment to conservation requires learning about the context and basis for current wildlife crises.

**Directions for Future Research**

This research provides important evidence about the educational impact of zoo education and interpretation on children and adolescents. However, there is more to be learned about the ways in which the learning identified in this study is constructed and re-constructed in long-term memory. In addition to the obvious issue of new learning fading over time if disused, we must leave open the possibility that for some pupils the educational impact of the zoo may increase some time later. Such a ‘sleeper’ effect can only be investigated through longitudinal research designed to track further development in pupils’ thinking about relevant concepts. To investigate
the possibility of a ‘sleeper effect’, as well as to assess any decrement or transformation in learning over time, a randomly selected set of school groups have been invited to participate in further data collection at different intervals up to a year after this main study. Results from this longitudinal data will address for the first time what kind of long-term educational impacts can be attributed to zoo visits.

**Conclusion**

Overall, this research indicates that visiting the zoo can yield both positive and negative learning outcomes. The risk of negative outcomes is greatest when there is not a naturalistic or immersive context for the viewing of live animals (e.g. outreach presentations in school). Within the zoo context, negative outcomes are much more likely when pupils have not been furnished with the conceptual tools they need to make the most of the experience of viewing live animals. Moreover, positive outcomes can be substantially enhanced by the provision of such conceptual tools.

For those pupils who enter the zoo with a positive or neutral perception of zoos and effective scaffolding by teachers, parents or other sources, self-guided visits can yield significant gains in knowledge and positive transformations or strengthening in pro-conservation attitudes. However, for pupils with insufficiently present, active and knowledgeable support, they are much more likely to benefit from education officer-led visits, which provide context and conceptual scaffolding tailored to facilitate learning from the zoo collection. Nevertheless, even within self-guided visits, the vast majority of pupils showed positive development on at least one of the dimensions included in the present survey instrument. As such, this study provides for the first time large-scale, reliable and generalisable evidence of zoos’ positive impact on children and adolescents’ scientific and conservation learning. Zoos will need to consider the overall finding that educational interventions can yield significantly improved learning outcomes on these dimensions in order to maximise impact both within and outside the formal learning context.
ACKNOWLEDGEMENTS

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