Title: Evaluating Children's Conservation Biology Learning at the Zoo

Abstract:

Millions of children visit zoos every year with parents or schools to encounter wildlife firsthand. Public conservation education is a basic requirement for membership in professional zoo associations. However, in recent years there has been increasing criticism of zoos from animal rights groups for failing to demonstrate their averred value for public understanding of conservation and related biological concepts such as animal adaptation to habitats. Indeed, no full-scale study to date has rigorously assessed conservation biology-related learning for the key zoo audience of children. The present study represents the largest (*n*=2839) investigation of the educational value of zoo visits for children aged 7-15 reported worldwide. This research evaluates the relative learning outcomes of educator-guided and unguided zoo visits at London Zoo, both in terms of learning about conservation biology (measured by annotated drawings) and changing attitudes towards wildlife conservation. Results show 41% on educator-guided visits and 34% of children on unguided visits evinced conservation biology-related learning. Negative changes in children’s understanding of animals and their habitats were more prevalent in unguided zoo visits. Overall, this study offers evidence of the *potential* educational value of visiting zoos for children. However, it also suggests that zoos’ standard unguided educational provision is insufficient for achieving the best outcomes for visiting children. The study supports a theoretical model of conservation biology learning that frames conservation educators as toolmakers developing conceptual resources to enhance children’s scientific understanding.

Keywords:

Conservation Education; Public Understanding of Conservation Biology; Informal Science Learning; Zoo Education; Science Education

Evaluating Children's Conservation Biology Learning at the Zoo

Conservation biology is a scientific field deeply intertwined with social, cultural and political factors. The fact that many of the most fundamental and intractable problems conservation biologists face have human interests, motivations, assumptions and behaviour as the central feature (Balmford & Cowling 2006) indicates the importance of developing and refining conservation education practice. While conservation education has urgent problems to address amongst adult populations, improving the long-term outlook for species conservation requires effective engagement with children. Millions of children visit zoos every year with their schools, where many will encounter educational messages relating to conservation biology alongside live animals. As such, zoos represent a major opportunity for engaging children with live animals, biological science and conservation. Indeed “keeping animals and presenting them for the education of the public”[i] is one of the fundamental activities of the contemporary zoo, required for membership in professional zoo associations such as the European Association of Zoos and Aquariums (also see Moss & Esson, 2012). Moreover, the recent emphasis on public engagement with science by government and scientific institutions (e.g. Holliman, Colllins, Jensen, & Taylor 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 purported 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.

> 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 *demonstrate* substantial impact. From our review of the literature, this does not yet appear to be the case" (emphasis added; RSPCA 2007, p. 97)[ii].

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 programs 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)[iii].

Reacting to such assessments, Maggie Esson (2009)[iv], 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 ethical criticisms of holding animals in captivity (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, evidence of educational impact is crucial if contemporary zoos are to empirically validate their role as charities promoting conservation biology-related learning and wildlife conservation.

However, as noted in the RSPCA report, prior published research on zoos often eschews fundamental questions about zoos' ability to deliver effective engagement with science and conservation, instead focusing on dependent (outcome) variables such as satisfaction, 'stopping power' and 'implicit connectedness to nature' and visitor behavior within the zoo (Moss, Esson, & Bazley 2010; Moss, Esson, & Francis 2010), 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), visitor density (Moss, Francis, & Esson 2007), the relative credibility of different zoo-based personnel (e.g. Fraser, Taylor, Johnson, & Sickler 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 learning 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 undermine the conclusions (both positive and negative) of most such studies of zoos' educational impact.

Prior Research on Zoo 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 learning about conservation. Falk defines this task in terms of 'identity-related motivations'. The focus on these motivations is justified 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) 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 an audience segmentation approach that defines visitors as 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 […and] value the zoo […] as part of the community"), Professional/Hobbyists ("tuned into institutional goals and activities"), Spiritual Pilgrims (attend zoos as "areas for reflection"). However, this entire 'identity-related motivations' approach has been called into question by a critical essay by Jensen and Dawson (2011). Jensen and Dawson (2011) also challenge the methodological approaches employed in the MIRP study for a range of fundamental errors in assumptions and measurement biases. Complementary critiques have also been published highlighting flaws in Falk's approach (e.g. Bickford 2010) and Falk et al.’s (2007) questionable survey methods (Marino, Lilienfeld, Malamud, Nobis, & Brogliod 2010).

The segmentation-based 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, “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 zoo visits was not investigated, leaving this issue still unaddressed in published research literature.

This lack of direct evidence of the value of zoo-based education for children prompted the present study. The specific case examined in this study is the rich variety of state and privately funded schools visiting the Zoological Society of London’s (ZSL) London Zoo in groups with teachers and sometimes with parents. State school visits, funded by the Greater London Authority, were either with an educational presentation to supplement the unguided visit or unguided. Independent, privately funded schools were able to access the same educational experiences on 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 or 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. That is, the present study takes advantage of a naturally occurring setting in which additional educational content was introduced to pupils on a non-self-selecting basis. This study therefore provides insights about the impacts of zoo-visits by comparing two common formats for such visits (zoo educator supplemented and unguided). The percentages of pupils evincing positive, negative or neutral change in the annotated drawing data collected for this study provides the basis for assessing the potential learning value of zoo visits.

This manuscript reports on a large-scale (*n* = 2839) study designed to address the lacuna in the literature identified above by assessing whether zoos' educational programmes can deliver positive conservation biology learning outcomes. It takes an innovative and methodologically rigorous approach to evaluating zoos' impacts on children and adolescents' understanding of animals and habitats. The present study draws on data collected from June to August 2009 from pupils at schools in the Greater London area. The research evaluates and compares educational impact for zoo visits accompanied by an educational presentation conducted by zoo educators and for unguided zoo visits. This comparison addresses the most relevant question for conservation biology educators: What can you achieve with pupils who are visiting your institution? This study address this question with a data set comprised entirely of pupils visiting a zoo. 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).

METHODS

As indicated above, the main purpose of the present research is evaluating learning in school pupils visiting ZSL London Zoo. This study directly measures stability or change in pupils' attitudes and understanding relating to conservation biology, addressing the following research question:

- Can a zoo visit facilitate the development of conservation biology learning amongst school pupils?

Two sub-questions are used to further refine the focus of this article:

1. To what extent do unguided school zoo visits lead to conservation biology learning?

2. Do zoo educator-guided school zoo visits lead to greater learning than unguided zoo visits?

One of the methodological aims of the present research is to overcome limitations associated with prior research on educational impact. In particular, 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 the present manuscript reporting on quantitative 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 could be robustly analysed to identify different possible forms of impact from children's 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 conservation biology. As such the methods for this study were tailored to explore this domain of pupils' thinking. To accurately 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 understanding in a medium that is less reliant on formal linguistic capabilities, thus making it more accessible to young pupils and those for whom English is not their first language.

A one-week pilot study used two versions of the pupil questionnaire with different formats and phrasing. These were assessed for the extensiveness and relevance of pupils' responses. The version that elicited the most extensive responses were then used exclusively.

The mixed methods (quantitative and qualitative) survey instruments developed for this study included a pre-visit form and a post-visit form. Different variations on these forms were used for primary school pupils and for secondary school pupils on zoo visits. The pre-visit form for primary school pupils visiting the zoo included the following elements to be addressed in this manuscript:

- Demographic details: Name, age and gender.

- A thought-listing item with 5 numbered lines and the instruction "What do you think of when you think of the zoo?".

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

- 'Conservation Self-Efficacy': This concept of conservation self-efficacy was operationalized in the present study through pupils' response to the following question both pre- and post-visit (secondary school version of survey only): 'Do you feel there is anything you can do about animal extinction?'. This is admittedly a very modest first attempt to operationalize this complicated idea of conservation self-efficacy.

- 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')

The post-visit survey forms retained thought-listing and annotated drawing items in exactly the same form as in the pre-visit in order to allow for direct comparisons. In addition, there were items measuring pupils' satisfaction and enjoyment. The question measuring satisfaction was ‘How was the London Zoo lesson?’. For primary school pupils, a five-point response scale using face drawings from smiling to frowning was provided; for secondary school pupils, a five-point response scale from ‘Very Good’ to ‘Very Poor’ was provided for this item. Enjoyment was measured for the primary school pupils with the question, ‘ (response options were ‘Yes’, ‘No’ or ‘Not Sure’); for secondary school pupils the question was, ‘Overall, did you enjoy your time at London Zoo?’ (response options: ‘Yes’, ‘No’ or ‘Not Sure’). In the secondary school version of the post-visit survey form, conservation self-efficacy and conservation concern items exactly matching the pre-visit survey form were also included. Data from other items in the pre- and post-visit survey forms are not used in this manuscript.

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 whose visit was supplemented by an educational presentation tailored to the zoo context, and those whose attendance was unguided, 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 zoo visit supplemented by an educational presentation (*n* = 1742) or for a unguided visit with their school (*n* = 1097). There were 890 boys and 834 girls in the education officer-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 education officer-guided respondents was 7 – 15, with a mean age of 10. In the unguided zoo visit sample, there were 470 boys and 607 girls (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 unguided respondents was 7 – 14, with a mean age of 9.9.

Procedure

Survey forms were administered both before and after pupils' experience with London Zoo formal learning activities. 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 zoo visit on pupils' developing understanding of animals, habitats and zoos.

The use of a before/after (repeated measures) survey design in this manner can result in false negatives because of inflated 'pre-test' responses to self-report items. However, the present study reports results based on open-ended direct outcome measures (viz. annotated drawings of animals in habitats) rather than relying on closed-ended self-report items, thereby mitigating the methodological risk typically involved in a repeated measures design. The selection of this repeated measures design was also weighted against highly fraught 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 along with a high risk of response bias.

Data Analysis

Questionnaire data was entered into a spreadsheet by research assistants, where it was organized prior to import into the Statistical Package for the Social Sciences (IBM SPSS) for data analysis. 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.

For the pupils' annotated drawings (the learning impact measure) the analysis was idiographic (within each case). A content analysis was conducted using a simple coding scheme. On the first measure, drawings were coded as having undergone positive development in learning (coded as '3'), no development (coded as '2') or negative development in learning (coded as '1') from pre-visit form to post-visit form. Positive development was defined in terms of increased evidence of elaboration of physiological characteristics of animals, increased conceptual sophistication in terms of the use of more scientific ideas such as shifting from describing a habitat as 'sand' to 'desert' and/or improved accuracy in the placement of animals within their correct wild habitats. Training in conducting this analysis was provided to the two undergraduate research assistants working on this project. To show how this coding determination worked, an example of positive development is provided below. In this case, there is a substantial improvement over the course of the pupil's zoo visit and educational presentation in the labeling of the 'woodland' habitat represented.

FIGURE 1 HERE – EXAMPLE OF POSITIVE CHANGE

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 understanding over the course of her visit to the ZSL London Zoo, which included an educational presentation on 'Teeth and Diets'[v].

A randomly selected sample (n = 350) was blind coded by the lead researcher for quality assurance purposes. A widely accepted statistic for measuring inter-coder agreement was employed (Cohen's kappa). The result was a finding of kappa = .885, which is considered a good level of inter-coder agreement in content analysis, particularly for latent content as in the present case. Differences uncovered through this quality assurance exercise were resolved through discussion.

RESULTS

Beyond reporting the percentages of positive and negative change in pupils' representations of animals in their wild habitats, the present analysis focuses on the distinction between zoo educator-led versus unguided visits to see whether the addition of a presentation from a zoo educator affected zoo visit outcomes. The dependent (outcome) variables analyzed in this manuscript include actual learning (as measured by annotated drawings), 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).

Descriptive results: Cumulative evaluation of positive change

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, in total 1075 pupils (38%) showed such a positive change in their drawings in the post-visit questionnaire compared to the pre-visit drawing (41% of education officer-led visits and 34% of unguided visits). 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 pupils' drawings. As with the other results presented below, this finding of a quantitative shift from pre- to the post-visit is based on idiographic (within case) analysis, and therefore represents the actual proportion of unique individuals undergoing this kind of change.

Personal concern for conservation. Respondents were more likely to switch from not indicating pre-visit personal concern with species extinction to beginning to express such concern post-visit (18%), rather than the other way around (3%).

Conservation self-efficacy. The relationship between perceived ability to do something about extinction as measured in the secondary school pupils survey forms in the pre- and post-visit surveys is limited. Pupils were marginally more likely to switch from having indicated an inability to do something about extinction pre-visit, to an ability to do something about extinction post-visit (13%), rather than the other way around (9%). Indeed, the present data suggest that existing zoo educational provision is better at promoting scientific learning and concern about wildlife conservation than empowering pupils to believe they can take effective ameliorative action.

Conservation Concern in Thought-listing Results. The thought-listing item provided open-ended responses that were compared from pre- to post-visit to assess aggregate changes in associations between ‘the zoo’ and conservation-related concepts. 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 aggregate conservation-related thoughts from pre- to post-visit[vi].

Comparing Zoo Educator-guided and Unguided Visits

A key question addressed by this study is, what contribution does having an educational presentation make to enhance or ‘guide’ pupils visiting the zoo? This section addresses this question by comparing results for those pupils whose visit was supplemented by an educational presentation connecting animals in the zoo to broader concepts relating to habitats and conservation with the pupils that attended the zoo without guidance from zoo educators (‘unguided’).

Annotated drawings. Pupils on education officer-led visits showed consistently more positive outcomes on this measure of learning when compared to unguided. Those on education officer-led visits were significantly more likely to have a positive change in their drawings (11%) than those on unguided visits (16%).

Sample means were also compared for education officer-led and unguided visits on the drawing-based measure of learning. While both categories evinced significant gains in learning (no impact would be a mean of 2), education officer-led visits yielded greater aggregate learning on this measure (M=2.297, SD=.659) compared with unguided visits (M=2.180, SD=.686).

DISCUSSION

The present impact evaluation study focuses on the overall effectiveness of zoo education aimed at enhancing understanding of conservation biology for children visiting with their schools. The headline finding in this study is that 34% of pupils in the study on education officer-led visits showed positive change, while 16% of unguided pupils showed negative change. This is a net positive for unguided visits, but indicates poorer educational impact when compared to the education officer-led visits, where the ratio of positive to negative learning was 41% to 11%. The 7% differential in positive learning impacts between guided and unguided visits may seem modest. Yet, given the millions of children who visit zoos and similar institutions every year, the prospect of increasing the level of positive impacts by this proportion is very important. It also establishes the principle that zoo education interventions may be able to make a positive difference in children’s conservation biology-related learning outcomes. While such learning outcomes may not fundamentally change conservation-related behaviour, conservation biology learning may establish the basis for further engagement targeted at fostering pro-conservation social change.

Zoos’ claims to serve a vital educational and engagement role in persuading publics of the importance of biodiversity conservation and involving them in this cause cannot be simply accepted at face value. As Moss and Esson (2012, p. 8) argue, "for many years, they have confidently promoted themselves as education providers particularly with regard to the conservation of biodiversity; perhaps even used this educational function as part justification for their existence. Because of this, the burden of evidencing educational impact falls squarely on the shoulders of zoos. Yet the research undertaken thus far (and there is a substantial amount) has clearly not been universally accepted as an effective demonstration of zoos' positive impact". This study was designed to address whether and to what extent zoo visits can help develop such positive impacts by employing rigorous social scientific impact evaluation (also see Jensen 2011a; Jensen 2011b).

This study is the first large-scale effort to quantify the potential educational impacts of zoos for children, and it is broadly supportive of the idea that zoo visits can deliver pro-conservation learning and attitudinal impacts. However, there are some important limitations inherent in this study. The most significant limitation given the study does not employ an experimental design is the uncontrolled risk of confounding variables, the most obvious of which is the role of the teacher (and accompanying parents). Although the results of this study are consistent with the explanation that the zoo visit yielded aggregate positive learning outcomes, it is possible that the teacher or some other unidentified factor was the key to the positive and negative impacts identified in this study, rather than the zoo[vii]. For example, one alternative explanation for the educational impacts observed in this study is that teachers use the zoo experience as a platform for delivering conservation biology learning. This research also leaves unanswered the broader policy question of whether zoos are worthwhile conservation education institutions when compared to other public engagement sites such as botanical gardens and natural history museums. This broader policy question should be addressed by future research, which would most likely need to employ a quasi-experimental and/or microgenetic evaluation (Wagoner & Jensen, in press) approach in order to better control for confounding variables.

The present results indicate that pupils visiting the zoo are significantly more likely to evince positive conservation biology learning impacts when they attend an educational officer-led presentation, when compared to zoo visits that are exclusively 'unguided' by teachers. This finding is consistent with a Vygotskian theoretical explanation: Zoo educators may be assisting pupils' learning within a 'zone of proximal development', as theorized 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 proximal zone of potential assisted learning and a zone of 'autonomous learning' (i.e., unguided) 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 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 yielded enhanced learning outcomes, beyond the level that could be achieved autonomously or by non-specialist teachers.

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 (1957) classic 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-equalize, children must extend their existing schema. Thus, in the present context, children 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 effectively by zoo interpretation and education, the re-equalizing process may have the potential to extend pupils' thinking about animals. However, from this point in the zoo learning process, 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 may have the potential to result in a form of cognitive disequilibrium as theorized 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 a zoo educator).

Thus the present research supports (but does not confirm) a theoretical model in which new stimuli (viewing live animals) create the *potential* for the assimilation of new information about conservation biology 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 (i.e., a conservation educator or tailored educational materials). In sum, regardless of the precise nature of the learning facilitator, this study supports Vygotsky's (1987, 1994) argument that the facilitator plays a vital role in drawing children's attention in useful directions and providing conceptual tools that allow children to develop their conservation biology learning. In other words, this theoretical model places conservation educators in the role of toolmakers, seeking to develop the most effective explanations possible to provision children for the process of developing a higher level of conservation biology-related understanding.

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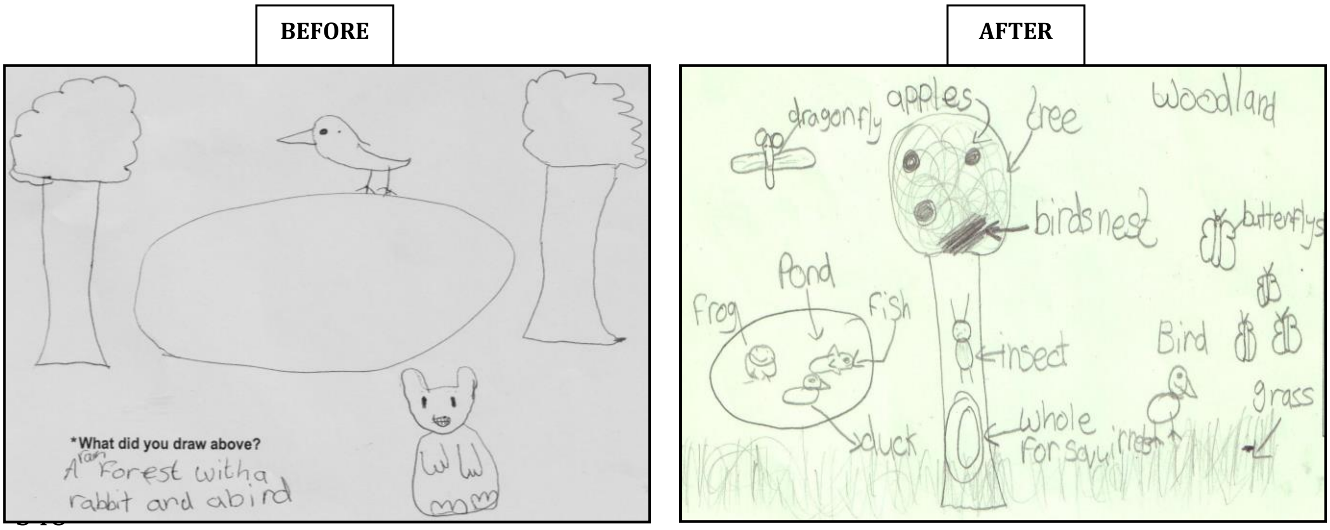
Figures

Figure 1: Greater elaboration, labelling post-visit evincing positive change (female, age 9)



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[i] http://www.eaza.net/activities/Pages/Activities.aspx
[ii] ‘Evaluation of the effectiveness of zoos in meeting conservation and education objectives’ in *The Welfare State: Measuring animal welfare in the UK 2006* (published by the RSPCA).
[iii] ‘Evaluation of the effectiveness of zoos in meeting conservation and education objectives’ in *The Welfare State: Measuring animal welfare in the UK 2006* (published by the RSPCA).
[iv]http://www.biaza.org.uk/resources/library/images/Part%202%20Apr%202009%20(2).pdf

[v] 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).

[vi] It is important to note that this aggregate increase in conservation-related thoughts does not mean that 34% of individuals evinced an increase, as each individual offered multiple thoughts. However, it is one indicator of positive change at the aggregate level.

[vii] Although the fact that unguided visits with teachers under-performed against the visits including a zoo educator would suggest this is not the case. Moreover, subsequent qualitative research at London Zoo indicated that teachers were playing a net negative role in pupils learning experience during unguided visits.